The challenge of scaling up

A report shows that biofuel expansion requires the support of public policies to be sustained at a global level

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The current state of scientific and technological development already allows for large-scale, worldwide bioenergy production. However, public policies that encompass the entire renewable energy production chain must be adopted for this goal to become a reality; these policies include land use and the efficiency of technologies for converting biomass into power, in addition to environmental, economic and social challenges. This finding is one of the primary conclusions of a report on the implementation of bioenergy systems worldwide, about which some aspects were presented during the opening of the second edition of the Brazilian BioEnergy Science and Technology Conference (BBEST) held October 20-24, 2014 in Campos do Jordão (São Paulo State). The report, entitled, “Quick Evaluation Process on Biofuels and Sustainability,” was prepared by researchers who participated in FAPESP’s special programs, specifically the Program for Research on Bioenergy (BIOEN), the Research Program in Identification, Conservation, Recovery and Sustainable Use of Biodiversity in the State of São Paulo (Biota) and The FAPESP Research Program on Global Climate Change (RPGCC).

“Global public policies are beginning to reflect that we need to triple our production of modern bioenergy by 2030,” says Glaucia Mendes Souza, a researcher at the Chemistry Institute of the University of São Paulo (USP) and the coordinator of BIOEN. She was responsible for organizing the report, which was compiled in collaboration with scientists from 24 countries under the auspices of the Scientific Committee on Problems of the Environment (SCOPE), a partner of the United Nations Educational, Scientific and Cultural Organization (UNESCO). The final document was released on April 14-15, 2015 during a FAPESP seminar, and it also included the launch of a summary to guide public policy.

The report highlights the role of bioenergy in food security. According to the document, modern bioenergy may have the ability to increase land productivity by integrating the production of maize and sugarcane, for example, to produce ethanol or soy and palm oil for biodiesel, with agriculture connected to the food supply. “Bioenergy production in the poorest rural areas can also boost the local economy by creating jobs and markets,” says Souza.

However, the report does note that we must have a better understanding of the impact of the land-use measures that are adopted for bioenergy production. The same type of biomass, such as sugarcane, may be used for different purposes, namely liquid fuel for heating or electricity generation, and it would then have different impacts. Monitoring these impacts is essential. “If planting sugarcane deposits tons of nitrogen into the soil, this can increase greenhouse gas emissions such as nitrous oxide. We have to be very careful with the technologies we use,” says Reynaldo Victoria, a USP researcher and a coordinating member of the RPGCC.

A BIOEN study shows that direct greenhouse gas emissions from sugarcane cultivation in Brazil are lower than those estimated in the international scientific literature. “The conditions under

EDUARDO CESAR

Sugarcane: Bioenergy power plant efficiency in Brazil is internationally recognized; the next step is to leverage new technologies to increase ethanol production

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Experts from around the world gathered in Campos do Jordão (São Paulo State) for the second edition of BBEST. The challenge of articulating policies for the bioenergy sector was on the agenda

which we produce sugarcane here do not lead to large emissions of nitrous oxide," says Heitor Cantarella, a researcher at the Campinas Agronomy Institute (IAC) and the study coordinator. However, the ideal is for sugarcane growers to adopt solutions to reduce or mitigate gas emissions, he says. Some strategies are beginning to be evaluated by Cantarella's research group in São Paulo. One such strategy is to avoid applying fertilizer and vinasse (vinasse is a byproduct of the industrial processing of alcohol) at the same time because the combination of these items leads to the production of nitrous oxide in the soil. "The current planting practice is to apply them simultaneously to speed up the process. We need to change that mindset," says Cantarella. "The sugarcane remains sustainable. Our goal now is to improve its indicators in relation to greenhouse gas emissions," he says.

"Bioenergy production in the poorest rural areas can boost the local economy," says Glaucia Mendes Souza

ETHANOL VERSATILITY

Bioenergy production from biomass can also contribute to the recovery and increase of environmental resources for the fauna of degraded soils. "In some circumstances, when degraded pastures are replaced with sugarcane or eucalyptus, this results in soil recovery and even an increase of resources for fauna in this area," says Luciano Verdade, a USP professor and coordinating member of the Biota-FAPESP Program, who also helped to prepare the report.

The experts at BBEST presented specific cases throughout the week to illustrate the potential of biomass utilization. One such case is the use of sugarcane ethanol to obtain hydrogen, which may be used in cars powered by fuel cells. This project is underway at the Hydrogen Laboratory at the University of Campinas (Unicamp), which seeks to develop small hydrogen extraction stations in partnership with the Hytron company by using the ethanol sold at gas stations. "The idea is to show that ethanol is versatile and the form in which it is sold today at gas stations could be used more efficiently," says Carla Cavaliero, a professor at Unicamp and a laboratory researcher.

Some manufacturers, such as Honda, Toyota and Hyundai, recently launched models powered by fuel cells. However, the cost of producing these cars is still high. In Europe and the United States, hydrogen extraction is performed directly at some gas stations, not from ethanol but through the electrolysis (decomposition) of water. "The advantage of using ethanol to obtain hydrogen is that Brazil already has a competitive advantage in producing fuel from sugarcane, which makes the process cheaper," says Cavaliero.

The possibilities of producing advanced liquid biofuels were also discussed at BBEST. The participants had the opportunity to learn about advances in the production of cellulosic ethanol that was made in Brazil from agricultural waste such as sugarcane bagasse. In 2014, two companies began the commercial production of second-generation ethanol, which is another name for cellulosic ethanol. One is GranBio, which opened a production plant in Alagoas

State. Approximately US$190 million was invested by GranBio in addition to another R$300 million from the Brazilian Development Bank (BNDES). The factory has the capacity to produce 82 million liters of anhydrous ethanol per year and will be fully operational by 2015. Another initiative is the Sugarcane Technology Center (CTC), which was created in 1969 by Copersucar and began operating a demonstration plant for second-generation ethanol, which is located in São Manoel, São Paulo State. The plant is capable of processing 100 tons of sugarcane biomass per day. The aim of the unit is to showcase the potential of the technology that has been developed by the center, which can multiply the production of ethanol without expanding the area planted with sugarcane.

In 2008, the process that was developed by CTC to obtain cellulosic ethanol from sugarcane was patented; it represents a strategic difference in comparison with the methods adopted by other companies that were competing in the race to develop second-generation ethanol in Brazil. The enzymatic hydrolysis process of the cellulose present in bagasse and straw will be fully integrated into the existing structure of the production plant (*see* Pesquisa FAPESP *Issue Nº 208*).

ENZYMES

However, there are still barriers that prevent the production of second-generation ethanol from advancing to an industrial scale. "The most difficult problem is related to enzymes," says Jaime Finguerut, a technical advisor to CTC's president. The production of second-generation ethanol depends on the enzymes used to break down the lignin and hemicellulose of the sugarcane cells to obtain cellulose and then glucose, thus enabling the fermentation of the sugar to obtain ethanol. "There are few suppliers of these enzymes and their cost is very high, which makes producing cellulosic ethanol very expensive," says Finguerut. In partnership with Embrapa and the Brazilian Bioethanol Science and Technology Laboratory (CTBE), the CTC is currently seeking new supplies for this process.

The BBEST program schedule was not limited to a discussion of biofuels, such as ethanol. The future of renewable

Wind turbines in Parnaíba, Piauí State: the future of renewable energy was discussed at the conference

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energy such as wind and solar was also featured during one of the days of the event. The idea was to show that there are other forms of electricity generation that complement the production of bioenergy made from biomass. "Photovoltaic films, for example, are flexible and can be used in the construction of houses and buildings or change the configuration of windows, decreasing or increasing the incidence of light," says Helena Li Chum, a Brazilian who has lived in the United States for 30 years and is a researcher at the National Renewable Energy Laboratory of the U.S. Department of Energy. According to Chum, the process of differentiating the capture and distribution of energy is a way to meet the specific demands of different industry sectors.

An example of renewable energy interactions was presented by Danny Krautz of the Berlin Partner for Business and Technology, a German agency that supports innovation. He demonstrated the advantages of crystalline photovoltaic cells, a technology that is used in the manufacture of very thin polymer films capable of converting sunlight into electricity more efficiently than silicon solar panels. "Crystalline photovoltaic cells are already used in Asia, particularly in rural areas. They are light and easy to install," says Krautz.

Just like photovoltaic film, wind mini-mills have also emerged as alternatives for generating electricity in a decentralized way. These mini-mills are made of small propellers that are five meters in height; they weigh approximately 800 kilos and can be installed in homes, factories or small communities. Jon Samseth of the Oslo and Akershus University College of Applied Sciences in Norway says that the idea of these projects, many of which are still under development, is to present an alternative to the centralized power distribution model that exists today. "Producing electricity in a decentralized manner is meant to meet specific needs, which avoids waste and high costs," he says. One example cited by Samseth is the NuScale SMR, a small nuclear reactor developed by the American company NuScale Power. This equipment will not be commercially available until 2020; it can be transported by truck or train and aims to meet the immediate needs of customers, such as industries and hospitals. Capable of generating 540 megawatts of power for 60 years, this mini-reactor can be built quickly, and if there is an accident, the environmental and economic damages are more easily controlled. ■

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