International Bioenergy Forum:
China –EU Cooperation

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BIOENERGY STRATEGY AND POLICY ISSUES IN THE WORLD

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Humanity is witnessing the beginning of a revolution in biosciences and engineering that will transform life during this century. Day by day new opportunities are open to develop economically competitive alternatives to fossil energy resources and to significantly reduce countries dependency on foreign oil; improve, and reduce the cost of consumer and industrial products; improve the environment; greatly increase opportunities for enterprises (particularly in the rural, farm, and forest economies); and reinvigorate exports.

Biomass is material originally produced by photosynthesis - such as wood or plants or related municipal and agricultural wastes. New technologies use biomass to produce heat, electricity or fuels that substitute for petroleum, petrochemicals, or
other energy intensive products.

Bioenergy resources such as woody crops, biomass residues and wastes already provide about 14% of the world's primary energy supplies. For the future, bioenergy offers cost-effective and sustainable opportunities that have the potential to meet up to 50% of world energy demands during the next century, and at the same time meet the requirement of reducing carbon emissions from fossil fuels.

The vision statements for many governments focus on overcoming the environmental, institutional, technological, and financial barriers to the near- and long-term deployment of bioenergy technologies.

It is also true that the speed and degree of these future changes largely depend on how wisely and effectively people can work together in national partnership of industries, academia, federal, state, and local governments, and non-government organizations to develop and harness biobased products and bioenergy.

This is not only a challenge to increase the nation's use of biobased products and bioenergy in a short period. Nor is it only a challenge to promote and accelerate
A viable, integrated industry that would enable nations to reach or exceed specific goals.

Rather, this it is a challenge to the way people do business—to the way, people see their roles and relationships. Traditionally, governments have had a very specific and insular view of biomass.

Some have viewed it from the perspective of wood and paper products. Others have viewed it from an agricultural perspective, concerned with planting, harvesting, processing, and distributing crops and derived products, including some liquid fuels. Some have been involved with its use as a source of energy in the forms of electricity and heat, usually coupled with the management of biomass residues. Others have dealt with the environmental effects of planting, processing, distributing, and using biomass.

Some have vested interests in the interstate commerce of biomass-derived goods. Several governments have adopted policies that spurred the growth of power and fuels from biomass and increased the use of recycled products.

Bioenergy is a more complex renewable energy system than other renewable energy systems such as solar or wind. It involves multiple feedstocks, conversion systems, and coproducts. Energy is unlocked from plant components such as lignin and cellulose through thermochemical and biochemical conversion processes. The resulting sugars and other chemicals are converted into liquid fuels and other biobased chemicals. Thermochemical processes of combustion or gasification from biomass produce both heat and electricity. While wastes from municipal collection systems or concentrated animal feedlots can also be used to generate bioenergy, the collection and conversion processes are often accompanied by intense public scrutiny and controversy.

In addition to this basic technological complexity, the authorities are confronted with multiple uncertainties about the potential of expanding bioenergy based on mostly undeveloped feedstock supply systems. There is no generally available market established for energy crops and agricultural residues. Most of the infrastructure required to support a renewable energy fuel cycle dependent upon farm produced feedstocks has yet to be developed.

Bioenergy is currently being asked to compete on an uneven playing field where its fossil fuel competitors (coal, oil and nuclear) are heavily subsidized. These uncertainties affect stakeholder views and concerns and their general support for bioenergy

To accelerate the development and growth of an integrated 21st century Bioenergy Industry, then the challenge is to move beyond these narrow points of view. The first approach should recognize that the scope of biomass, bioprocessing, biotechnology, biobased products, and bioenergy is not limited to food, wood, chemicals, fuels, or power alone.

Actually, it embraces all of these fields and more, and needs all sectors— their missions, and all of the relevant policies, sciences, and technologies.

Today, the world depends on biomass to provide energy now and in the future. With no doubt the advances in biological and physical sciences and engineering would accelerate the use of biomass.

This revolution will have important impacts on:

- stimulating economic growth, especially in rural, farm and forest economies, and industries.
- reducing emissions of carbon dioxide and airborne pollutants, reducing soil erosion, sequestering carbon, protecting water supplies and quality, and increasing the diversity of crops and products.
- increasing energy security by securing domestic production and reducing our enormous dependence on foreign sources of fossil fuels.
- securing a competitive position by opening up new technologies, industries, and export opportunities.

The Challenges:

- To advance science and develop technologies to overcome difficulties posed by the complexity of biomass resources and processes.
- To coordinate government policies to meet the national and international goals.
- To accelerate the commercialization of new and emerging technologies and products to meet the national goal.
- To ensure that new technologies and increased use of biomass will not adversely affect land, water, air, and public health, but rather provide environmental benefits.
- To provide information for institutions, enterprises, industry, farmers, landowners, and the people in general that will help them understand biobased products and bioenergy .
- To coordinate efforts to encourage the growth of an integrated industry.

The advances in the science and technology of biobased products and bioenergy present a great opportunity to expand the renewable carbonbased industries while simultaneously moving toward a more environmentally sustainable economy.

Biobased products and bioenergy offer considerable environmental benefits. They often require less energy to produce than the fossil and inorganic products they replace. Biobased products often reduce waste as well as improve air and water quality relative to the products they replace. In addition, biobased products can sequester large amounts of carbon while adding little if any net carbon emissions to the atmosphere.

However, biological feedstock growth, processing, and use can pose environmental challenges as well. Changes in land use, pesticide, fertilizer, water,
and other requirements could carry risks to habitat, public health, diversity, and air and water quality. To ensure that this initiative maximizes environmental benefits and minimizes potential risks, the environmental benefits and costs have to be assessed at all stages, from planning to commercialization.

The challenges of developing new biobased products and bioenergy are formidable. Biomass resources are more complex and harder to process than petroleum or coal. A large number of production, conversion, and utilization technologies are possible.

There are many ways to integrate individual technologies. Because of the fast pace of progress in biological sciences and technologies, the number of alternatives will increase rapidly.

Carbon-based products from both fossil and renewable sources play a critical role in the world economy. They are present in fuels, in packaging and clothes, in vehicles and homes, and in workplaces and leisure activities.

Renewable resources such as trees, grasses, and crops were the primary source for such products until the mid-19th century. Then gradually, as understanding of chemical, geological, and physical sciences and engineering progressed, and the demands of industrialization grew, fossil fuels began to replace renewable resources and became the dominant raw material for energy, chemicals, and products in the 20th century.

Today, the cost and security risks of fossil fuel imports, environmental concerns with increased pollution and with global greenhouse gas emissions from fossil fuel use, the desire to improve the rural economy, and breakthroughs in biological sciences, technologies, and processes have renewed the interest in biobased products and bioenergy.

For example, sugars and biosynthesis gas from biomass are two examples of building blocks from which can derive many other products. These building blocks should be supported by developing critical technologies such as biomass hydrolysis and gasification. These critical technologies can unlock a wide range of products—just like thermal and catalytic cracking did for petroleum in the 20th century.

Sugars could be as important to the bioproducts industry as ethylene is to today's petrochemical industry. The chemical industry uses ethylene as a starting material to make thousands of consumer products, including polyethylene bags and polyethylene terephthalate (plastic bottles for soft drinks).

Analogously, with sugars derived from lignocellulosics found in trees, grasses, or residues from agriculture crops, we can use fermentation and chemistry to make hundreds of products including:

- Alcohols, such as ethanol, glycols, and sorbitol.

Ethanol is used as an oxygenated fuel that helps reduce toxic air pollutants and increase gasoline octane numbers. Glycols are used for making antifreeze, brake fluids, and solvents.

And sorbitol is used in adhesives, as a softening agent, and as a sweetener.

- Acids, such as lactic acid, which is used for preparing cheese, soft drinks, and other food products. It is also developing into a starting material for biodegradable plastics.

- Polymers, such as xanthan gum, which is used as a food-thickening agent and as a gel in toothpaste, medicines, and paints.

On the other hand, Biomass gasification uses heat to convert solid biomass into a biosynthesis gas—which is primarily a mixture of carbon monoxide and hydrogen, with carbon dioxide, water vapor, and small amounts of tar. Once this biosynthesis gas is cleaned of tars This can be used it to produce:

The biosynthesis gas can be used in advanced turbines or in fuel cells to produce electricity at more than twice the efficiency of today's combustion systems. By using gasification technology to replace aging power and heat-generating equipment, the pulp and paper industry could become energy self-sufficient and could even export electricity.

Two of many important classes of biobased products are plastics and surfactants.

- Plastics. The chemical industry today produces more than 80 billion pounds of plastic products annually. The great majority of these products are derived from fossil resources. Biomass resources account for only a small percentage, many filling high-price, value-added applications. Accelerated R&D could help biomass-derived plastics in two ways.

First, it could help lower the costs of a wide range of biobased plastics, which would then enable these plastics to penetrate high-volume applications that could offset increased petroleum- based plastics production.

Second, it could help continue the development of a slate of highquality plastics with unique properties, which would penetrate many markets based on their performance. A variety of important specialty plastics could be sold at premium prices.

Finally, the common starting point for all these products is the biomass feedstock— green plants. Research and development are critical for increasing the supplies of sustainably grown crops and for reducing the cost of biomass so that it will become the worlds green petroleum of the 21st century.

Feedstock research includes plant science, understanding and using plant productivity factors, and the growth and selection of plants with specific attributes. As selected plants move into development, cost-effective, regionally adapted, and environmentally beneficial crop production methods are needed.

Improved crop harvest, handling, storage, and transportation methods could further assure reliable biomass supplies. In this way a broad range of cost-competitive products can be made from biomass feedstock.

Already known Biobased Industry

- Paper and packaging Writing papers, newsprint, magazines, and packaging cartons
- Wood-based composite materials Lumber, plywood, flooring, furniture, laminates, engineered wall systems, and structures wood/polymer and structural composites, and lignin-based polymers

Emerging Biobased Industry in many countries

- Plant-based plastics and polymers Polylactide plastic, starch biodegradable polymers, and films spider silk polymers
- Lubricants and functional fluids Biodegradable soybean oil-derived lubricants, used grease-refined products
- Inks Soybean-derived inks
- Enzymes Cellulase for orange juice clarification and stone-washed jeans, amylase for corn industry, enzymes for nutrition enhancement, novel property enzymes
- Renewable alternative fiber papers and Kenaf, milkweed, and other agriculture products used for fibers, packaging packaging, and products.
- Absorbents, adsorbents, and Odor control, spill absorbents, animal bedding, pet litter, biocement masonry and road materials support, roofing, insulation, road oil, and asphalt
- Adhesives and bonding products Sealants, glues for building products, glues for envelopes, wall paper adhesives, soy-based adhesives, marine glues
- Biocontrol products Soil amendments, such as topsoil, aggregate, and enrichment, fertilizer and pesticide carriers

- 11 Solvents, chemical intermediates, and Methyltetrahydrofuran from levulinic acid, methanol from synthesis gas, cleaning agents cleaners, conditioners, and surfactants

- Coatings and paints Paints using cellulose-derived water soluble polymers

- Cosmetics and personal-care products Biobased products in toothpaste, lotions, and shampoos

- Landscaping products Decorative bark, railroad ties

- New fibers, fillers, yarn, and insulation Cotton fibers and rayon (cellulose derivative) textiles. New insulation using cotton processing trash and recycled textile fibers, filler for auto fenders, and panels for vehicle liners

- Pharmaceuticals and veterinary products for cancer treatment

Biomass in the United States

Biomass resources supply the United States with 3 percent of its primary energy. From this primary biomass input, nearly half is lost in conversion processes. The other half is consumed in the form of heat, electricity, and liquid or gaseous fuels. Major bioenergy uses by sector include the following:

- Buildings. About 25 million homes use wood for primary or supplemental heating, and wood provides 10% of total residential heating in America.

- Electricity. Biomass residues, municipal wastes, and landfill gas are used to generate heat and 60 billion kilowatt-hours from 10 thousand megawatts of electric power (nearly 1 percent of the generating capacity in the United States). The
- electricity derived from the biomass residues avoided 7 million tons of carbon emissions per year because of diversion of biomass from landfills and their resulting emissions.

- Industry. Biomass process streams and residues provide 56 percent of the electricity and heat used by the pulp and paper industry and 75 percent of the electricity and heat used by the solid and engineered wood products industries and composites.

- Transportation. Ethanol (primarily derived from cornstarch) accounts for 0.4 percent of liquid fuels and is provided as an ethanol-gasoline blend in 3 percent of U.S. gasoline supplies. Of the 35 billion gallons of diesel consumed in 1998, 6 million gallons were biodiesel.

Bioenergy in the Asian Countries.

Some studies have been conducted to assess the energy supply from biomass plantation in some Asian countries. The energy potential of plantation biomass is 5-6%, 5-24%, 0.2-0.8%, 2-11%, 7-35%, and 3-31% of the projected total energy consumption in 2010 in China, India, Malaysia, Philippines, Sri Lanka and Thailand, respectively. (S.C. Bhattacharya , Ram M. Shrestha, H.L. Pham 2000)

Are these countries, the key barriers to biomass production for energy include some of the barriers already analized.

- *Technical barriers:* high investment costs of dedicated plantations, and low biomass productivity.

- *Financial barriers:* lack of investment in the forestry sector, difficulty in accessing finance, and lack of incentives.

- *Institutional barriers:* lack of co-ordination among different government agencies, lack of mechanism for their interaction with private sector, lack of a designated agency for promoting biomass energy/plantation and lack of access to expertise on plantation in degraded land.

- *Policy barriers:* unclear, unsupportive and biased government policy and absence of national strategy or priority for promoting biomass energy use.Some Asian countries have come up with clear mission/policy objectives statement on renewable energy

China: Raising efficiency and reducing cost in order to boost the share of RE in national energy supply.

India: Meeting minimum rural energy needs, provision of decentralised energy needs and grid quality power generation and supply.

In all study countries renewable energy is now recognised as important for providing energy services, particularly in remote and rural areas. For this purpose, investment subsidy is provided to all major renewable energy technologies and is also available to a lesser extent in China and Thailand.

In India, 100% depreciation in the first year is allowed for certain equipment. Other fiscal incentives available in India include exemption/reduction in excise duty, and customs duty concessions on imports. Tax incentives for biomass energy projects are also available in Malaysia, China and Thailand.

Provisions for Power Purchase Agreements are quite well established in India, China and Thailand. Wind farms in China have a right to sell electricity to the grid at a price giving them a reasonable profit even if the price is higher than the grid's average price level. Improved cookstove programs have been undertaken in practically all countries.

Relatively less has been done regarding traditional biomass energy systems in rural industries. In Asia, only India and China have achieved some success in R&D efforts on modern biomass energy systems.

Bioenergy for the world in the near future

There are significant opportunities to improve the efficiency of converting primary biomass to convenient electricity, heat, and transportation fuels.

For bioenergy to become more competitive and more widely used, increased use of combined heat and power would help. But even greater increases in efficiency are needed.

And this can be achieved only through advanced technologies like advanced biomass gasification coupled with advanced turbines in combined cycles, possibly with fuel cells (which could reach conversion efficiencies of 60 percent or higher).

The technical and commercial risk of these technologies must be reduce so that industry can adopt them in an expeditious manner as they replace capital equipment and develop additional supplies.

Some bioenergy deployment is compatible with the current fossil energy infrastructure. Gasification of biomass is a feasible way to combine biomass energy with coal at very high proportions of biomass.

It is also a way to couple biosynthesis gas (processed to pipeline quality) to increase natural gas supplies for distribution and home applications.

Cofiring solid biomass residues along with coal directly could lead to biomass efficiency increases with relatively low capital investments.

Bioenergy Strategies

1. Bioenergy and environment

- Monitor and evaluate the environmental and ecosystem impacts of biobased products and bioenergy systems at all stages of development and apply this information toward improving these systems' safety and environmental benefits.

- Identify and foster R&D on biobased products and bioenergy areas that have substantial potential to replace fossil-based fuels, power, heat, chemicals, and materials (including inorganic products replacement) with substantial potential to provide environmental benefits.

- Establish specific review committees with broad public representation and open processes to oversee environmental monitoring and evaluation, in-field biomass production, and facility conversion processes.

- Conduct ongoing life-cycle analyses to evaluate integrated systems and determine areas for environmental improvement.

- Utilize advanced information technologies to collaboratively assemble, analyze, and publicly disseminate information on relevant environmental and ecosystem impacts.

2. R&D and Human resources

- Strengthen and integrate basic scientific research programs and complementary competitive grant programs across the nations and their laboratories, academic institutions, and private-sector firms.

- Enhance human resource development to support scientific R&D programs.

- Strengthen partnerships between the public and private sectors.

- Evaluate biobased products and bioenergy R&D portfolio to identify gaps in frontier science and technology.

- Identify opportunities for technology transfer from other functional genomics and metabolic engineering R&D, such as on human systems.

- Identify R&D issues that would be appropriated, extend existing or develop new programs that address key challenge areas.

- Reserve a portion of the R&D funding for highrisk frontier science opportunities to nurture innovation.

- Support research fellowship programs at universities and national laboratories in key science areas that benefit biomass feedstocks, biobased products, and bioenergy.

- Identify in detail the principal barriers to the research, development, demonstration, and deployment of biobased products and of bioenergy and systematically develop coordinated policy mechanisms to overcome them.

- Develop science-based education and outreach programs and materials, directed toward classroom teaching and consumer education to explain the environmental sustainability and product performance of biobased products and bioenergy.

3. Market and other policies

- Incentives to stimulate the creation and early adoption of technologies needed to make biobased products and bioenergy competitive with fossil-fuel-based alternatives

- This may include tax incentives, environmental offsets, risk mitigation mechanisms in early deployment, buy-down mechanisms, and others.

- Identify existing state authorities that can be used to facilitate early adoption of biobased technologies and products.

- Link environmental benefits of biobased products and bioenergy to public policy development.

- Resolve infrastructure, performance, environmental, and health testing issues that present a barrier to the market adoption of biobased products and bioenergy.

- Encourage early development and adoption of standards and labels for biobased products and bioenergy. Work with the private sector and nongovernmental organizations to identify the appropriate role of government in this effort.

- Inform consumers and government employees about the benefits of biobased products and bioenergy so they will support the effort.

- Facilitate enactment of legislations to assist purchases of biobased products and bioenergy.

- Use targeted demonstration programs to collect data over time and quantify benefits and costs of biobased products and bioenergy use.

- Collaborate with the appropriate state, and local agencies to facilitate private-sector investment in key areas of biobased products and bioenergy for widespread implementation of technologies.

4. Assistance and R&D.

- To promote the utilization of technologies and systems for enhanced sustainable energy production from biomass.

- Advance understanding of technologies that can reduce emissions of greenhouse gases to the atmosphere.

- Promote the deployment of technologies with important local and global environmental benefits.

- Recognize technologies with local or regional economic benefits or employment opportunities that contribute to a secure energy supply.

- Examine the implications for embedded generation and the role of utilities in deployment of bioenergy products and services.

- Encourage deployment of bioenergy products and services in developed and developing countries.

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