together with scenario analysis, can be used to decide which policies to use to deal with an impending energy crisis and what their limitations are. These methodologies show that there are no definitive technological solutions; some that appear perfect in one segment of their implementation may fail in another, ruling them out. A solution in one region may not work in another, or may only work to a lesser degree.

Combining options may offer the most feasible and efficient solution. For example, ethanol and HEVs may save more GHG emissions and energy together than each of them alone. Efficient public transport systems must be built and enlarged.

It will take time to implement any option enough so its impacts are felt. This is also the case for technologies already existing on the world market. Is there time for Mexico? VM

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[1] http://www1.eere.energy.gov/hydrogenandfuelcells/pdfs/benefits.pdf.

Biofuels and Sustainable Rural Development in Mexico

María Elena Goytia Jiménez*

Stringer/REUTERS

Global production of oil, a non-renewable resource, is expected to peak between 2010 and 2019, when conventional reserves in most oil-producing countries will have practically run out, and only Saudi Arabia, Kuwait, Iraq and the United Emirates will still possess this resource.

Recent studies show that Mexico hit its peak oil production levels in 2004,[1] and that from 2014 it will begin to have to import it. The political and financial costs will be high, since the Mexican economy is heavily dependent on oil, which contributes between 36 and 40 percent of the federal budget.

* Coordinator of the Research Center on Biofuels for Sustainable Rural Development, Autonomous University of Chapingo (CIBED-UACh).

Although biofuels may offer important opportunities for reducing poverty and fostering rural development by creating jobs for agricultural workers and markets on a small scale, this scenario is impacted by large inflows of capital into rural areas.

In Mexico, oil provides energy for transportation, and gas for domestic and industrial use, and raw materials for the pharmaceutical, cosmetics, plastics, leather, cement, and fertilizer industries, and many more. Therefore, the reduced availability of this resource will double or triple the prices of these products, and Mexico, like other countries, will have to find ways to create companies to produce energy and industrial products that can replace the energy generated by oil.

Another factor closely related to this energy crisis is the obsolescence and deterioration of Pemex's installations, leading to an 18.3-percent drop in diesel production from 318 200 barrels a day in January 2009 to 259 800 in December 2010. As a result, diesel imports in 2011 were up by 186.9 percent compared to 2010 figures.[2] This affects the price, which at the time of writing is Mex$9.75 per liter; and it will continue to rise for at least the next three years, driving up the cost of products transported or produced with this fuel.

Impact on Aviation

Aviation is another industry affected by the energy crisis. The price of jet fuel in Mexico, according to companies working in this sector, reached critical levels: Mex$11.47 per liter. And officials at the decentralized government Airports and Auxiliary Services Agency (ASA) say that this figure will continue to rise, putting the sector in a difficult position: falling profits for companies and higher airfares for customers.

American Airlines, which has entered purchase agreements with Mexico for jet fuel, says that the increase of one cent of a dollar per liter of fuel raises its expenses by an extra US$25 million per year. The aviation industry is also under pressure from restrictions imposed by the European Union, since only aircraft using biomass fuel will be allowed to land in its airports. They claim that this aims to reduce pollution produced by burning fossil fuels, as these companies create two percent of global CO_2 emissions. Biofuels will gradually be introduced, from one percent in 2011 to 100 percent in 2020.

For Mexico, this is the equivalent of the production of between 40 to 70 million liters of this biofuel within the next five years. To meet this target, the ASA has developed the so-called "Sustainable Flight Plan for Mexican Aviation," which calls for the production of bio jet fuel using biomass; according to this project, in the future this will be cheaper than oil-based fuels.

The "Green Energy" Program

Mexico has enormously varied climate and flora, making it suitable for generating the products needed to meet the demands of the national energy sector and to make the most of the opportunities offered by this emerging international market. Global awareness exists about this issue, and since 2003 the Inter-American Development Bank (IDB) has been behind the promotion of agrofuels through the "Green Energy" program, in which small businesses participate by proposing bioethanol and biodiesel projects as principal energy sources.

Although biofuels may offer important opportunities for reducing poverty and fostering rural development in Mexico by creating jobs for agricultural workers and markets on a small scale, thus increasing the availability of energy in rural areas, this scenario is being impacted by large inflows of capital into rural areas. These investors promote single-crop cultivation and setting up industries to produce oil and biodiesel, with scant regard to sustainable rural development in the areas involved. Land ownership has been clearly affected by this, since most of this land (53 percent) belongs to *ejidatarios* (collective landowners) and 3.4 percent to *comuneros* (traditional indigenous community landowners) who hold one or two hectares each.

This shows that land ownership in Mexico is atomized, and there are no large landholdings, *latifundios*, where extensive plantations can be located. This obstacle has been overcome by companies by using a agriculture-for-hire model, whereby campesinos commit themselves to plant energy crops and to sell companies their harvests for a period of at least from 5 to 10 years with the price fixed in the contract so as not to exceed Mex$7 per kilo. Therefore, the peasants no longer plant basic grains and instead become pawns for these companies; land use also changes, which could cause agricultural biodiversity to be lost along with local people's understanding of it.

Small agro-industries are being designed to be managed by peasants organized in cooperatives; this would help them remain as skilled workers rather than going abroad or swelling the ranks of organized crime.

The principal crops being planted to produce oil for biodiesel are the Mexican pine nut bush (*Jatropha curcas* L.) and the African oil palm (*Elaeis guineensis* Jacq.) The MDLM Green Oil Corporation has planted 50 000 hectares each of pine nut bushes in Tamaulipas, in the Isthmus of Tehuantepec, and the coastal regions of Oaxaca; the South Korean company Energy J. K. has done the same on 50 000 hectares in the valley of Apatzingán, Michoacán, and another 20 000 hectares in Yucatán. And there are a reported 32 500 hectares planted with African oil palm across Mexico.

Small-scale production of biofuels can provide the opportunity to push forward sustainable development of rural communities, provided that energy crops do not compete with food crops. The former can be planted on marginal land or in conjunction with maize, squash, or beans. The full use of these crops by local inhabitants of these regions will help create self-employment, with women and young people from rural families able to help in the new type of work created with these crops. This in turn could reduce Mexico's high migration rate, particularly by the young, which has created an ageing population.

One example of this type of crop is the castor oil plant (*Ricinus communis* L.) found in the central valleys of Oaxaca. This plant's oil was used in colonial times before electricity for lighting the area's streets and churches. Today the crop is produced on a smaller scale and is used to produce firewood for personal consumption; the seed is sold to intermediaries or directly to extraction plants who then sell the oil to churches and producers of cosmetics, soap. and natural remedies. Castor oil can be used to produce biodiesel, needed in rural areas for tractor engines, to pump water to irrigate fields; in Sri Lanka and India some communities' electricity is provided by electrical generators run on biodiesel manufactured using vegetable oils.[3]

The idea is therefore to work together with peasant organizations to plant these energy crops, either alongside basic grains or as single crops in deforested areas in order to recover soil and capture water. A wide range of products can be obtained from the oil: biodiesel or bio jet fuel, lubricants for engines and car brakes, plastics, cosmetics, and insecticides. And extracting the oil leaves behind a cake that is rich in protein that can be used to produce balanced food for cattle and fish, or as bio-fertilizers and biogas, the latter with domestic applications or useful for agro-industries set up in the regions to transform the oil and the cake. Other derivative products include firewood (to help prevent further deforestation) and the plants' leaves which can be used as fodder or for composting.

To provide these crops with value added, the suggestion is for peasants not to sell the seeds but the refined oil; and to keep the cake to make balanced fodder for their livestock. Small agro-industries are being designed to be managed by peasants organized in cooperatives, with charge of the transformation processes of rural communities where the crops are grown. This would help them to remain as skilled workers rather than going abroad or swelling the ranks of organized crime.

This type of agroindustry would be able to process seeds from 500 hectares. We believe this model can be replicated and that the technology transfer created, both on a farming and industrial level, should be in the hands of the peasants themselves. VM

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[1] L. Ferrari, "México después del petróleo: ¿Transición o colapso?," 2010, www.geociencias.unam.mx/.../areas/.../ferrari.html.

[2] "Pemex importará más combustibles en 2011," January 30, 2011, www.eluniversal.com.mx/finanzas/84311.html.

[3] "Lessons from Case Studies on the Livelihoods Impacts of Small. Presentation of Draft Report," FAO, Rome, November 26, 2008. Case studies: India's jatropha electrification; India's biodiesel water-pumping; Sri Lanka, www.rivelo.net/fre/.../fao-pisces-case-studies-presentation-comp.ppt.