# Will Biofuels Revolutionize the Southeast Asian Energy Industry?

With billions of investment dollars going into the field, the stage is set for players to invest and reap rewards.

Southeast Asia faces the same energy challenges that most other regions of the world face. With increasing crude oil prices, limited fossil resources, and environmental sustainability issues, there is a huge demand for alternative energies. Political instability in key resource regions makes the crude oil supply even more uncertain.

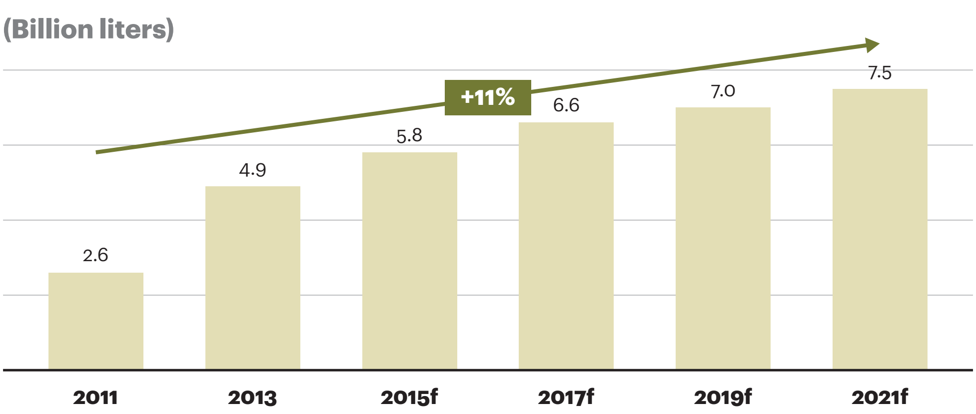
## Second-generation biofuels **address all the concerns** posed by fossil fuels and first-generation biofuels.

On the verge of high growth with few specific hurdles to overcome, second-generation (2G) biofuels have the potential to bring drastic energy relief to Southeast Asia. The latest biofuels address all the concerns posed by fossil fuels as well as first-generation (1G) biofuels. There is no resource scarcity, for example. Feedstock used for 2G ethanol is mainly cellulosic material such as grass, corn stover, rice husk, and wood fuel, implying practically unlimited resources. There is minimal food chain risk, as the feedstock is not part of the food chain. Moreover, the emission levels are lower, thus improving environmental sustainability.

Among the barriers holding back the industry is unfavorable economics, yet recent technological advances (primarily second-generation technology) can overcome them. That technology will help jumpstart significant production growth in the Southeast Asia region with Malaysia, Indonesia, Thailand, and the Philippines expected to be the major contributors (see figure 1).

What remains, then, are the five hurdles that stand between Southeast Asia and the promise of nearly unlimited fuel. We examine those hurdles below and recommend ways to surmount them (see figure 2 on page 2).

Figure 1
**Southeast Asia biofuel production forecast**




Note: Includes numbers for Indonesia, Malaysia, Philippines, Thailand, and Vietnam.

Sources: International Energy Agency (IEA), Organisation for Economic Co-operation and Development (OECD), Food and Agriculture Organization (FAO); A.T. Kearney analysis

Note: First-generation (1G) biofuel is produced from food biomass feedstock (for example, palm oil or sugarcane); second-generation (2G) uses non-food biomass (such as grass or corn stover); third-generation (3G) uses algae.

Figure 2
**Key requirements in clearing the way for growth**

| Requirement | Fulfilled | Contingency |
|---|---|---|
| **2G technology availability and affordability** | ✓ | Technology commercially available with good economics |
| **Feedstock availability** | ✗ | Abundant availability but supply chain yet to be developed |
| **Regulatory support** | ✗ | Appropriate incentives and policy mechanisms to drive production needed |
| **Vehicle technology** | ✗ | Not an issue currently due to lower blending; potential issue in future |
| **Concerted effort across stakeholders** | ✗ | Adequate investment, policy, and drive from NOCs and IOCs needed for success |

Notes: 2G is second-generation. NOC is national oil company. IOC is international oil company.
Source: A.T. Kearney analysis

# The Five Biofuel Hurdles and How to Overcome Them

## Affordable, available technology

**2G versus 1G and 3G.** A revolution in the energy space is under way, thanks in part to 2G technology entering the fray. Production costs have fallen to levels below crude oil, with commercial operations already active at the Beta Renewables' plant in Crescentino, Italy. That may be halfway around the world from Southeast Asia, but players in the region could capitalize on this development and look for potential licensing opportunities.

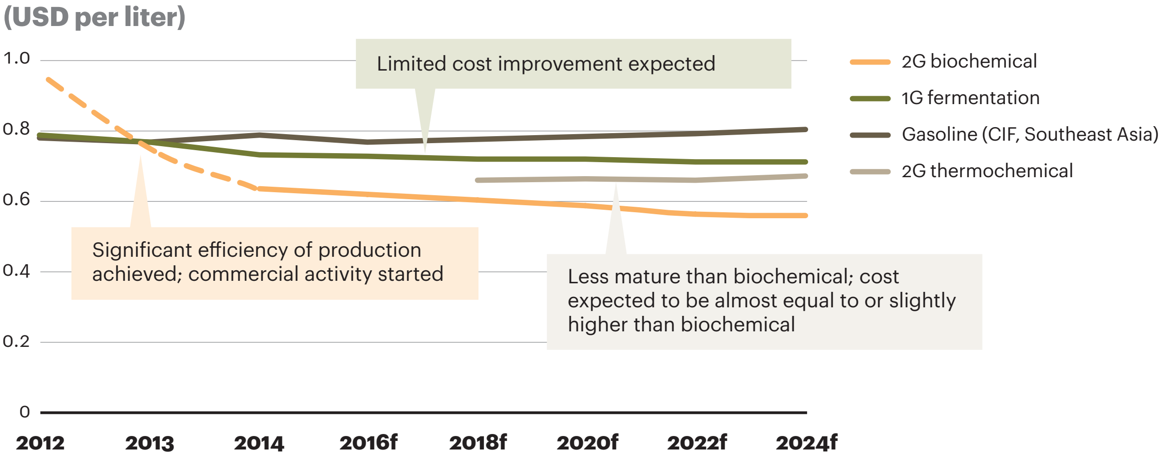
In comparison, unfavorable economics are adversely affecting 1G technology for both ethanol and biodiesel. We expect limited cost reductions going forward due to minimal future optimization potential and primary dependence on volatile feedstock prices, which are driven by market dynamics and 1G's link to the food chain. Thus, 1G technology faces curbed growth. What's more, over the next decade, production-cost optimization will be limited for 1G technology, due to narrowing efficiency improvement and volatile feedstock prices (see figure 3 on page 3). Players are starting to look ahead to 3G technology as a game-changer as well. While its commercialization remains distant, rapid progress in 2G has reduced costs leading to commercialization and the next generation.

**Biochemical technology.** Multiple companies across the value chain, including chemical and biochemical companies (such as the Mossi Ghisolfi Group, Novozymes, and DSM), technology companies (including DuPont and UOP), and biofuel producers (such as POET) were eager to unravel the mystery of 2G technology through increased research investment. As a result, there were significant improvements in 2G costs from 2008 to 2013, led primarily by yield improvement and the use of more efficient enzymes, which resulted in a 70 to 80 percent decrease in enzyme costs. These factors are expected to drive further cost reduction in the next 10 to 15 years (see figures 3 and 4 on page 3). The latest developments (from companies such as Beta Renewables and INEOS Bio) prove that 2G biofuel can reach production costs as low as USD 0.60 to

0.70 per liter, which are below the current production costs of fossil gasoline and 1G ethanol. Production costs are expected to go as low as USD 0.55 to 0.60 per liter during the next decade.

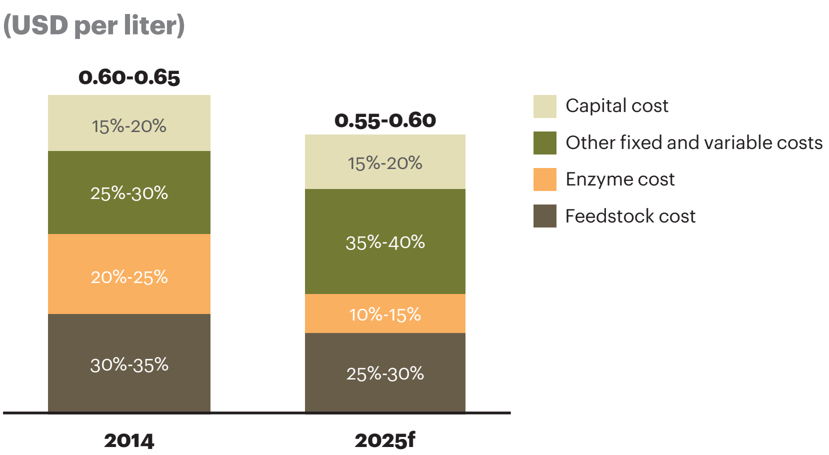
**Thermochemical technology.** Costs with this technology have been achieved (by INEOS Bio) similar to that of biochemical technology. Yield improvements in syngas formation and utilization, and subsequent conversion to ethanol, have resulted in higher efficiency and lower costs. We expect these factors to further drive down costs to approximately USD 0.65 per liter by 2017, but that progress will be countered to some extent by the increasing cost of feedstock for syngas (see figure 3). Production costs will be relatively higher than 2G over the next decade at USD 0.65 to 0.70 per liter.

Figure 3
**Ethanol production costs for Southeast Asia**




Note: CIF is cost, insurance and freight.
Source: A.T. Kearney analysis

Figure 4
**2G biochemical ethanol production cost split**




Note: 2G is second-generation.
Source: A.T. Kearney analysis

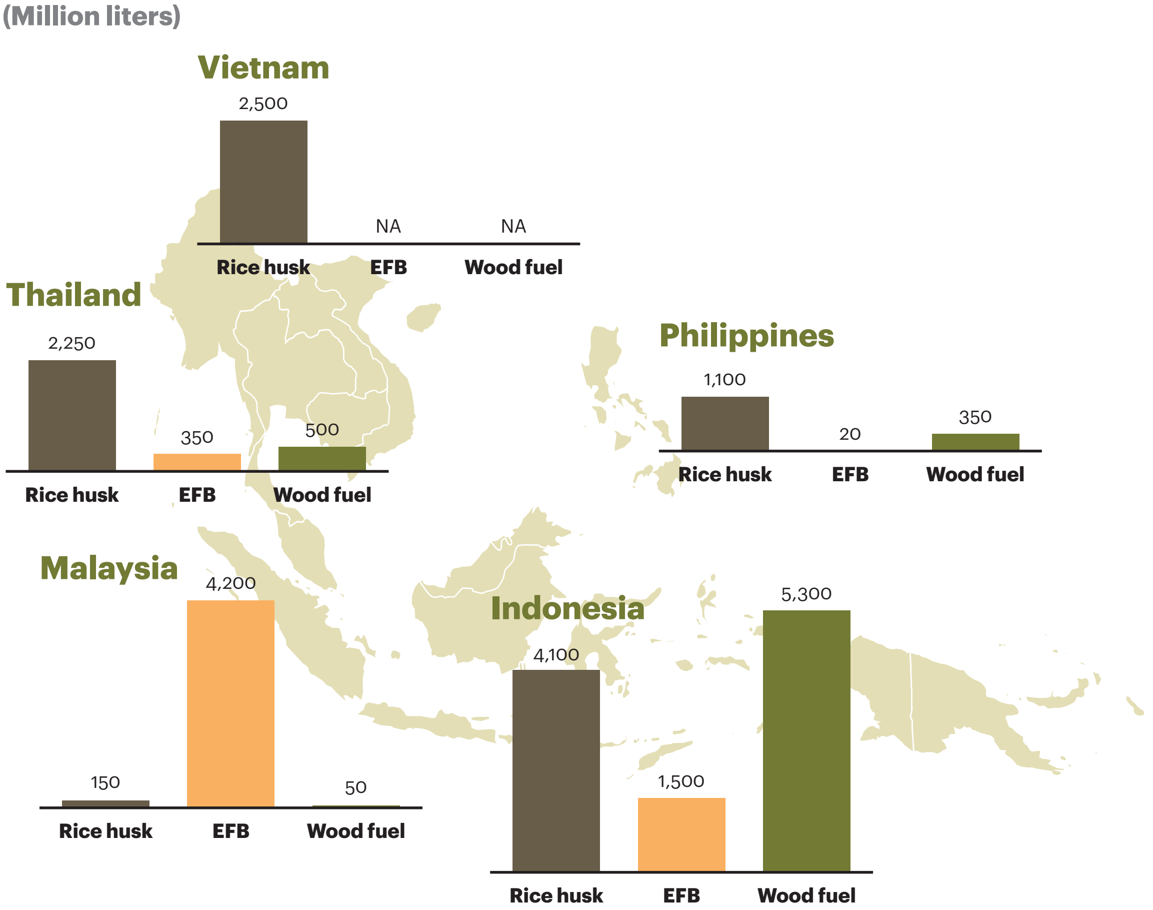
### Feedstock availability

**Supply alternatives.** As discussed above, 1G technology, the most widely used biofuel technology, requires feedstock that interferes with the food chain. One of the primary concerns about biofuels has been the raging food versus fuel debate, which highlights the risk of food supply disruption due to increased diversion of land for biofuel feedstock. Other concerns include soil erosion, increased pressure on water resources, loss of biodiversity, and environmental imbalance caused by large-scale clear-cutting of forest land for biofuel production.

2G technology can potentially address these concerns. It uses non-food-based feedstock, namely lignocellulosic material, which is currently used primarily for self-consumption as fuel or fodder. Typical feedstock includes rice husks and straw, grass, empty fruit bunches (EFBs), palm fronds, wood fuel, and corn stover.

The Southeast Asia region has abundant availability of 2G-specific feedstock (see figure 5). For example, Malaysia and Indonesia are the largest palm oil-producing nations in the world, resulting in high quantities of available palm waste (such as palm fronds and EFB). Wood fuel and rice waste are also available in large quantities, which can be leveraged for biofuel production.

Figure 5
**Feedstock-wise ethanol production potential in Southeast Asia**




Note: EFB is empty fruit bunch.
Sources: FAOSTAT; A.T. Kearney analysis

**Supply challenges.** Ensuring a strong and efficient supply chain for 2G feedstock is one of the key problems facing the industry today. Supply chain costs can constitute up to 50 percent of feedstock cost. With no established supply chain, intense coordination is required across multiple stakeholders (including farmers, collectors, logistics partners, and producers). What's more, the feedstock is dispersed across vast agricultural areas. The geographical spread of some countries, such as the archipelago Indonesia, magnifies the logistical problems.

For biofuels to succeed, establishing an efficient feedstock supply chain is one of the key prerequisites. It also will play a major role in determining the economic feasibility of production.

Biofuels can **generate multiple benefits for governments,** including a reduction in oil-import bills, answers to environmental concerns, and economic development.

Broadly, there are two ways to address the issue of supply chain: increasing the current supply chain's efficiency and developing alternate means of logistics.

Multiple approaches can increase supply chain efficiency. Defining an optimal network for bio-refineries, including the number and location of storage facilities and capacity planning, is a good start. Refining the design of collection, storage, and transportation according to the type of feed-stock and storage facilities (such as bale form versus pelletized) is another option. In addition, increasing the energy density of feedstock before transportation may help optimize costs, specifically after weighing the benefits with the additional preprocessing costs that would be incurred. Finally, pipeline transportation of feedstock, in slurry or liquid form, could be an answer.

### Regulatory support

Biofuels can generate multiple benefits for governments, including a reduction in oil-import bills, potential answers to environmental concerns, and economic development of a region (through job creation and heightened agricultural activity, for example). These benefits will be augmented by 2G technology.

Knowing this, some governments in Southeast Asia have issued biofuel mandates, but we believe that incentives and policy mechanisms are still needed to support industry growth. Indonesia, for example, is considered one of the powerhouses for biofuel growth and has biofuel blending mandates in place. Yet, its ethanol-blending targets have not been met and industry growth has been stunted, due in part to the country's price cap on ethanol, which has kept the fuel's selling price so low that fuel-ethanol production is unviable and currently at a standstill in Indonesia.

Supportive policies, therefore, could have a tremendously positive effect for the industry, at least until the time efficient 2G technology is widespread in the region. Governments in the region could boost growth first by considering the industry from the point of view of major stakeholders including producers, investors, and oil marketing companies. Robust support would include blending targets to propel production, 2G-specific tax and incentive policies, market-determined and optimal price setting for economically viable production, and subsidies for producers (especially until 2G technology enters specific countries or areas). Constructive policies also can drive financing for capital expenditure on biorefineries, R&D in biofuel technology, and aid in supply chain setup, from harvest points to refineries. Several countries have enacted some of these policies, including the United States (see sidebar: U.S. Policies Designed to Aid Biofuel Growth).

Industry lobbies are pushing for reforms as well. The Association of Indonesian Biofuel Producers is lobbying against Indonesia's price cap by proposing a mutually beneficial price formula that will lead to profitable production for producers and the achievement of blending targets for the government.

### Vehicle technology

While blending mandates remain low in most Southeast Asian countries, vehicle technology for handling biofuel blends will not be a major issue.

Going forward, however, increasing blends will challenge vehicle technology and deter biofuel growth, especially as blends reach 10 to 15 percent biofuel. Automotive associations in Indonesia and other countries have begun protesting against blending. The solution may lie in introducing incentives for vehicle manufacturers that encourage them to develop technology that can handle higher blends and introduce more alternative fuel vehicles.

### A call to action for key stakeholders

Despite the hurdles, the biofuel revolution will see the light of day if stakeholders work together to make it happen. The major stakeholders (along with their roles and potential influence) include:

**International oil companies (IOCs).** With high rates of return for 2G technology (typically greater than 15 percent) in the cards, biofuels present a very lucrative business proposition for IOCs. They will also help them comply with the biofuel blending mandates appearing in a number of countries. With these regulations in mind and fueled by attractive financial returns, IOCs will enter the sector in growing numbers.

### U.S. Policies Designed to Aid Biofuel Growth

Among more prominent countries, the United States has enacted a number of policies to support biofuel investment and use. While they are working, there is still significant room for improvement.

#### Mandates and directives

- Targets set by the Renewable Fuel Standard (RFS) and Renewable Identification Numbers (RIN); resulted in increased ethanol production
- Phasing out of methyl tertiary-butyl ether; led to increased usage of ethanol and ethyl tertiary-butyl ether as a better oxygenate and fuel replacement

#### Tax incentives

- Federal income tax credits for flex fuel and alternative fuel vehicles
- Tax credit for cellulosic-biofuels producers
- Tax credit for alternative fuels infrastructure

#### Subsidies and credit facility

- 2G biofuel plant depreciation deduction allowance
- Multiple credits, grants, and loans for development of bio-refineries and research on advanced biofuels

Seeking partnerships with select technology providers will help IOCs keep pace with the industry. Additional partnerships with investors can help with funding, if needed. Since deploying 2G requires coordination across the entire supply chain, a joint venture model, such as a partnership with investors, feedstock suppliers, technology providers, and operations and maintenance players, may be the preferred mode of operation.

Several major U.S. players have already begun active investment in the field. Actively investing time and money now will help IOCs attract the best investors.

With intense activity taking place in both spheres, **the time is ripe for players to captalize on the opportunity.**

**National oil companies (NOCs).** As an arm of governments, NOCs can spearhead regulatory change and lead the drive toward environment sustainability. In multiple geographies, there is an increasing expectation that NOCs will lead the renewable energy charge and meet government targets. Lucrative returns further build the business rationale for NOCs as they start exploring 2G technology and scout for partners.

**Technology providers.** Leading biofuel technology companies such as Beta Renewables and INEOS Bio are their field's pioneers and can leverage this opportunity to the maximum and actively pursue leads for licensors. They also will be in position when high-growth Southeast Asian countries such as Indonesia experience a surge in biofuel demand. Meanwhile, securing intellectual property rights can minimize the risk of increased exposure or loss of their most valuable technology secrets.

**Investors.** The anticipated high rates of return for biofuels make an investment in the biofuel space potentially very lucrative. Investment can be in technology research or in the biofuel projects led by established players. Investment in technology is a high risk-high return game, however, whereas investment in production projects generates a comparatively stable return.

With intense activity taking place in both spheres, the time is ripe for players to captalize on the opportunity.

**Governments.** As we mentioned previously, in return for introducing biofuel mandates and providing tax incentives, subsidies, and support for foreign investment, governments can decrease dependence on imported oil, which is a major issue for many Southeast Asian countries, and advance their environmental and economic-development agendas.

Even though biofuels present a very lucrative business proposition for IOCs and NOCs in the long term as production costs decrease, government will play a crucial role in the next three to five years. That is the time needed for increased utilization and percolation of efficient 2G technology to all regions, an efficient feedstock supply chain to take root, and lower production costs to be realized. Governments also can help by setting price floors for biofuels, thus aiding producers. The onus is also on governments to lead change via the NOCs. Eventually, biofuel production will be self-sustaining, and governments will be able to reduce their role while still enjoying biofuel's benefits.

## Southeast Asia's Future Is Biofueled

The precedent has already been set. The consolidated efforts of stakeholders have yielded fruit in many countries beyond Southeast Asia such as the United States and Brazil, where biofuel sales are seeing significant growth. Many Southeast Asian stakeholders have high aspirations for biofuel as well. With billions of dollars worth of investment going into the field, the future looks bright. As long as we overcome the sector's hurdles, the path is lit for companies to invest in and reap the biofuel rewards.

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