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## Talk by Dr. A.L. Bement, Jr. on Energy Sustainability

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Talk by A.L. Bement, Jr. on Energy Sustainability  
Before the Purdue Energy Club  
Tuesday, November 9<sup>th</sup>, 6-7 pm  
Krannert G018

The following remarks were invited by Purdue's Energy Club based on questions prepared by the club students. The meeting took place on November 9, 2010 and was well attended. The responses to the questions elicited were many well posed follow-up questions and comments.

**Q. Where does energy sustainability stand now (policies in place and driving factors for energy sustainability)**

**R. Response**

- a. I am assuming a broad definition of energy sustainability, to include energy for transportation, buildings, manufacturing, and energy production. I will exclude energy exports, since imports far overshadow exports.
- b. The Obama Administration's priorities place energy sustainability at a high level because it is a top driver of our economy. Energy is a major component of complex-coupled global policy issues. For example, one cannot have sustainable energy without sustainability food production, a sustainable environment and ecology, and a sustainable economy. Energy also is coupled with other complex systems such as security, health, and quality of life. In an information economy, energy is a critical determining factor. The Administration recognizes this and has set the following priorities as part of its economic agenda:
  - Provide short term relief to American families (cost of energy)
  - Eliminate current oil imports from the Middle East and Venezuela within 10 years
  - Create millions of green jobs
  - Reduce greenhouse gas emissions by 80% by 2050
  1. Each one of these goals is dependent on energy
  2. As part of this plan the Administration places a high priority on educating more American students in science, engineering and entrepreneurship for careers related to clean energy
- c. Also much of the policy development in the United States is sub-national, with many states providing leadership in energy policies. For example:
  1. Over 400 cities in 50 states, representing approximately 20% of the U.S. population, have adopted the Kyoto protocol.
  2. The U.S. Department of Energy and Environmental Protection Agency have issued a national action plan to state policy makers proposing a 50% reduction in energy demand by 2020 and a reduction in greenhouse gas emissions equivalent to the emissions from 90 million vehicles. There are now regional coalitions in place to promote aggressive initiatives in response to this proposition.
  3. One of the more active states is the State of California, which if a sovereign nation, would be the world's 7<sup>th</sup> largest economy and the 12<sup>th</sup> largest emitter of greenhouse gases.
  4. The governor of California has called for the:

- Greater use of alternative fuels
  - The installation of more green energy
  - The creation of green jobs
  - The reduction of tailpipe emissions from automobiles
  - Promotion of hydrogen as an alternative fuel
  - Tax exemptions for auto makers to produce zero-emission cars
  - The installation of 3,000 megawatts of solar energy systems on homes and buildings
5. Because of high unemployment and economic stresses in California it is doubtful that the legislature will accommodate all of the governor's requests. However, with the change in the governorship California will be a state to watch in the coming months.
6. Energy sustainability is also critical for food security and sustainability. About 40% of energy use in the U.S. is used for food production and processing. Water and soil sustainability are also critical to these needs, and will be determining factors in the production and conversion of biofuels.

**Q. Is energy sustainability necessary? If so, how soon do we need to become sustainable?**

**R. Response**

- a. Energy sustainability is essential for the U.S. to maintain worldwide competitiveness. Productive capacity for manufactured products and high value-added services has taken ascendancy in the information age over the production of natural commodities. In today's economy, however, the greatest annual growth in GDP is occurring in the developing world partly because of the rising world demand for commodities, especially those in limited supply, and because of the growth of manufacturing in these countries. In contrast, the GDP growth in the developed world is stagnating because of shifts in global competitiveness due to labor cost disparities. This has brought about the intentional weakening of the dollar in the United States to retain and create jobs through exports. Energy is a critical offset to high labor rates in order for the U.S. to remain competitive.
- b. Much of our low cost energy is supplied by hydro power, which unfortunately has reached saturation. Another category of relatively, low-cost production is from fossil-fired generation plants. About twenty-percent comes from nuclear energy. There is political interest in retaining fossil-derived energy, since the U.S. is the "Saudi Arabia" of coal, especially coal of high energy content. However, to retain coal- and natural gas-fired plants and reduce our carbon footprint we will require greater conversion efficiencies through co-generation and the capture, sequestering, or conversion of emitted carbon dioxide. These measures will substantially raise the cost of coal-derived energy and will change the comparative advantages relative to natural gas-, nuclear-, solar-, and wind-derived energy.
- c. The role of energy impacts on our total economy can be measured by the nation's contribution to the emission of greenhouse gases. When measured on a per capita basis, the U.S. and China rank as the world's largest emitters of greenhouse gases. However, when measured on the basis of GDP, the United States ranks relatively low, comparable with the European Union and somewhat above Japan, which is the lowest in the world. On this basis, China would still rank number one.

**Q. What are future policies and practices that could be implemented to get us to become sustainable?**

**R. Response**

a. *As a measure of responding to this need the DOE Office of Energy Efficiency and Renewable Energy is developing a family of projects to define pathways to reduce GHG emissions by 80% by 2050. The emphasis has evolved away from the traditional approach of looking at energy efficiency by industrial sector to explore GHG emissions at the unit production level. It applies three distinct levers: carbon intensity, energy intensity and use intensity. From previous experience work on reducing energy intensity alone cannot achieve the desired levels of reductions. Strategies for de-carbonizing energy inputs are relatively straightforward. What is really challenging in addressing use intensity without reducing utility and productivity.\**

*\*paraphrased from personal communications with Thomas Schneider, NREL*

- b. Greater emphasis is needed in the smart use of energy. This will require greater emphasis on developing a smart grid and smart metering and changes in rate policies and incentives to shift energy use to off-peak times of the day and flatten the 24-hour demand cycle. Currently, most rates are flat because of the inability to track energy use throughout the day. Smart metering will enable this.
- c. Current strategies of producing bio-fuels are not sustainable. Work by Professor Tyner in the Agricultural Economics Department shows that the net energy derived from corn-based ethanol is not economical sustainable because of the amount of energy consumed in planting, harvesting, and transporting grains to ethanol producers. Little research has been done to analyze water and soil sustainability in shifting national production from carbon-based to bio-based fuel production. Fortunately, Purdue researchers are paying attention to third and fourth generation bio-fuel conversion that has many advantages:
- i. They focus on bio-conversion to produce butanol or gasoline and other hydrocarbon derivatives from cellulose and lignin that can provide greater economic sustainability and reduce competition with food production.
  - ii. They allow the use of current engine technologies, storage and pipeline infrastructures, and refinery capacity, greatly reducing the demand for new, massive capital formation to meet national goals for biofuels.
  - iii. The increased emphasis on green, smarter, LEED buildings to reduce energy consumption and provide for more effective use of building materials is a national movement that is gaining traction. The extension to the Mechanical Engineering building at Purdue is an example of the use of LEED technologies. Unfortunately, these practices are not as applicable to improving energy use in existing building and housing stocks, and may require greater financial incentives to apply.

**Q. What role do specific alternative energies play in the future energy portfolio. Is sustainable energy economical? How will it affect our future economy?**

**R. Response**

- a. Green, renewable energy is already a major component of energy

generation in the U.S. The U.S. is the world's largest producer of nuclear energy and leads the world in installed wind power. It also has the world's largest solar generating station, and remains the world's leader in installed geothermal capacity. Most cars on the road today run on blends of up to 10% ethanol, and there are already more than 8 million E-85-compatible vehicles on the roads designed to run on blends ranging to 85% ethanol.

- b. Solar and wind energy have high interest. Both are relatively expensive with wind energy being the most viable in most parts of the country. Both rely on energy storage to be sustainable. There is scarce water storage in the U.S. and battery, capacitors and fuel cells are very expensive. Consequently, these forms of renewable energy depend on large base-load fossil and nuclear power plants to achieve uninterrupted supply.
- c. Nuclear energy is undergoing resurgence in the U.S. with about twelve plants already
- d. licensed and about six in various stages of final design, financing, and early construction. Unfortunately, most major primary circuit components such as pressure vessels, pumps and steam generators are manufactured overseas, and the waiting lines for production and delivery are very long.
- e. No one energy supply by itself will be dominant in any region of the country, since they are interdependent in meeting base, intermediate, and peaking load requirements. However, each form of energy can make an important contribution to future energy sustainability. Future efforts to reduce energy use through material substitution, improved insulation, passive heating and cooling, and distributed energy will continue to have high priority.

**Q. Will energy be a global policy issue or is it something that is internal to each nation?**

**R. Response**

- a. Energy is a major component of sustainable development and has high priority in every part of the world; however, the strategies and purposes for achieving it vary widely. Some nation's see sustainable energy as a major strategy for reducing the world's carbon footprint. Others see it as a means of economic growth and achieving a better standard of living. Others see it as a means of sustaining international competitiveness.
- b. Some nations are also endowed with large amounts of renewable energy. For example, New Zealand, Norway and Columbia generate a large fraction of their total energy supply through hydro power. There are many nations; however that lack natural sources of energy supply. Others have some coal but it has low specific BTU content (such as Russia). Russia is rich in oil and natural gas, and is a major supplier of natural gas to European nations.
- c. Therefore, strategies for increasing energy supply and sustaining it will be vastly different among the nations of the world. Only a relatively small number of countries can economically afford to achieve carbon neutrality in the coming two or three decades. Many lack the technological infrastructure to expand their electrical generating and distribution capacity. That is not the case for the U.S., which can become an important technology provider for most of the developing world in competition with Europe, Japan, Korea, and increasingly China.

**Q. How is GPRI involved in energy and energy policy?**

## R. Response

- a. GPRI is a center among centers at Purdue University. There are about forty centers of excellence affiliated with GPRI. The role of GPRI is to incentivize interdisciplinary research in complex-coupled policy issues. We have already completed one round of competitive awards to address such issues, some of which address energy issues. We have initiated a second-round solicitation in food security, which will address sustainability issues including energy. This is a cross-campus initiative coupling efforts of several colleges with those in the College of Agriculture.
- b. GPRI has been a strong proponent of third and fourth generation bio-fuels research, in which Purdue is already a leader. There are already small business enterprises in the renewable energy market that are based on faculty-led research. These include:
  - i. Green Tech America, which produces genetically-modified yeast that substantially increases ethanol yields from cellulose by being able to ferment dextrose and xylose in addition to glucose to increase ethanol yield. This company was founded by Professor Ho.
  - ii. Sorion, Inc., which produces sensors and control systems that optimize wind turbine performance under changing wind conditions. This company was founded by Professor Doug Adams,
  - iii. Swift Enterprises, which synthesizes aviation “drop-in” fuels from acetone distilled from biomass. This company was founded by Professor John Rusek, and
  - iv. ALGaCo, which produces aluminum-gallium alloys that, when reacted with either fresh or salt water, can produce hydrogen on demand to power fuel cells. This company was founded by Professor Jerry Woodall.
- c. GPRI also promotes efforts of the faculty to inform public policy by co-sponsoring seminars and posting their policy-related publications on our website. We will soon be announcing an external advisory committee of top national and international leaders who will advise Purdue on its global outreach and policy initiatives.

I hope these remarks are responsive to your questions. I would be happy to respond to your questions in the time remaining.