Prospects for the Biofuels Sector in Cambodia: The Opportunities and the Trade-Offs

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Biofuels: Perceptions of the Future

Biofuels are seen as an industry of the future, as well as the present and the past, representing both the origin of fuels for heat, for transport, and nowadays as a potential replacement, at least in-part for fossil fuels in the generation of electricity. Although thought of as a marginal contributor, biofuels are widespread, contributing nearly 30% of total fuel consumption in Cambodia, much of which is for domestic consumption in rural areas. Several industries, including the garment sector, choose to replace fossil fuels with biofuels for heat generation for industrial processing, reflecting the well-espoused principle of switching away from fossil fuels. In addition to having the potential to replace fossil fuels, biofuels present potential opportunities for exports, especially to regions such as the EU, which have specific targets to increase biofuel usage. Development of biofuels can also provide jobs, particularly in rural areas with the growth of biofuel crops and collection and processing of agricultural waste. Furthermore, biofuels have the potential for increasing farm incomes by generating another source of income by growing additional crops such as jatropha from which oil can be extracted to make biodiesel.

Many countries are considering the same opportunities and prospects, and particularly ASEAN countries, as each, with the exception of Brunei and Singapore, has a large agricultural sector, and the potential to produce biofuels on a large scale, or a small scale at the individual farm level. The biofuel industry has expanded greatly in countries such as Indonesia and Malaysia, which have focused on biodiesel based on palm oil production, and Vietnam, which has focused primarily on ethanol derived from cassava, sugar cane and agricultural residues such as rice husks.

Guidelines and policies are developing worldwide as the impetus for biofuel usage grows, and organizations such as the Food and Agriculture Organization of the UN, have been proactive in producing guidelines and policy frameworks. The primary reason for this is that biofuels come at a cost. Growing crops for fuel will create competition for land that would otherwise be used for growing crops for food, impacting food security. Environmental impacts such as deforestation are seen as risks. It is the trade-offs between the benefits of biofuels, replacing fossil fuels and potentially creating incomes, versus the costs of biofuels potentially replacing food crops, the competition for land space this represents and the environmental impacts that could result from switching significant areas of land to biofuel production.

Biofuels: A Renewable Energy?

Biofuels are a form of renewable energy, as are solar energy, wind power, geothermal energy hydropower, and energy from the oceans and moving water. At a practical level renewable energy is not depleted, as it is renewed or is available in sufficient supply that there is no risk of depletion. Biofuels, although renewable, would have to regenerate. Wind and solar power are, within reason, available constantly, although this depends on windy days and sunny days. Biofuels, taken from biomass, have to regenerate year on year. Energy from biomass has to regrow, and appear in the form of agricultural waste, crop residues, or specific crops and plants grown for the purpose of biofuel. In this sense, this makes the land the prime resource, as biofuels need to take up land space for a given period of time, usually a year, to regenerate. Land is very much the scarce resource.

What are the Sources of Biofuels?

Sources of biofuels are generally classified into four generations, food crops, non-food crops, algae, and engineered biofuels which are used to make synthetic gases.

First generation biofuels are derived from edible crops, which contain high levels of sugar or starch, or vegetable oil. These include sugar cane, sugar beet, cassava, wheat, corn, rapeseed, palm oil and potatoes. Sugar and starch-based crops are a feedstock for ethanol, and oil-based crops are a feedstock for biodiesel. Production of first-generation biofuels directly impacts food supply, having the potential to drive up prices of foods if this results in a food shortage, and require large amounts of fertile land and water.

Second generation biofuels are derived from non-edible plant materials and agricultural waste, focusing on the tough fibrous part of the plant (lignocellulosic biomass). These include wood chips, rice husks, cashew nut skins, wheat-straw, corn stover (husks/stalks), perennial grasses, and also municipal solid waste. Also included are inedible crops such as jatropha, tung and castor bean, which can be grown specifically for biofuel. Second generation biofuel crops provide a feedstock for cellulosic ethanol or renewable diesel. These do not compete with food crops, and can be used as a complement to food crops, such as using rice husks to generate heat or electricity, now increasingly common in Cambodian industry. Non-food crops such as jatropha can be grown at large scale or small scale on marginal land where food crops do not thrive.

Third generation biofuels comprise algae and related micro-organisms which are extremely valuable as a potential source of biofuels as they grow very fast and contain a very high oil content. Feedstocks include microalgae and macroalgae (seaweed). Algae can produce 10-100 times the amount of fuel per unit of land that can be produced from traditional food or non-food crops, and they have a much more limited requirement for land, and so have limited impact on food security. Algae can also be grown in waste water and salt water, so do not require fresh water. Algae can be processed into biodiesel, biobutanol and aviation (jet) fuel, with by-products such as animal feed, fertilizer and nutritional supplements.

The fourth-generation biofuel are the "engineered" biofuels, derived from synthetic biology and carbon capture using genetically modified organisms (GMOs) to maximize the fuel output. Feedstocks include bioengineered algae, plants and captured CO2 and industrial exhausts which can be converted directly into biofuel using solar energy. Fourth generation biofuels are designed to be carbon-negative, and most are still in the research and development phase but these are likely to have a high profile in the near future with expected technological process especially in the area of carbon capture.

What is the Potential of Biofuels for Cambodia?

Biofuels are used significantly in rural areas of Cambodia for domestic heat, in the form of charcoal. Several industries, such as the garment industry also use biofuels for the production of heat for industrial processing. A total of 30% of all Cambodia's energy consumption is estimated to be taken from biofuels in these ways.

Biofuel energy is used for creation of electricity, mainly through burning agricultural waste products, wood fuels, and rice husks, of which Cambodia produces 1.6 million tons annually. Electricity production is primarily generated from hydropower and imported coal, and fuel for transport is entirely imported fossil fuel.

However, there are also some industrial facilities such as sugar and rice mills which produce electricity from biofuels, and small off-grid-projects to use crops such as jatropha, or biodigesters at the household level to generate electrical power for local communities. At the local level, some projects promoted by the MAFF have introduced biofuels to local communities using biodigesters, which can be used for local heating and power generation, although the returns on the initial cost of biodigester have yet to be shown to profitable in some cases.

There is significant potential for biofuels in Cambodia. Crops such as jatropha can be potentially used as it can grow in areas of marginal production, at small farms level or at plantation level, with the possibility of generation of up to 20kg of oil per plant per annum. This could be a form of biofuel suitable at either small farm or plantation level. Certain algae farms exist, but this is not a big industry in Cambodia currently. Export opportunities exist with the genuine aim of developing an export oriented or import

substitution biofuels sector, with possibilities for small scale revenue generation, local electricity production.

The Potential Impact of Biofuels

Switching to biofuels can reduce reliance on energy imports, particularly in the form of local energy projects and small-scale electricity production from biomass. This can lead to increased farm incomes, availability of jobs and potentially can contribute to poverty reduction in rural areas. But switching to biofuels could also result in an adverse impact on food supply and food security by increasing the demand for and competition for land, and could also risk deforestation and potential over use of agricultural waste for the production of biofuels. Whether or not the climate is positively or negatively affected by biofuels is not yet clear as reduction of greenhouse gases in growing biofuels is countered by the release of carbon and the additional use of fossil fuels in extracting and processing biofuels.

The impact on climate change is hotly debated. Whilst biofuels absorb carbon during growth, the process of conversion of wetlands, grasslands and forests for biofuel production can release large amounts of carbon into the atmosphere. The manufacturing process for biofuels is energy-intensive and would often involve fossil fuels for fuels, production of fertilizer, irrigation and refining and blending. Requiring large amounts of water and fertilizers could lead to water depletion. There are many environmental issues related to biofuels and the jury is out. There are social issues and potential trade-offs as well that come from competition over scarce resources such as land. As this affects the wellbeing of farmers and communities, attention to ESG and international standards for RBC helps create needed safeguards. The UN Guiding Principles on Business and Human Rights and the OECD Due Diligence Guidance for RBC are important reference points to identify and manage trade-offs around biofuel production.

Policy and Regulatory Framework for Biofuels

Whether small or large scale, investment in infrastructure is required, and finance for investment is a subject of government policy. For an objective based on small-scale adoption of biofuels, cooperatives, local electricity production facilities, and biodigesters at the individual household level would be key. For large-scale objectives a supply chain is necessary, including refining and blending facilities. Determining objectives of policy for biofuels and financing the infrastructure needs is a primary objective of policy. Standards need to be set (e.g. ethanol 5%) for cars, and a regulatory framework created which provides the incentive and the cost and tax structure, which provides the incentives to produce biofuels without making them so attractive as to create competition for land.

Cambodian Policy for Biofuels

Cambodian Policy for biofuels had been focused on market signals and local coordination rather than specific policy towards promoting biomass energy. Biomass energy has been incorporated into the Power Development Plan 2022-2040, which has prioritized expansion of renewable energy resources including solar, wind, biomass and hydropower, and provides incentives for local initiatives. There are only about two companies actively farming biomass energy at the moment, but the 2020s is seeing a renewed interest in the biofuels sector.

ASEAN Policy on Biofuels

ASEAN policy started with the ASEAN Plus Three Comprehensive Strategy on Food Security and Bioenergy in 2010 balancing the objectives of food and energy security, promoting biofuels from agricultural waste, and fostering research and development of biofuel technologies to establish best practice. This came with the Strategic Plan of Action for Food and Energy Security of 2010. The ASEAN Strategy on Sustainable Biomass Energy for Agricultural Communities and Rural Development in 2020-30 was introduced in 2021, aimed at fostering reliable, affordable and sustainable biomass energy, with the specific objectives of innovating biomass energy in rural areas, improving the standard of living for rural communities, and fostering shared research, education and policies, awareness, data sharing and technology transfer across ASEAN.

The plan includes the provision of finance for biomass production, and the development of a regional and national biomass market. As access to electricity is still low in several ASEAN countries the objective of using biomass energy to improve rural lives has been paramount. Several countries have sought to greatly expand the use of biomass energy, including Indonesia, Malaysia, Philippines, Vietnam and Thailand.

The Need for Biofuel Infrastructure

Infrastructure is needed for biofuels in order to collect, process, refine, and blend the biofuels. This requires processing plants, either as cooperatives for local farmers, or a larger scale supply chain for more plantation crops. Cooperatives have been tried in many countries such as Brazil, Kenya, and Thailand for the production of palm oil. Countries with more export-oriented policy objectives have invested in larger scale supply chains with processing and blending facilities for ethanol and biodiesel, such as Malaysia and Indonesia. Other countries, such as India, have invested in biodigesters at the local community level. Government subsidies have been made available to make biodigesters affordable for the many. One step up from the household level bio-digesters, are the cooperatives used for collecting the biofuels from individual small farmers and converting this into local electricity.

Conclusion: The Economic Case for Biofuels

One of the main issues is whether the economic case for biofuels is certain. At the local level biodigesters have been shown to be viable in some cases, but expensive in others. If larger-scale biofuels are sustainable we would expect to seeing commercial interest increasing. Examples internationally suggest that government support is currently a prerequisite, both at local level and at large scale level, perhaps while the economic case is still being proven and while countries are still in the process of developing the required infrastructure. One scenario is to see a commercially viable biofuels industry in the future. But the benefits of biofuels will also accrue in terms of additional incomes for farmers, export revenues, import substitution, benefits to climate, these benefits cannot be all obtained at the private investment level.

This leaves the case for government subsidy, and it becomes a policy decision to decide what the objectives of switching to biofuels should be, for the local level, or for export potential, or both. The biofuels sector will grow, both in Cambodia and more broadly in ASEAN, but it is worth being wary of the need for trade-offs. Land is the scarce commodity and biofuels take time to regenerate. As with current policy, it may be better to let the market emerge, and evaluate the benefits and the costs, and learn from the experiences of other countries. New business models could result at the local level, and the more public private partnerships, and a strong emphasis on ESG evaluation to ensure that the benefits and costs derived are recognized and addressed.

For the full case study on Biofuels Industry in Cambodia: Building a Sustainable Business Environment for Replacing Biofuels, see the CamEd Website.

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