Summary of the April Forum for the Center for BioEnergy Sustainability

April 16, 2009

In his introduction of the speakers, Paul Leiby noted that a life-cycle systems approach to sustainability can be used to guide R&D goals. It is difficult to state exactly what sustainability is, but we know what is not sustainable, and we have clear evidence that humanity is not living sustainably. Sustainability is often considered to be a generally applicable attribute, leading to the question: Does sustainability include everything? If it does, it risks being about nothing. Criteria are needed for what is to be measured to define and assess sustainability.

Rekha Pillai and Mike Hilliard of ORNL's Decision Engineering Group initiated a broadly participative discussion on an Integrated, Decision Engineering Framework for Understanding BioEnergy Sustainability. Some of the points brought up in that discussion were:

To take a systems approach, one needs to identify and discuss key components of the focus system, develop graphs that show the interactions of those key components, analyze them, envision potential scenarios and their end states, and consider major questions for this system. For assessing bioenergy sustainability, expertises in biology, engineering, computation, mathematics, measurement science, etc. need to be brought together. All of that expertise needs to be converted into a modeling language to allow the development of an approach to systematic change, the assessment of options and impacts, and the achievement of a sustainable future.

Sustainability boils down to conserving and managing scarce resources: land, air, water, ecosystems, the biological and human environment, and nonrenewable energy. Species diversity and other attributes should be added to this list. For bioenergy sustainability, soil erosion, greenhouse gas emissions, and water quality are the three major concerns about resources being affected by bioenergy use, and these impacts need to be evaluated and quantified.

The components of sustainability are social, economic, and environmental goals: Environmental goals include land, air, and water quality; climate change; biodiversity; and productivity. Economic goals include integrated resource management and planning, supply-demand economics, and the life-cycle cost. And social goals include socio-economic well-being and resiliency.

Temporal and spatial scales influence what is observed and measured. Also, society is dynamic, and sustainability is a path through the varying states of social history.

It needs to be understood that both human and natural *activities* lead to *biogeochemical transformations* that lead to *climate change*. Here, *activities* include weather, volcanic eruptions, land use, industry, transportation, and habitation. *Biogeochemical transformations* include the atmospheric concentrations of greenhouse gases and aerosols, and water quality and quantity. *Climate change* includes the intensity and spatial distribution of precipitation and temperature rise at the regional and global scales.

Governmental powers and institutions that could effect such changes also need to be included in the equation. However, the economy and the environment are multi-objective phenomena and are therefore difficult to specify and measure. Measures of social impacts are not well quantified or standardized.

Substitutability can be represented in several forms: economic (cost) or change (what do you give up?). An integrated framework could be represented as an input-output table, and one could make it as inclusive as desired. Certain components could be considered as controlling variables: technology R&D, policy changes, and process changes. A conceptual framework is needed to allow the determination of what should be measured and modified and how they should be measured and modified.

The world needs to start thinking at a global scale because of the global nature of climate, economies, and human society; but decision makers also need information at local and regional scales because (1) scale makes a difference and (2) the global solution is an integrative culmination of all the local and regional effects.

Sustainability implies a long time frame in contrast to the typical political process time frame.

Taking the technology component of the framework, one can build an architecture for the biofuel supply chain that involves choices in crops; preprocessing processes; storage facilities (location, size, and prices); refineries; and demand (suppliers, transport modes, and quantities). The outputs of this supply-chain model (resource usage, waste products, etc.) provide the major inputs to the earth-system models and to social-impact analysis.

Elements that need to be discussed about such a framework include:

- A global, not just a United States, view needs to be taken.
- Time scales need to be reconciled.
- Societal changes and population growth may overwhelm technological change and growth.
- A number of architectures are possible and need to be considered.

A framework needs to account for measurements, policies, technologies, and processes. CBES should map ORNL’s resources to pull them together to see what we know, what we don’t know, and what we need to know. Next steps might include forming an integrated team to flesh out the details (a path forward, starting to understand global sustainability impacts of bioenergy activities, etc.) so it can be seen what needs to be focused on across the Laboratory.

What if CBES held a series of two-hour workshops (with writing assignments in between) to develop an overarching perspective of the bioenergy system, including temporal and spatial scales and issues to be addressed and phenomena to be included at each scale?

At least three potential approaches to this perspective are possible:

1. An integration of expertises (business as usual);
2. A high-level, very general, global representation (the approach adopted by David Reister); and
3. A highly detailed, massively parallel model of interactive economic, environmental, and social considerations (following the Manhattan Project approach).

It might be good if all three types of perspective were developed because each could inform (and thereby improve) the others.

Presentation Slides