EXECUTIVE SUMMARY

Biofuels have been at the center of intense interest, discussion, and debate in recent years. The global biofuels boom began in 2004-2005 with the announcement by the United States (US) and the European Union (EU) of policies and incentives to support increased use of biofuels. In addition to spurring domestic production in several countries, especially the EU, the policies encouraged producers to seek out feedstocks and fuel from tropical and subtropical regions, initiating pan-global trade in biofuels. Soon thereafter, several Asian governments announced ambitious plans to promote biofuels production for both domestic consumption and export. Within a few years, biofuels had been transformed from a niche energy source to a globally traded commodity attracting billions of dollars in investments. Total biofuels production in Asia has grown more than five-fold since 2004, from just over 2 billion liters to almost 12 billion liters in 2008.

While it is clear that biofuels present a broad range of opportunities, they also entail significant environmental, social, and economic risks. Advocates maintain that biofuels can help displace fossil fuels and lower GHG emissions; support the farm sector; and revitalize rural landscapes in developed and developing countries. In contrast, opponents argue that biofuels compete with food crops for land, water, and agrichemicals; do not deliver cost-effective carbon emissions reductions; demand a disproportionate amount of subsidies and incentives; and negatively impact biodiversity.

Over the past 12 months, the intense volatility in the global commodity and oil markets has eroded the profitability of Asian biofuels producers. Concerns about the sustainability of biofuels imports to Europe from Asian countries have curbed export demand. Currently, biofuels production facilities in most Asian countries are operating at a fraction of their installed capacity. Many experts now believe that the biofuels bubble has burst. Policymakers are reconsidering the policy tools and mechanisms for supporting and promoting the expansion of biofuels. For example, the EU is closely reviewing its biofuels mandate for 2020 and has banned imports of palm oil from tropical Asia, citing environmental concerns. In addition, the unfolding global economic crisis and the recent slump in oil prices may further dampen interest in biofuels. Investors are increasingly wary of biofuels, governments are rethinking their strategies toward biofuels, and some researchers are advocating a complete ban on biofuels production.

However, Asia may miss an important opportunity if biofuels are rejected summarily. Asia continues to face significant challenges related to energy and environmental issues. More than half a billion Asians, mostly in poor communities, lack access to modern forms of energy. Throughout Asia, there are local opportunities for development of biofuels on a more decentralized, local level. It is imperative that key Asian stakeholders in the government and private sectors, as well as non-governmental organizations (NGOs) and researchers carefully evaluate the sustainability prospects of different biofuels in Asia, assess international best practices that can help realize the full potential of biofuels, and design and implement the appropriate policies to enable their production and utilization in a sustainable manner.

It is against this backdrop of complex market trends, along with conflicting policies and beliefs on biofuels, that the United States Agency for International Development (USAID) identified the need for an objective, comprehensive, and fact-based evaluation of the viability of biofuels in Asia. This report was developed by USAID's Environmental Cooperation-Asia Clean Development and Climate Program (ECO-Asia). The report focuses on seven Asian countries: China, India, Indonesia, Malaysia, the Philippines, Thailand, and Vietnam.[1] Throughout this report, these seven Asian nations are referred to as ***focus countries***. They were selected because they either produce or plan to

1 Six countries—China, India, Indonesia, the Philippines, Thailand and Vietnam—are the focus of the ECO-Asia Clean Development and Climate Program. Malaysia and Singapore are not ECO-Asia focus countries but were included in this study because of their key role in the biofuels industry in Asia.

produce significant amounts of biofuels. In some of the analyses, data from Singapore were also included because of its importance as a regional processor and trader of biofuels.

OBJECTIVES OF THIS REPORT

The purpose of this report is to provide an objective and comprehensive regional analysis summarizing the benefits and risks of biofuels development in Asia, and examining the distribution and use of biofuels through the lens of global climate change; biodiversity conservation; energy alternatives; food security; economic development; and local livelihoods. This report does not undertake a detailed evaluation of biofuels in comparison to other clean energy supply options for power generation and transport.[2]

The primary focus of this report is on liquid biofuels for transport applications, and to a limited extent the report also assesses applications for power generation in decentralized contexts. The report examines **first-generation** fuels derived from grains (e.g., corn, wheat, rice), starches (e.g., cassava), oil crops (e.g., oil palm, coconut, soy, and rapeseed), sugarcane, sweet sorghum, and non-food plants such as jatropha and pongamia; **second-generation** fuels (cellulosic ethanol) produced either from agricultural residue or from dedicated "energy crops" such as grasses and fast growing trees; and **third-generation** fuels, primarily focused on biodiesel produced from microalgae.

The report is intended to serve as a resource for decision-makers in the focus countries and to contribute to the ongoing national and international dialogue on biofuels development. It is not intended to offer prescriptive measures for countries, but rather to identify priority areas that may benefit from greater attention at the national, regional, and international levels. The report will also be used to inform the planning process for possible future activities funded by USAID that may address these challenges. It is hoped that the report will help inform the decision-making of other US Government agencies, multilateral development banks, and USAID partners.

KEY FINDINGS AND CONCLUSIONS

This report addresses three broad questions (see **Section 10** for detailed conclusions):

1. Do any of the biofuels that can be produced in Asia have the potential to replace fossil fuels as a sustainable energy source and simultaneously reduce net GHG emissions?

By 2030, biofuels will meet only an estimated 3-14 percent of the total transport fuel demand in Asia. This estimate is predicated on the optimistic scenario that countries will rapidly expand cultivation of efficient first-generation biofuels crops on underutilized land while promoting second-generation, "cellulosic ethanol" using agricultural residues.

*Overall, **non-irrigated sugarcane grown on existing croplands,** with efficient use of co-products and wastes, has the most favorable net energy and GHG balance, making it one of the best crops for ethanol production in Asia, where conditions allow. For biodiesel, **oil palm** provides the best net energy and GHG benefits, but only when its cultivation does not involve land conversion and when there is full utilization of co-products and wastes. **Sweet sorghum** holds much promise as an ethanol feedstock in the near term. **Jatropha** may provide significant advantages as a biodiesel feedstock; however, a complete evaluation cannot be done in the absence of detailed information on its agronomy and fuel yield under commercial conditions. Biofuels can be an important part of national strategies to expand access to modern energy to more than half a billion people in Asia. Decentralized energy production systems, when managed by community-level institutions, can help to support rural livelihoods, ameliorate local soil and water quality problems, and reduce GHG emissions—to the extent that they avoid forest loss and displace fossil fuels.*

Large-scale production of biofuels is unlikely to make a significant contribution to Asia's future transport energy demand. By 2030, biofuels will account for only an estimated 3-14 percent of the total transport fuel mix in the focus countries, with the greatest contribution occurring in Thailand, India, and Indonesia, assuming rapid expansion of high-yielding, first-generation biofuels crops on underutilized land, as well as the rapid commercialization and scale-up of cellulosic ethanol production from agricultural residues.

2 Readers interested in such an analysis are referred to: USAID, May 2007, From Ideas to Action: Clean Energy Solutions for Asia to Address Climate Change, Bangkok, Thailand.

Countries vary in their ability to achieve national ethanol and biodiesel mandates. All the focus countries except Indonesia and the Philippines are expected to achieve their ethanol blending targets. Only Indonesia, Malaysia and the Philippines are expected to meet their biodiesel blending targets (see Section 5).

Many biofuels have limited GHG or net energy benefits. Generally speaking, only high-yielding feedstocks grown on existing cropland and converted to fuel using highly efficient processes result in significant net energy and GHG benefits. Ethanol produced from non-irrigated sugarcane grown on existing croplands or degraded land, with efficient use of co-products and wastes, has the most favorable net energy and GHG savings. Ethanol produced from sweet sorghum grown on degraded land as well as cellulosic ethanol also provide favorable energy and GHG balances. However, current grain-based biofuels systems in Asia result in negative or low net energy and GHG savings. Biodiesel produced from oil palm provides the best net energy and GHG benefits, but only when its cultivation does not involve land conversion and where there is full utilization of co-products and wastes. Biodiesel produced from jatropha planted on degraded land and coconut produced under optimal conditions can also provide benefits compared to fossil fuels.

Most large-scale biofuels production systems are not economically viable without extensive subsidies and are subject to boom and bust cycles. Asian biofuels are expensive relative to fossil fuels, and effective utilization of co-products and wastes can be crucial to achieve profitability, which is otherwise highly volatile. In Asia, ethanol from molasses and biodiesel from oil palm and waste oil tend to have the lowest production costs.

The return on investments (both public and private) and the rate of market maturation will depend on how government policy, R&D, and operating costs evolve. In addition, opportunities for expanded trade in biofuels will be limited as long as countries enforce trade barriers and protectionist policies.

The greatest promise for biofuels in Asia lies in decentralized production and use. Decentralized energy production systems, when managed by community-level organizations, can help to support rural livelihoods, ameliorate local soil and water quality problems, and—to the extent that they avoid deforestation and displace fossil fuels—reduce GHG emissions. The preliminary results are promising for several small-scale decentralized pilot initiatives using jatropha, pongamia, and oil palm.

2. Under what conditions should the above biofuels be produced, distributed, and consumed to avoid threats to biodiversity conservation; food security; impacts on fuel prices, smallholders, and rural livelihoods; and other economic, social, and environmental concerns?

Biofuels should be produced in a way that minimizes the use of land, water, fertilizers and fossil energy, and does not exacerbate the pollution of air, water, and soil. The focus should be on feedstocks that do not compete with food production. This can be done by establishing plantations on land that is currently not under food production. Dedicated measures that promote involvement of smallholders, fair trade, labor rights and the rights of indigenous peoples are required to ensure equitable outcomes from biofuels expansion. Smart economic subsidies and incentives are needed to strengthen best practices in existing production systems while paving the way for more efficient feedstocks and technologies. This will ensure that countries are not locked into supporting inefficient, expensive, and unsustainable options. Finally, the dismantling of trade barriers and the establishment of effective standards and certification systems can help promote a modest level of regional and international trade in sustainable biofuels.

Sustainable biofuels polices are needed to safeguard food security. Recent analyses have concluded that the demand for biofuels contributed to higher food prices during 2005-2008, although the magnitude of the influence is subject to debate. The impact of biofuels on food prices in Asia was lower than in other regions, although ethanol from corn and cassava, and biodiesel from oil palm may have contributed to higher prices for food, feed, and edible oils, respectively. While food prices have dropped recently, it is likely that competition between food and fuel will resume in time. In the medium- to long-term, strategies to ensure food security include: (1) intensifying food production and enhancing yields in existing croplands; (2) restricting biofuels crops to marginalized lands not used

for food crop production; and (3) increasing reliance on non-food-based and cellulosic ethanol feedstocks.

The environmental impacts of biofuels depend greatly on the type of feedstock, production system, location, and land cultivation practices. The cultivation of grain-based feedstocks tends to result in higher associated environmental impacts than oil seeds, oil palm, sugarcane,[3] and perennial crops. Sweet sorghum, due to its low demand for water and nutrients, has relatively low impacts, as do jatropha and second-generation feedstocks, owing to their perennial nature and low water and nutrient requirements. Growing biofuels on either croplands or marginalized lands using business-as-usual agricultural practices will exacerbate soil erosion, increase nitrate- and phosphate-related water pollution, and cause a decline in biodiversity. In India and China, large-scale biofuels production can increase demand for fresh water and exacerbate water shortages. Biofuels cultivation can avoid significant environmental impacts through the adoption of agricultural best practices at every stage of production. The conversion of "new" lands, such as primary and secondary forests, to biofuels production, presents a significant threat to biodiversity, particularly in Indonesia, where large tracts of primary rainforest may be slated for biofuels plantations.[4]

On balance, switching from fossil fuels to biofuels may benefit local air quality in Asia. Although land clearing and vegetation burning remains a significant concern, increased use of biofuels could result in reduced ambient levels of sulfur oxides (SO_X), particulates, and carbon monoxide (CO). However, in some cases, biofuels, especially biodiesel, can cause increased emissions of nitrogen oxides (NO_X) and formation of ozone (O_3).

Positive social impacts are not a guaranteed outcome from the large-scale deployment of biofuels. While ethanol production systems have a strong tendency toward economies of scale and neglect of smallholder-based production, biodiesel appears to be better suited to smaller-scale operations. There is widespread evidence across Asia that the development of biofuels can perpetuate poor labor rights and working conditions, threaten lands used by indigenous and marginalized communities, and precipitate local conflicts over resources. Focused policy interventions to address these concerns can include support of smallholders through contract farming arrangements and technical assistance, as well as enforcement of labor rights, protection of land rights, participatory processes for indigenous peoples, and implementation of certification systems.

An international framework is needed for sustainable standards and certification of biofuels. An international dialogue on sustainability criteria and the development of transparent and harmonized standards and certification schemes is currently under way through the Roundtable on Sustainable Palm Oil (RSPO), the Roundtable on Sustainable Biofuels (RSB), and other forums.[5] It will be important for smallholders and other stakeholders in developing countries to receive the necessary technical assistance to be able to comply with these schemes. Also, given the projected growth in domestic demand for biofuels in Asian countries, it will be important for certification efforts to focus on both domestic and export markets.

Smart incentives are needed to promote sustainable biofuels. Experience to date strongly suggests that existing policies and incentives for biofuels production have been counterproductive and, in most cases, too expensive. Subsidies for current biofuels production systems that ignore more efficient next-generation technologies could lock-in inefficient, unsustainable practices.

Mandates and targets alone have been shown to create undesired effects because they have scaled up production very quickly. A more cautious and comprehensive approach combines mandates or targets with explicit sustainability criteria and related measures to encourage sustainable production of biofuels. These targeted measures include capital grants, low-interest or guaranteed loans, demonstration projects, technical assistance, and research and development specifically for biofuels that are produced sustainably.

3 Except in cases where large amounts of water are used to grow irrigated sugarcane (e.g. India).

4 Recently the Ministry of Agriculture in Indonesia announced that it plans to remove an existing ban on the conversion of significant amounts of peatlands—which store large amounts of carbon and support biodiversity—into plantations.

5 One such forum, the Global Bioenergy Partnership (www.globalbioenergy.org), in which the US government is a leading partner, is developing a harmonized approach to GHG emissions reductions from biofuels as well as a voluntary framework of international sustainability principles on bioenergy.

Support is needed to dismantle trade barriers and establish certification systems. Asian countries, like those in the OECD, have erected a suite of import tariffs and non-tariff barriers that restrict the use of foreign raw materials or processed biofuels. Efforts to dismantle trade barriers should be coupled with strict certification systems for quality and sustainability.

Decision-making under uncertainty. The uncertainty and potential pitfalls surrounding the environmental, social, and economic viability of biofuels makes it difficult to structure appropriate biofuels policies or make investment decisions. A two-tiered decision tree presented in this report (see **Section 9**) offers a framework for guiding decisions on individual biofuels development projects—the primary assessment addresses environmental, economic, and social issues, while the secondary assessment helps project developers improve project performance and competitiveness.

3. What priority interventions by USAID would be most useful in promoting the sustainable production of biofuels in Asia?

USAID could encourage the development of a sustainable biofuels industry in Asia through support for land resource mapping and agronomy research, promotion of second-generation and third- generation biofuels, support for development of sustainable biofuels polices, and establishment of certification systems and standards for quality and sustainability. Technical assistance areas that are best addressed within a regional context include the development of biofuels policy, replication and scale-up of decentralized biofuels projects, and development of standards and certification systems for quality and sustainability.

Develop a policy framework for sustainable biofuels in Asia. Asian governments need to review the cost-effectiveness of current biofuels policies with respect to energy security and environmental impacts, and then promote those policies that will foster long-term sustainability. For example, USAID could support a regional dialogue on policies addressing sustainable biofuels production and regional trade.

Improve land resource maps. Claims about the extensive availability of land in Asia for biofuels production are often based on gross-scale national maps that do not reflect land quality, current land use, local populations, or conservation value. In partnership with local NGO and civil society partners, USAID and its US government partners could support detailed land resource assessments to identify the availability of marginal lands, in cooperation with national governments.

Support scale-up and regional replication of sustainable, decentralized biofuels projects. There is an opportunity to scale up ongoing efforts that have been initiated by donors and NGOs to support community-level projects for feedstock development and energy production from biofuels. USAID could support the replication and scale-up of best practices by providing technical assistance to: (1) establish local cooperatives, marketing associations, and coordinated supply systems for larger production facilities; (2) support small-scale and carbon financing; and (3) improve small-scale processing and increased local use of vegetable oils and fuels in engines and generators.

Support agronomy research and crop improvement. The rate at which non-food crops, such as jatropha and pongamia, and cellulosic ethanol feedstocks, are commercialized will depend on how quickly Asian countries can better understand and tailor production systems to maximize yields under local growing conditions. USAID could facilitate US-to-Asia and Asia-to-Asia research partnerships and technology transfer in association with key regional entities such as the International Rice Research Institute (IRRI) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT).

Support development of regional environmental standards and certification schemes. USAID could play an important role by supporting the development of national and regional standards and protocols within Asia that are consistent with emerging international standards, performance guidelines, and certification schemes (such as RSPO and RSB), and by providing technical assistance on compliance efforts to smaller, decentralized operators.

Support technology transfer on cellulosic ethanol. Given the advantages of cellulosic ethanol over first-generation biofuels, it will be important to facilitate

the transition to second-generation technologies in developing countries. Current research, development, demonstration, and deployment (RDD&D) efforts under way in the US could be transferred to Asia through public-private partnerships, demonstration projects, and technology transfer initiatives. USAID can also facilitate the sharing of research findings, best practices, and lessons learned among Asia's key research centers and international research bodies.

Provide technical assistance on life cycle analyses (LCAs). LCAs have become an important tool to evaluate biofuels feedstocks and production systems. To date, only a handful of LCA studies have been carried out for Asian feedstocks and locations. USAID can support capacity building for Asian stakeholders to conduct LCAs for various Asian feedstocks and growing conditions, in order to help Asian policymakers, investors, project developers, and community organizers make informed decisions that will facilitate the scaling up of biofuels production in a sustainable manner.