Tailor-made solutions: Small-scale biofuels and trade

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In current debates on biofuels trade, the focus tends to be on large-scale production. However, the production of small-scale biofuels is better suited for many smaller developing and least-developed countries. Small-scale biofuels can bring many social and environmental benefits at the local level and, cumulatively, their production and utilisation can bring significant trade benefits.

Biofuel markets and trade

A large number of countries are now producing biofuels in order to achieve multiple objectives. Apart from contributing to lower carbon emissions, biofuels - both liquid and gaseous - could potentially contribute significantly to energy security, sustainable development and improved waste management in rural and urban areas.

As awareness of climate change has grown, and fossil fuel prices have become increasingly volatile over the last ten years, the market potential of biofuels has become clear. Many national mandates and voluntary measures to promote biofuels as a complement to conventional energy sources have emerged. This has led to greater commoditisation of biofuels, which are now established in international energy trade.

Liquid biofuels for transport, which are produced at a large scale, are the most traded today. In 2009, global production of ethanol was about 74 billion litres, a four-fold increase since 2000. A large part of the production was absorbed by local markets - such as in the US - but Brazil has been a significant driver of bioethanol trade and is currently the world’s largest exporter. Global production of biodiesel has been estimated to be approximately 19 billion litres, with the bulk of tradable supply coming from Malaysia and Indonesia.

Small-scale biofuels

But despite the massive potential, large-scale production of liquid biofuel is often in conflict with small-scale agricultural systems rooted in many developing countries. For these countries, alternative biofuel production systems are needed in order to ensure compatibility with local realities.

Recent studies have looked at key trade aspects for the identification of suitable developing and least-developed countries for bioethanol production. The criteria for selecting such countries were the following: (1) surplus cane sugar, (2) dependency on imported fuels, and (3) potential for economical production.\(^1\)\(^2\) The same studies have noted the many technical, socio-economic, and environmental benefits of small-scale biofuels as a means to promote sustainable development. The focus has been on energy access for the poor, reducing oil imports, income generation via specialised exports, rural development and reduced environmental degradation.

Especially in least developed countries, energy supply is complicated by poor infrastructure. This provides an opportunity to develop local bioenergy potentials, such as biogas and other small-scale waste-to-energy pathways, which have social and environmental advantages that complement regulatory efforts in fulfilling environmental standards.

There are several examples of attempts to insert small-scale production into the broader liquid biofuels production chains. These include the biodiesel program in Brazil, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) pro-poor initiative in Africa and India, and Colombia’s experience with small-scale jatropha biodiesel production in the Mesoamerica project.

Trade dimensions of small-scale biofuels production

At a first glance, the direct connection between small-scale biofuels and international trade appears to be related to their cost-competitiveness as compared to alternatives (fossil fuels such as gasoline, diesel, natural gas, LPG, and kerosene). Promoting a renewable energy system, given that the system provides more expensive fuel than the conventional alternative due to its small scale, is a challenge. However, if examined from a broader perspective, small-scale biofuel production can be economically feasible, while at the same time delivering gains for sustainable development. The following approaches have been identified:

- **Focusing on foreign markets:** Countries and regions that have blending mandates and/or sustainability criteria in place are more likely to pay price premiums for biofuels, accommodating the costs of small-scale production. This is nevertheless dependant on the capacities of the producers to deliver biofuels that adhere to the standards required by the target markets.
- **Exploring marginal production possibilities:** Economies of scale as an enabling factor for market penetration of biofuels is not universally applicable. In isolated regions, fuel costs can be extremely high due to expensive transport and lack of local competition. Availability of non-monetary factors (i.e., labour) leads to the emergence of economically viable small-scale biofuel production for fuel, cooking and electricity generation.
- **Piggybacking on existing industries:** For example, Nepal can produce 18,045 m\(^3\) of molasses-based ethanol per year without compromising food security by using leftovers from its sugar production. US$10 million can be saved annually by reducing imports of gasoline if molasses-based ethanol becomes the base for an E20 blend in Kathmandu Valley. Nepal could therefore cut foreign debt caused by petroleum imports simply by realising existing domestic potential for transport-grade ethanol.
- **Exploring trade-offs between domestic consumption and exports of fossil resources:** In developing countries dependant

\(^1\) DSDG, 2005. Dutch Sustainable Development Group (DSDG). Feasibility study on an effective and sustainable bio-ethanol production program by least developed countries as alternative to cane sugar export. Ministry of Agriculture, Nature and Food Quality (LNV), the Netherlands.

on hydrocarbon exports (e.g., Bolivia and Venezuela), the buildup of local biofuel capacities can also be meaningful, as biofuels could lower the carbon intensity of the economy. Moreover, biofuel production could generate profits from additional fossil energy exports, made possible by a domestic shift to a larger share of biofuels in the total consumption.

These options are not mutually exclusive, but rather complementary. The first option features a direct link to trade, as it aims to direct exports towards regulated markets that could command the necessary price premiums. The second, third and fourth options offer indirect benefits to trade, which are nevertheless substantive.

Prices of fossil energy are often high in developing countries. For example, Zambia has one of the highest liquid fuel prices in the world, according to a recent assessment from GTZ. Nepal subsidises imports of gasoline for transportation and kerosene for cooking. The fact that developing countries often mobilise scarce resources to cater to their energy needs represents a large macroeconomic burden, especially in terms of usage of foreign reserves. High payments for energy and fossil energy imports could undermine efforts to maintain the value of the national currency, jeopardising their terms of trade.

As an indirect benefit, realising local small-scale biofuel potentials might free foreign reserves, which can then be used to stimulate trade of goods and services needed for development processes in these countries.

**Biogas and trade**

One example of a small-scale biofuel with large untapped potential and numerous benefits is biogas, produced from waste and residues, and improving living conditions both directly and indirectly. Biogas is a local business that affects national trade. Small-scale production with simple technologies can replace kerosene and LPG for cooking. Bio-fertilisers can replace traditional fertilisers. Additional environmental gains include reduced contamination and eutrophication of water sources, as residue flows are redirected into biogas schemes, not waterways. National effects on trade are seen through local activities that reduce dependence on imported fossil energy and fertilisers.

The authors have looked at examples in Bolivia and Nepal. In Bolivia, household waste-to-energy initiatives are replacing fossil fuel for cooking. Industry waste-to-energy can also substitute fossil fuel sources, mainly natural gas, and enable the use of larger biogas plants applying more advanced digester technology. Replacing natural gas with biogas in industry could permit an increased export of natural gas to neighbouring countries. The domestic use of natural gas is subsidised by the government in Bolivia. Given the positive effects on trade, environment and social conditions, an equivalent subsidy on biogas should be pursued.

In the case of Nepal, biogas is primarily derived from cattle dung and has been an emerging technology to provide basic energy services in rural households for cooking and lighting purposes. There are numerous benefits in biogas production, for example, health benefits (i.e., improved indoor air quality), agricultural benefits (i.e., biogas slurry as the best fertiliser), environmental benefits such as reduction in usage of firewood, kerosene, LPG, reduced carbon emissions and employment generation, workload reduction and empowerment of women. In Nepal, the Biogas Support Programme (BSP) was the first renewable energy project with the registration of two simultaneous Clean Development Mechanism (CDM) projects in 2005, taking account of 19,396 biogas plants, and annual carbon revenue in excess of US$600,000. Until 2009, more than 200,000 biogas plants were constructed and it is estimated that Nepal has production potential of 1.9 million plants.

In Nepal, biogas technology could replace 4,713,495 litres/ year of kerosene, and 377,000 tons/year of fuel-wood. US$4 million can be saved annually by reducing imports of kerosene. Furthermore, at the individual household level, the following qualitative benefits are possible: greenhouse gas emissions reduction of 7.4 tons, 25 litres kerosene savings, 1.75 ton slurry compost fertiliser production per household per year, and three hours time saving per day. These are significant contributions in regard to resource utilisation, trade balance and sustainable development at the local level considering small-scale biogas plants.

Additional financing through the CDM is available for biogas schemes, which further adds to the feasibility of such initiatives. Finally, small-scale biogas is only the first step in the process of attributing value to waste and seeing it as a resource. Small scale biogas is therefore a first step to developing larger plants with more sophisticated technologies that can be used to replace natural gas and further reduce dependence on fossil energy.

**Conclusion: Why it matters**

The initial perception that biofuels are only economical when produced in large scale must be changed. Realising small-scale biofuel opportunities is essential to the process of integrating developing and least developed countries into the international bioenergy arena without clashing with local socio-economic structures. Experiences in Nepal and Bolivia illustrate the feasibility of realising local small-scale biofuel potentials, and their multiple benefits that trickle down to improve terms of trade.

Fuel prices are often very high in poor, isolated regions. By creating local biofuel capacities that are viable at a small-scale, developing and least developed countries can benefit directly from biofuel exports towards mandated markets, or indirectly from improved terms of trade by freeing local resources once employed for pricey domestic energy or energy imports.

In countries like Nepal, commercial renewable energy sources such as bioethanol and biogas could enhance socio-economic benefits, reduce environment burdens, such as indoor air pollution (by using biogas as cooking fuel instead of firewood or kerosene), urban air pollution (bioethanol in transport reduces tail pipe emissions from automobiles), and delivering trade gains by reducing imports of fossil fuels (gasoline and kerosene). In countries such as Bolivia and Venezuela, which are big hydrocarbon exporters, the promotion of biogas could reduce the opportunity costs of consuming fossil fuels locally; domestic consumption of biogas could free more natural gas for export to neighbour countries.

While the promotion of small-scale biofuel production faces many challenges, the examples presented here demonstrate the importance of trading experiences in an global effort to move small-scale biofuel production in developing countries to the forefront of the bioenergy agenda.