Shaping Oklahoma's renewable energy future

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The Central Philosophy

The important issues surrounding our energy supply are well known. In 2007, the U.S. spent over $300 billion on energy imports. Our dependence on foreign sources for energy is expensive, and makes us extremely vulnerable. As world-wide energy demand continues to increase, the immediacy of the problem becomes more and more apparent.

Our vision of the future intersection of energy and agriculture involves a decentralized energy production system.

The goal set forth by the 25 x '25 National Steering Committee is to be able to replace 25% of our energy consumption with renewable forms of energy. If new forms of energy generation are modeled after traditional energy production, economics will suggest very large scale plants. According to conventional thinking, the most efficient means of producing the amount of renewable energy necessary to approach this goal will be to build huge renewable energy plants. These massive plants, in turn, will require tremendous feedstock supplies, place a huge toll on local water utilities, and concomitantly produce huge amounts of byproducts and wastes, all in a single location. Traditional economics suggest that bigger is better; but this may not be the case for all forms of renewable energy.

Our vision of the future intersection of energy and agriculture involves a *decentralized energy production system*. The decentralized system would consist of dispersed energy generation plants, with potentially a different technology/feedstock combination in every region of the country. Decentralization offers numerous benefits. The advantages are more than just economic; there are social and ecological advantages to the decentralized system as well. The distributed nature of such a system provides:

- Regionally optimal technology selection
- Reduced feedstock supply risk
- Reduced waste/byproduct utilization issues
- Reduced transportation costs
- Reduced burden on local utilities
- Reduced vulnerability to intentional sabotage
- Increased rural economic development

Regionally Optimal Technology Selection

As new technologies are developed and become available, all options should be evaluated on a regional basis to determine which type(s) of renewable system make the most sense. Rather than attempting to pick a single winning technology and force it into every locality around the country, this vision involves matching a region to the appropriate feedstocks and resources, and generating a local solution for the fulfillment of energy needs. As a result, renewable energy may take a different shape in every region of the country. A decentralized system allows this flexibility in technology development.

Reduced Feedstock Supply Risk

New energy systems will require new feedstocks. With decentralization comes diversification of feedstocks. We have seen, and continue to see, the implications of a single feedstock being used to support an entire new industry. Considering the staggeringly large amount of energy that this country expends, the required amounts of feedstocks to replace 25% of that energy demand are also staggeringly large. The supply logistics and risks associated with fueling huge energy production systems becomes very cumbersome, particularly for the low density feedstocks that will potentially be used in agriculturally-based energy systems. Decentralized processing systems greatly reduce problems associated with moving massive amounts of feedstock to a central location.

Renewable energy may take a different shape in every region of the country.

Reduced Byproduct Utilization Issues

As with any processing facility, simultaneous production of byproducts and/or waste products is also a serious consideration. The larger the facility, the larger the waste generation, and the higher the level of difficulty in making use of that waste stream. Utilization of byproducts and/or waste products is simplified in a decentralized system, as many will find local uses.

Reduced Transportation Costs

Transportation costs are a significant factor in the economic outcome of many renewable energy ventures. A reduction in transportation costs is a huge advantage in a decentralized system. Transportation costs are reduced three-fold: in the feedstock supply chain, in the distribution of the final product, and in the dispersal of the waste products.

Increased Rural Economic Development

The decentralized energy system also provides important potential economic benefits to rural communities. Dispersed energy production means dispersed monetary gains, particularly into local economies. Agricultural producers have historically been underpaid for their products. If agriculture is to play a significant role in the future of renewable energy, there must be a significant benefit to agriculture and to rural America. Economic opportunities for agricultural producers are greatly enhanced in the decentralized system.

Reduced Vulnerability to Sabotage

The distributed nature of such a system also protects us against potential attacks on our energy supply. The dependence of our entire economic engine on energy makes us extremely vulnerable in this area. The more that we can disperse our energy supplies, the more insulated we are from such an attack.

If agriculture is going to help share the responsibility of energy production, it must be a distributed load.

Reduced Burden on Local Utilities

As new industries are introduced into local communities, the burden on local utilities can be significant. Large water supplies may be required for processing, as well as increased wastewater treatment capacity. A decentralized energy industry provides a better means to distribute the load, and reduce the impact on local municipalities.

Intersection of Energy and Agriculture

In short, our vision of the future intersection of energy and agriculture is one of many crossroads; it is not a single highway leading to a single destination. Our energy demand is astounding, and the task to replace significant amounts of that energy with renewables is a daunting one. In order to meet that demand, all potential sources of energy must be pursued. If agriculture is going to help share the responsibility of energy production, it must be a distributed load.

Land grant institutions, such as OSU, have a tremendous opportunity to help spur and shape the development of renewable energy technology through cutting-edge research and quality education of students, industries, and the general public. In addition, it is OSU's intention to develop a set of tools that could aid communities in evaluating their options regarding renewable energy development. These decision-making tools would then be used by a resource team consisting of a wide range of expertise to help guide communities in evaluating development options while balancing economic, social, and environmental needs within a given locality.

OSU's History in Renewable Energy

Oklahoma State University has a strong history of renewable energy research and education. Its involvement has included major efforts in feedstock development, conversion technologies, and in outreach and extension programs. In the early 1990s, OSU was identified as one of the key institutions participating in U.S. Department of Energy's Biofuels Development Program with switchgrass being the primary feedstock of interest. Even though DOE's program was discontinued, OSU's program continued, becoming well-recognized internationally.

About a decade ago, a multi-institutional team of scientists and engineers led by OSU embarked on a research program concentrating on the conversion of low-cost, underutilized feedstocks to ethanol utilizing a gasification-syngas fermentation process. The unique microorganisms used in this process have been licensed to a new company, Coskata, Inc.

(www.coskata.com). This company, having recently announced a partnership with General Motors, intends to construct a pilot plant later this year and its first commercial facility by 2011.

The Oklahoma Cooperative Extension Service (OCES), administered through OSU, has a long history in providing fact-based information to a broad cross-section of Oklahomans. In recent years, the interest in renewable energy has resulted in many opportunities for extension professionals to educate the agricultural community on the world energy situation, the status of selected conversion technologies, and what farmers should consider before producing renewable energy crops. OCES's programs extend beyond the farmer/rancher. For example, in 2004 OCES released a CD entitled "Alternative Energy" which was distributed to agricultural educators throughout all secondary education schools in Oklahoma.

OSU also accepted an invitation to become one of five Centers as part of the Sun Grant Initiative (SGI). The SGI was authorized in 2004 as an amendment to the Farm Bill to harness the capacities of all land grant universities to conduct research and educational programs that emphasize agriculture-based renewable energy and products.

OSU has a strong history of renewable energy research and education.

Both OSU and the state of Oklahoma have demonstrated a strong commitment to the support and development of renewable energy programs. The state has recently initiated the Oklahoma Bioenergy Center (OBC), providing $10M per year to three different institutions, one being OSU, for bioenergy research and development. This virtual center emphasizes collaborations among the three institutions to address the critical issues to bring renewable energy industries to Oklahoma. A holistic approach is being taken involving the entire value chain from feedstock to liquid fuel. Project areas are feedstock development; feedstock production; harvesting, handing and storage logistics; and conversion technologies. The primary emphasis is cellulosic ethanol; however, other projects include biodiesel and direct fermentation of sweet sorghum juice.

As further evidence of the state's commitment to renewables, the Oklahoma legislature has provided $10 million in special appropriations toward the development of the Institute for Agricultural Biosciences in Ardmore. This Institute will be part of OSU's statewide Oklahoma Agricultural Experiment Station system. One of the Institute's highest priorities will be the development of research programs in support of biofuels.

OSU's commitment to bring renewable energy to the forefront has been exemplified through a number of actions. Support has been provided for strategic faculty hires in areas such as plant sciences, biological engineering, molecular biology, and energy education, as well as the construction of a new bioenergy laboratory.

OSU's Role in Key Transformational Processes

As agriculture and energy intersect, the transformational process will involve a change in mindset. Renewable energy development today often begins with asking the question 'Where should I build the next 100 million gallon corn ethanol plant?' A system of that size and that specific technology may or may not be the right answer for a given geographical area. Instead, developers should begin at a given location, and then ask questions such as 'What are the biggest opportunities for energy generation in this region? What feedstocks have the most potential? What infrastructure exists? What are the biggest environmental considerations?' We intend to provide the necessary decision-making tools and expertise to help answer those key questions.

With the decentralized philosophy in mind, it has been our goal to continually work to develop and evaluate many different renewable energy technologies. It is our intention to strengthen OSU's leadership role in renewable energy development and implementation. We have, and will continue to, foster key collaborations with educational institutions, federal laboratories, agribusinesses, and state and federal decision makers.

The renewable energy landscape will come in many different colors, shapes, and sizes, as depicted in the following figure. In the case of Oklahoma, we could potentially generate energy from wind in the west, forests in the southeast, and perennial grasses and sorghums in other regions. We, as a land grant university, have both the opportunity and the challenge of helping to shape that new energy landscape, using all three of our core missions: Research, Education, and Extension.

Research is a vital component to renewable energy development. We will continue to expand our research efforts in the areas of enhancing productivity of potential feedstocks, improving conversion technologies, and optimizing the value of co-products and byproducts. Additionally, research will continue on the effects of shifting agricultural lands to energy producing crops. The most notable of these effects is environmental – land, water and air. Research will also be expanded to address key issues associated with the addition of a

biorefinery to the local community. These issues include infrastructure needs, labor supply, transportation, water supply availability, expanded wastewater treatment loads, economics, community development, as well as localized environmental impacts.

Extension roles will continue to expand, addressing the needs of existing as well as new clientele bases. Agribusinesses will need to be educated on the opportunities and limitations of shifting from the existing agriculture commodity basis to energy producing crops. Outreach will include all aspects of production, from land preparation to crop harvest and storage management plus economics. As the number of biorefineries grows, an increased emphasis will be placed on process and business management to help maintain or improve the industry's sustainability.

An often overlooked but critical clientele is the general public. To advance renewable energy, land grant universities must provide fact-based information to the masses to help educate them regarding new energy choices and in some cases to minimize the potentially misleading or inaccurate information from special interest groups.

One of the key missions of Oklahoma State University is to educate the next generation of engineers and scientists in renewable resource utilization. The overall educational program goal is to provide education at the university, pre-college, and industrial levels by integrating knowledge of renewable energy into both existing and new programs. Educational programs are designed to significantly impact graduate and undergraduate students, pre-college students and teachers, industrial collaborators, and the general public. As advances are made in science and technology related to renewable energy development, it is the goal of the university to disseminate that information for the enhancement of educational programs around the country.

An often overlooked but critical clientele is the general public.

In order to fully utilize the University's resources, it is critical to extend the renewable energy knowledge base to the community. Our vision is to be able to reach out to local leaders and serve as a resource team to help them evaluate their options regarding renewable energy generation. The goal is to develop a set of decision-making tools for local evaluation. The tools may include economic analysis tools, local utility infrastructure evaluation, and predictive tools for land-use changes. Some additional issues that would be addressed include environmental impacts, social considerations, and sustainability issues.

In developing these tools and expertise, we intend to take advantage of all available resources. Some of the more notable resources available in Oklahoma are:

- Detailed GIS maps of the biomass feedstock resource base
- Oklahoma Mesonet, a world-class network of environmental monitoring stations
- New Product Development Center, a partnership of university and state agencies, for bringing engineering expertise to rural manufacturers
- Extensive energy infrastructure

The resource teams created will attempt to better understand the most important issues related to the various renewable energy alternatives being considered for a given geographical location. Some of the more relevant issues may include the critical relationship between feedstock availability and conversion technology, and how the total system impacts economics and local infrastructure. Teams will then utilize all available tools to connect the economic, social, and environmental issues, and help guide local leaders in their endeavor to make renewable energy a reality for their community.

Summary

Renewable energy development is critical for the long term stability of our economy. Agriculture will play a major role in that development, and the intersection of energy and agriculture will bring about many changes. We strongly believe that a decentralized approach to renewable energy is the most beneficial way to approach this change. Decentralization offers numerous benefits. It reduces feedstock supply risk; it reduces transportation costs, including feedstock transportation, final product transportation and byproduct/waste transportation; it reduces the burden on local utilities, including water supplies and wastewater treatment; it provides broad-based rural economic development; it reduces the risk of intentional sabotage to our energy infrastructure. Most importantly, the decentralized energy model allows the development of the renewable energy technology which is most suitable for a given region. Land grant universities must take an active role in shaping the renewable energy landscape of the future. Oklahoma State University has demonstrated a clear commitment to renewable energy. Our vision is utilize all available resources to develop the necessary tools and the relevant expertise to help guide communities in their decisions involving renewable energy development while balancing economic, social, and environmental needs.

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