New Developments in Sustainable Technology

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Sustainable technology is making significant advances across several industries -- and that's encouraging news for a nation that is largely dependent upon countries outside of the United States for energy. So exactly what kind of sustainable technology is out there?

Here is what several experts have to say:

Alexander A. Koukoulas, Ph.D., ANL Consultants, LLC, is a consultant for the pulp and paper and biofuels industries. He provided these useful insights into the biofuels arena, and how and why it has become increasingly important.

Biofuels: A Promising New Energy Source

"As the global population grows, so does the need for more energy sources," said Koukoulas. "To sustain the demand, without stressing our planet further, new solutions, that are more environmentally friendly, are needed."

According to Koukoulas, accelerating this need for alternative energy sources is a perfect storm with all the conditions to give it a sense of urgency: (i) escalating oil costs, (ii) legislation banning the use of methyl-tertbutylether (MTBE) in gasoline, (iii) geo-political forces that are putting US oil supplies at risk, (iv) increasing evidence that androgenic carbon dioxide contributes to global warming, and (v) growing consumer demand for environmentally-friendly energy solution.

Koukoulas noted that one of the major solutions emerging is bio-based fuels, that is, fuels made from plant matter such as corn and other agricultural products and by-products. The United States is currently producing about four billion gallons of ethanol per year, which represents about three percent of our total gasoline consumption, according to Koukoulas.

"Over the next six years, ethanol production is expected to double to about eight billion gallons," said Koukoulas. "While this represents progress, it unfortunately means that it will be still be a small fraction of total liquid fuel consumed in the United States. Corn is the predominant feedstock used to make ethanol in the United States."

According to Koukoulas, currently, about 12 percent of United States corn production is used to produce ethanol. In this process, cornstarch is enzymatically converted to sugar, which is then converted to ethanol by yeast, he explained.

Koukoulas noted that this is an ancient process that has been improved upon by both incremental process improvements and biotechnical advances, such as high-efficiency enzymes. While corn-to-ethanol is definitely part of the solution, it cannot be the total answer to supplementing renewal energy sources, explained Koukoulas.

"Even if all United States corn production is diverted into ethanol production, it would only provide about 20 percent of United States liquid fuel needs," said Koukoulas. "Moreover, the use of corn for energy has triggered an on-going world debate that questions whether a food source should be used to create fuel rather than feeding its hungry."

In addition, the overall efficiency for converting corn-to-ethanol fuel is not optimal, with too much energy expended in the production process to consider it as a major energy source, according to Koukoulas.

The United States could produce a significant portion of its liquid transportation fuels from renewable resources, such as agricultural wastes and forest residues. The incentives are in place. But it will take a combination of both new technologies and commercial alliances to make this a reality.

"Clearly, one approach in overcoming the limitations of grain-derived biomass feedstocks, such as corn, is cellulosic ethanol, which uses non-food sources of biomass, such as agricultural wastes and forest-derived biomass to produce ethanol," said Koukoulas. "It has been estimated that there is more than 1.4 billion dry tons per year of bio-material feedstocks available in the United States that could be used in the production of cellulosic bio-fuels."

Koukoulas noted that in fact, if all of this biomass is converted to liquid fuels, it could supply up to 30 percent of demand for liquid transportation fuels. Unfortunately, the technologies needed to produce cellulosic ethanol are either unavailable or unproven on a commercial scale, according to Koukoulas.

The challenge, Koukoulas pointed out, will be in developing the technologies and manufacturing practices that can utilize this material and produce bio-energy in a cost-competitive way in relation to conventional energy sources.

"Cellulose is readily available in the form of wood and agricultural wastes, such as corn stover and bagasse," said Koukoulas. "However, these materials are made from two natural products: cellulose and lignin. Cellulose is a large-chain carbohydrate, similar in structure to starch. Lignin is a complex polymeric structure made from predominantly coniferyl, sinapyl and coumaryl alcohol derivatives."

In fact, lignin is the largest natural occurring polymer, according to Koukoulas. But its complexity provides a serious hurdle to its use, added Koukoulas. In most cases, such as in the pulp and paper industry, the most economic end-use for lignin is to burn it in steam boilers to generate power, he added.

Koukoulas admitted that the promise of "cellulosic ethanol" is not yet a commercial reality. While there are pilot scale projects that can convert woody-materials to liquid fuels via acid hydrolysis, there has been no large-scale demonstration of this technology yet, he noted.

Further R&D will be required to overcome technical hurdles facing large-scale cellulosic ethanol production, according to Koukoulas. Promising new technologies, however, are on the horizon and are expected to emerge in the near future, he noted.

"Clearly, more R&D will be needed to overcome the technical challenges in producing cellulosic ethanol," said Koukoulas. "To this end, the United States government, through the Department of Energy, recently allocated up to $80 million to assist in the building of "biorefineries" to convert non-food biomass into liquid fuel and power."

The goal of this effort is to demonstrate a commercial process for converting cellulosic biomass into liquid fuels within three to four years, according to Koukoulas. By addressing the current technical and commercial barriers facing cellulosic ethanol production addressed, it is possible that we can supply 30 percent of the liquid fuels consumed by the United States from a renewal resource -- cellulose, he added.

"Within a few years, we should know what technologies will needed to produce cellulosic ethanol within the context of a commercially viable process," said Koukoulas. "It is exciting to be a part of this biofuels revolution and to see environmentally friendly process technologies and renewable resources as a mean of addressing our nation's energy needs."

Curtis J. Sparks, P.E. is president of North American Wetland Engineering (NAWE) of White Bear Lake, Minnesota and EcoCheck. NAWE is a pioneer in the development of engineered wetlands for wastewater treatment and remediation of contaminated sites. They are recognized worldwide for their contributions to environmental preservation and restoration.

Using Ecological Practices to Sustain the Environment and Development

"Sustainable development through sustainable designs for water and wastewater infrastructure is a means of accomplishing balance," said Sparks. "Sustainable means that when removing something from a system it has to be replaced at the same rate. If it is not replaced, balance is not achieved."

According to Sparks, removing trees from the forest faster than they can grow and replace themselves is not sustainable. Words like consumption, harvesting, mining and withdrawal represent sustainability issues, Sparks added.

But how do we meet human needs of food, water, housing without exhausting or overloading the key resources upon which our natural systems depend?

"The water we mine (extract) from the earth and flush to our wastewater treatment systems, which is then dumped into the river is not a sustainable process," said Sparks. "The water dumped to the river is adding more pollutants to our already impaired waters and there is no water being returned to our underground aquifers. Each home in a development that goes on the sewer line exhausts more of our water resources."

We now have ways to manage our wastewater from residential developments in a way that is sustainable, according to Sparks. We can extract groundwater, consume it, treat the waste products and place them on the land for growing things, explained Sparks. Then we can recycle that clean water back into the soil -- thus creating a sustainable system, he added.

"Traditional wastewater systems sometimes called "septic systems" require lots of land for soil to treat wastewater," noted Sparks. "Often as a result of this process, the soil eventually plugs. This technology has lead to the "Large Lot" zoning that is consuming land across the country at an enormous rate."

Recognizing that housing now consumes more land than any other human use, we need to be more judicious by reducing per/house consumption of land while conserving as much of the land for other uses, according to Sparks.

He noted that Pratt Homes has proposed a sustainable housing design project in an ecologically minded community called Afton, Minnesota. Current large lot development in Afton is dotting the landscape with just a few homes and consuming land at enormous rates, according to Sparks. The neighboring Woodbury represents maximum development on the big pipe sewer system discharging to the Mississippi River, he added.

"The vision of Len Pratt of Pratt Homes is for a cluster development of smaller lots on former pastureland," said Sparks. "He would preserve the forested areas, wetlands and drainage ways and use a wastewater system that purifies the water before returning it to the soil and back into the groundwater system."

This is sustainable infrastructure, according to Sparks. Even more desirable is his plan for using constructed wetlands for wastewater treatment using natural biodegradation processes friendly to the environment, noted Sparks.

In another project, Dorsey Creek Ranch in Wyoming will take groundwater for the 138-home development and again use constructed wetlands to purify the water, according to Sparks. Dip irrigation technology common to ranchers in the west will efficiently return this water back into the system to grow crops from an organic farm, he explained.

"There are numerous other home developments that utilize sustainable infrastructure to develop responsibly that can be used as examples for this article," said Sparks. "The first key is to understand the environmentally sound options and their cost effective implementation. This will help builders and developers to enhance their development possibilities and create revenue while also doing what's right for the future."

Converting End-of-Life Electronic Equipment Into News Products and Parts

Xerox Corporation pioneered the practice of converting end-of-life electronic equipment into new products and parts.

"We developed a comprehensive process for taking back end-of-life products from customers in the early 1990s by establishing a remanufacture and parts reuse program that fully supports our waste-free initiative," said Anne Stocum, manager of market support for Xerox's Environment, Health and Safety organization.

The process has saved Xerox hundreds of millions of dollars and prevents millions of pounds of waste from entering landfills each year -- 107 million pounds in 2005 alone, according to Stocum.

By reusing parts, Xerox reduces the amount of raw material and energy needed to manufacture brand new parts, she noted. Energy savings from parts reuse in 2005 is estimated at nine million therms (280,000 megawatt hours), according to Stocum.

Stocum explained that through the years, the company has evolved a comprehensive product lifecycle strategy. It maximizes the end-of-life potential of products and components from the start by incorporating reuse considerations into the design process, according to Stocum.

"Machines are designed for easy disassembly and contain fewer parts," said Stocum. "Parts are designed for durability over multiple product life cycles, are easy to reuse or recycle, and are coded with disposition instructions. As a result, equipment returned to Xerox at end-of-life can be remanufactured -- built to as-new specifications, often reusing 70 to 90 percent of machine components by weight while meeting performance specifications for equipment with all new parts."

According to Stocum, some machine frames, for instance, have been out in the field three or four times, returning again and again to be a base for the next-generation of Xerox products.

"By designing product families around modular architectures and a common set of core components, we have further extended our ability to reuse parts," explained Stocum. "These advances offer Xerox multiple options for giving new life to old equipment. A returned machine can be rebuilt as the same model through remanufacture, converted to a new model within the same product family, or used as a source of parts for next generation models."

Stocum noted that maintaining quality standards is key to the success of this program. All Xerox products, regardless of their reused or recycled part content, meet the same specifications for performance, appearance, quality and reliability. As a result, products with reused or recycled parts carry the same Xerox guarantees, warranties and service agreements as Xerox equipment made from all new parts, according to Stocum.

Wind Energy Goes Mainstream With Residential Small Wind Generator
A new small residential wind generator from Southwest Windpower will give homeowners a new weapon in the fight against rising electricity costs, according to

Andrew Kruse, co-founder of Southwest Windpower, the world's largest producer of small wind generators (400-3,000 watts).

Kruse noted that Skystream 3.7 is the first fully integrated wind generator designed specifically for the grid-connected residential market. He explained that a combination of new technologies, developed in collaboration with the United States Dept. of Energy's National Renewable Laboratory, resulted in a product that quietly produces electricity for a fraction of the cost of current technologies.

"Skystream's low cost and low profile provide homeowners an affordable energy supplement that's appropriate for installation in many residential areas around the nation," said Kruse. "With no batteries, Skystream 3.7 connects directly to the home to supply power. When the wind is not blowing, the home is powered by the electric utility."

According to Kruse, depending on the local utility, excess electricity can be sold back to the utility or used at a later date. With a typical cost of $8,000-$10,000 to purchase and install, Skystream 3.7 can pay for itself in five to 12 years, he added.

"This payback period will vary and can be much quicker in states with investment rebates," said Kruse. "It's anticipated that Skystream 3.7 will save the average homeowner $500-$800 per year, based on 4,800-6,600 kWh produced per year and a 0.12/kWh cost of electricity. This output would provide 40-90 percent of an average home's energy needs."

Information for this article was provided by Curtis J. Sparks, P.E. is president of North American Wetland Engineering (NAWE) of White Bear Lake, Minnesota and EcoCheck, Alexander A. Koukoulas, Ph.D., ANL Consultants, LLC, a consultant for the pulp and paper and biofuels industries, Anne Stocum, manager of market support for Xerox's Environment, Health and Safety organization, Andrew Kruse, co-founder of Southwest Windpower, and Lara Bain of Porter Novelli.

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