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Press Release

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Trend Report No. 16: Energy Concepts for the Future

China is a fertile ground for biomass

- **Renewable energy laws fuel escalation**
- **Ethanol, biodiesel and renewable plastics are key markets today**
- **New technologies in this field will be highlighted at AchemAsia in Beijing**

By the year 2050 world energy consumption will have doubled. However, the demand for energy and chemicals cannot be met by petroleum and natural gas alone, renewable resources have to be exploited as well. By 2050, only around 50 percent of the world's energy will still originate from petroleum and natural gas, the balance will proceed from coal and, increasingly, from biomass. Biomass as a renewable material is in the focus of interest worldwide both as a chemical feedstock and as biofuel.

New technologies and trends in this field will also be highlighted at the 7th AchemAsia International Exhibition-Congress on Chemical Engineering and Biotechnology from May 14 to 18, 2007, in Beijing. More than 500 exhibitors and 20,000 visitors from 25 countries will have an opportunity to exchange ideas and experience with other professionals from industry and to make new contacts.

Biomass, which includes agricultural crops and residues, municipal solid waste, forestry residues, construction debris and animal wastes, is one of the oldest energy sources known to man. Until recently, its use declined dramatically throughout the industrialized parts of the world, being replaced by coal and petroleum-based feedstocks. In developing nations such as China, biomass still makes up a significant portion of the energy mix, but mostly via direct combustion for heating and cooking. According to SRI Consulting's (SRIC) Biomass Gasification Report, biomass provides more than 30% of China's total energy requirement. As China updates its energy infrastructure, biomass is poised for a larger, and more sophisticated role.

Moving forward, industrialized nations and developing ones, alike, are taking an increased interest in biomass due to renewed focus on energy security and

environmental preservation. As the world's third largest oil importer, after the United States and Japan, China imported a record-high 36.38-million tons of refined oil last year, 15.7% more than in 2005, to fuel an estimated annual economic growth of 10.7%, reports China's official Xinhua news service.

China's motivation for more biomass

The Chinese government has taken several steps to address this escalating demand for oil imports both in the short and long terms. At the top of the list is the new Law on Renewable Energy, which took effect on January 1, 2006, with a stated goal of increasing the use of renewable energy to 10% of the country's electricity consumption by 2010. Meanwhile, China has targeted a 10% ethanol gasoline blend by 2010, which would amount to a biofuel consumption of about 23-million metric tons/yr.

In the longer term, senior Chinese officials have announced goals of reducing the nation's use of refined oil by 10 million tons, or more than 25%, by 2020 through the use of liquid biofuels like ethanol and biodiesel, Xinhua reports. Shi Yanquan, deputy director of the Ministry of Agriculture's department of science, technology and education, says using crops and excrement in rural China to produce biofuels would meet the country's growing energy demands and boost rural economy. Apart from liquid biofuels, the government will focus on developing methane, compressed stalks for burning and oil-rich crops in the next five to ten years, Shi adds. The ministry plans to provide 40 million rural households with access to methane by 2010, more than double the number in 2005.

A fringe benefit of increased biomass use in China is the related environmental advantages that it offers. In comparison to fossil fuels' greenhouse-gas contribution, biomass has a positive carbon-dioxide balance because it is derived from renewable resources. This is an important factor in the context of the upcoming 2008 Olympics in Beijing. China has pledged to stage a "green" Olympics and is expected to use the games to demonstrate the vigor with which it has embraced renewable energy.

China's biomass projects will be funded, at least in part, by the Ministry of Finance, which has decided to increase input in projects involved in developing bioenergy and other alternative energies between 2006 and 2010. The ministry has not elaborated on the investment figures. The key consideration for foreign investors who wish to take advantage of government funds and other development opportunities provided within existing Chinese laws and relevant well-defined regulations is to maintain at least 10% Chinese ownership in its joint ventures. Such is the strategy outlined by Tiger Ethanol International Inc. (Montreal, Quebec) in its recent acquisition of 90% interest in Gallant Energy International Ltd. The company's business model focuses on the development of facilities for the production of renewable ethanol in China.

The routes for biomass

It is necessary to point out that the routes for biomass are vast, both in terms of the beginning feedstocks and the end products. While there are various methods for biomass conversion, the European Biomass Industry Association (EUBIA; Brussels, Belgium; www.eubia.org) groups them into four basic categories: direct combustion, thermochemical conversion processes (including pyrolysis and gasification), biochemical processes (including anaerobic digestion and fermentation, i.e. the route to ethanol) and physicochemical processing (the route to biodiesel). The technology

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of choice depends on the chemical makeup of the particular raw material and downstream product.

Biomass gasification: Biomass gasification is one method to make biomass more compatible with the existing fossil fuels infrastructure, explains SRIC's Biomass Gasification Report. Biomass-derived syngas can be substituted for natural gas or fossil-derived syngas for the production of heat and electricity. It can also be used as a feedstock for the production of hydrogen, chemicals and liquid fuels.

Biomass feedstocks

One of the current challenges in processing biomass is that the same precursors that require the fewest and simplest processing steps, such as monomeric sugars and starches, are also important sources of food because, quite simply, they also break down easily in the human body. Another motivation to diversify feedstock options lies in the world's enormous appetite for fuels and chemicals. "Even if all of the corn and soy being grown in the U.S. right now were used to make biodiesel in its 100% vegetable oil form," says research firm Kline & Co., "it would only satisfy about 15% of the current demand for diesel fuel." Making the situation even grimmer, many other non-food products already rely on corn or soy, for example, as a base component, Kline adds.

Therefore, due to the aspirations for large-scale biomass contribution in the long term, today's midterm research efforts are refocusing on feedstocks that can meaningfully contribute to sustainable energy and chemistry without jeopardizing sustainability of the world's food supply — an especially important issue in developing nations such as China. These options include forest crops, agricultural crop wastes, wood and paper wastes, and energy crops such as *Jatropha Curcas*, a inedible, oil-bearing crop that is common in China and India.

Downstream biomass products

While the complete landscape is too vast and fast-growing to describe concisely, a number of downstream chemicals and building blocks that can be made from biomass include green chemicals such as organic commodity chemicals, such as solvents, fuel additives, lubricants, surfactants, adhesives and inks; renewable plastics, which include starch esters, cellulose acetate blends, polylactide (PLA; poly lactic acid), polyhydroxybutyric acid (PHB) and thermoplastic proteins; and natural fiber, which range from materials for insulation to those for soil erosion control. Eventually, the biorefinery will proliferate, producing a range of downstream fuels and chemicals at a single facility. But in the meantime, the most popular end-routes for biomass are biodiesel, ethanol and PLA.

Biodiesel: There is much available land in China, as well as in other neighboring countries, for large crop plantations; and climatic conditions are good for producing oil bearing crops such as jatropha and oil palms. The employment rate in Southeast Asian countries is often low, in particular in rural areas, and manpower is available to develop these plantations. Because of these factors, China (along with India) has announced large-scale biodiesel programs.

Only five years ago, the Asian biodiesel industry in Asia was inconsequential in relation to the rest of the world, according to SRIC's late-2006 Biodiesel Report. While there were already 67 plants known in Asia at the end of 2000 (corresponding to 4.5% of the total), biodiesel capacity in the region accounted for less than 1% of total World capacity. This has changed, with Asia accounting for 7.8% of the world's total biodiesel production capacity in 2005. At the end of 2005, every second

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biodiesel plant known to be operational in Asia was located in China. According to SRIC, China's 2010 annual biodiesel output from Jatropha oil is expected to reach 520 thousand metric tons/yr while that from recycled fats and oils, such as used cooking oil and tallow, will reach 735 thousand metric tons/yr.

Ethanol: Producing more than 4,525 thousand kiloliters/yr in 2005, China is the world's third largest ethanol producer, behind Brazil and the U.S. SRIC estimates that there are more than 200 ethanol production plants in China. SRIC expects the consumption of ethanol to increase at an average annual growth rate of about 4% for solvent use, about 5% for chemical raw materials use and about 7% for fuels use over the next five years. China's aim to increase the use of ethanol in automobile fuels by 2010 is a major driver here.

PLA: Polylactide (PLA; poly lactic acid) is a biodegradable polymer made from renewable resources, such as corn and other cereals. It is said to be the biodegradable polymer with the highest market potential, with a current global production capacity of 250,000 metric tons/yr. PLA can be used for thermoformed packaging, bottles, fibers and film, and for medical-engineering applications, such as sutures, screws and bone-connecting meshes.

Demand for biodegradable polymers in China has been rapidly escalating as the problem of plastic waste pollution has gotten more serious. China's Solid Waste Pollution Prevention and Control Law encourages plastic film and disposable package products that enable reduced solid waste. SRIC forecasts that Chinese demand for environmentally degradable polymers to continue to increase at an average annual rate of over 20% over the next five years.

One example of China's important role in the PLA landscape, Harbin Weilida Pharmaceutical Co. Ltd. is building what is claimed to be the world's first fully continuous PLA plant at Harbin Heilongjiang Province, China. When the 10,000-metric ton/yr plant starts up in the second half of 2007, it will be the first commercial plant to make PLA using a process developed by Uhde Inventa-Fischer (Dormat/Ems, Switzerland and Berlin, Germany).

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