Chapter 3
Fueling Transformation in the Mekong: Thailand's Trade in Agro-Energy

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Abstract The Mekong region stands at an important development juncture, where the dynamics of sustainability are being defined through an unprecedented level of cooperation on agriculture, energy, and trade in combination with action to address climate change. This chapter examines the policy space to develop sustainable agriculture while fueling transformation in the Mekong region based on research from the field. This research brings together evidence, pointing to the need for a paradigm shift in the food, energy, and water nexus toward greater policy integration. The use of bioenergy may promote energy security, revitalize rural economies, and reduce greenhouse gas emissions if implemented at the local community level. However, meeting food and energy needs in the twenty-first century, especially in Southeast Asia, will require a range of approaches to shift the current development paradigm in order to enhance natural resource governance and climate-friendly agricultural practices. This research shows that if current practices prevail, Thailand is likely to use an unsustainable model of trade-led development

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at the regional level. To the end, this chapter puts forward an alternative development strategy to build on the synergies between small-scale initiatives and agro-energy sustainability. However, evidence indicates that these synergies will be difficult to capture in the current policy climate that separates people's well-being, social progress, and ecosystem sustainability from intensifying resource use in the Mekong.

Keywords Mekong region · Thailand · Trade · Regional integration
Bioenergy · Agro-energy · Biofuels · Sustainable development
Resource use · Community-based resource management · Smallholders
Value chains · Climate change

Introduction

Trade between Thailand and its Mekong neighbors has shown an unprecedented level of growth in the past few decades.[1] With the entry into force of the ASEAN Economic Community in 2016, enhanced market integration will give further impulsion to regional systems of food, fuel, and fiber. This regional integration will not be without social and environmental impacts. Rapidly increasing demand for energy has led to the expansion of first-generation bioenergy produced from agricultural biomass. Such a trend, if not managed, has the potential to displace food production and impact the food supply chain (Greater Mekong Forum on Water, Food & Energy 2015; Giampietro and Mayumi 2009; FAO 2008; UNE 2007; Doornbosch and Steenblik 2007).

A review of the literature makes it clear that the current energy situation in the Mekong is not sustainable due to a rapidly increasing demand from growing economies and reliance on energy imports; this situation has been made more complex given the uncertainty of climate change impacts (Bruckman et al. 2016; WWF 2016). In this context, bioenergy is considered to be one way to lessen the region's dependence on oil imports and diversify its energy mix, while at the same time stimulating regional connectivity (Bruckman et al. 2016; Smajgl and Ward 2013; Tharakan et al. 2012; ADB 2009a).

Trade in bioenergy represents opportunities as well as challenges for the region. This is particularly the case for Thailand as a leading global food supplier and the eighth largest agro-energy producer. In order to capture the opportunities, bioenergy strategies need to bring together theory, policy, and practice in a way that allows local experiences to inform policymaking. Hence, the approach being pursued

[1]The Mekong is comprised of Cambodia, Lao PDR, China (Yunnan and Guangxi), Myanmar, Thailand, and Vietnam.

should ensure agro-crops contribute to sustainable development and do not replace food crops or result in forest clearing or biodiversity loss. The expectation is that the coming decades will witness a transition to more resource-efficient generations of bioenergy (e.g., algae, cellulosic) (Samai 2016; USDA 2016; ADB 2013; UNEP 2011).

Thailand has gained experience in adapting to the impacts of globalization, which have tested traditional ways of structuring the economy. Importantly, the *unintended* environmental consequences of modernity have emerged as a *common threat* to our existence (Beck 1992). Modernization of the Thai economy has included strengthening community-based agro-energy initiatives. In Thailand, small-scale farmers predominately cultivate plots of between 2–5 hectares. The Thai model for integration of smallholders into the agro-energy value chain offers a basis from which to build resilience at the local level. This chapter offers evidence that this model can also help to bring about a transition to low-carbon economies in a highly climate-vulnerable region.

Methodology: Goal, Scope, and Context of the Research

This chapter explores the relationship between Thailand's trade in bioenergy based on evidence from the field. The shift to bioenergy was launched in Thailand's 15-year Renewable Energy Development Plan in 2008 and strengthened in the Alternative Energy Development Plan (AEDP) in 2015. The AEDP now forms a part of Thailand's Integrated Energy Blueprint (2015–2036), endorsed in October 2015 alongside the National Economic and Social Development Plan. The AEDP sets targets to increase alternative energy consumption to 30% by 2036, with ethanol projected to increase from 1.17 billion liters (BL) in 2015 to 2.6 BL by 2036, and biodiesel from 1.23 BL in 2015 to 5.1 BL by 2036. The expectation is for second-generation bioenergy to increase, with cellulosic technology (USDA 2016; IEA 2015, 2011; ADB 2009a).[2] Data for this research are based on a literature review, fieldwork using a survey questionnaire, observation, and semi-structured interviews with 143 respondents between 2008 and 2010.

Table 3.1 contains the list of informant organizations by category. While the focus was Thailand, the entire region is covered to some extent. The survey questionnaire was designed to gain insight into the challenges and opportunities presented by agro-energy development in Thailand and the Mekong as perceived by the representatives of the five informant categories. The questionnaire consisted of ten questions with multiple choice answers (Table 3.2).

[2]As in most countries, fossil fuels continue to be heavily subsidized. In 2012, Thailand spent US$7 billion on fossil fuel subsidies, amounting to 1.9% of GDP (IISD-GSI 2015).

Table 3.1 Informants by category and method of data collection

Method of data collection	C1 Government		C2 International & regional intergov organizations		C3 NGOs		C4 Private sector		C5 Local level		TOTAL	
Informant Interviews	114		110		173		36		76		545	
In-depth informant interviews[a]	29		25		38		28		22		143	
Questionnaire	29		25		38		28		22		143	
Focus groups[b] individual/mixed	6	14	4	6	4	17	11	6	3	7	21	28

[a]Informants for the in-depth interviews also responded to the survey questionnaire

[b]Of the total of 49 focus groups, 28 were amongst individual categories of informants and 21 were mixed to bring together informants from different categories

Table 3.2 Survey questionnaire

1. What is the main driving force behind your country's *policies* on biofuels?
2. Could your Government benefit from more **information** in formulating biofuels policies?
3. Could **coordination** between ministries on biofuels policy be *improved* in your country?
4. What is the *main challenge* to the development of the **biodiesel** sector in your country?
5. What is the *main challenge* to the development of the **ethanol** sector in your country?
6. Which actor should *take the lead* in developing the biofuels sector **in your country**?
7. Which actor should *take the lead* in developing the biofuels sector **in the Mekong region**?
8. Are you aware of, or do you benefit from **Government incentives** to promote biofuels?
9. Are you aware of, or do you make use of **standards** related to biofuels?
10. In your opinion, is your country's biofuels sector *developing* along the **right path**?

Interviews were conducted with five categories of key actors in the bioenergy sector. This was supplemented with focus group discussion. The objectives of the field survey were the following:

(a) To assess the challenges and opportunities related to Thailand's development of bioenergy.[3]
(b) To investigate how a broad range of actors is integrating trade and environment considerations related to bioenergy.
(c) To assess the implications of bioenergy development on sustainable development in the context of the Mekong region.

Field research was conducted through six case studies, as outlined in Table 3.3, based on the recommendations of experts in the field. The first set of three case studies focuses on community bioenergy in different regions in Thailand. The second set of three case studies illustrates commercial bioenergy operations in selected sites in Lao PDR, Myanmar, and Thailand.

In order to assess the policy options for bioenergy development in Thailand and the Mekong region, the investigation distinguishes between the following three categories of bioenergy development:

Type A: community biodiesel to revitalize rural development and build resilience in food and energy systems at the *local* level (in case studies 1, 2, and 3).

Type B: commercial ethanol and biodiesel production for *domestic* use, with the potential to export tapioca-based ethanol (in case study 4).

Type C: Thai investment in agricultural feedstock in the neighboring Mekong countries (Cambodia, Lao PDR, and Myanmar) for export to Thailand to be used in commercial ethanol and biodiesel production (in case studies 5 and 6).

[3]Bioenergy includes liquid, solid or gaseous fuels produced from plant biomass, such as from agricultural crops and by-products, aquatic plants, forestry products, wastes and residues, and animal wastes. Liquid bioenergy, the subject of this chapter, include biodiesel (from oilseeds such as palm oil or *jatropha curcas*) and ethanol (from sugar, cassava, maize, and other starchy crops).

Table 3.3 Case studies of community and commercial bioenergy

	Agro-energy crop	Cultivation area
PART I: Community biodiesel		
Case study 1	Oil palm	Rangsit, **Central Thailand**
Case study 2	Oil nuts (Jatropha)	Vanghinlad, Chumpae, **Northeastern Thailand**
Case study 3	Oil palm	Aoluk, Krabi, **Southern Thailand**
PART II: Commercial agro-energy		
Case study 4	Sugarcane and cassava	Khon Kaen, **Northeastern Thailand**
Case study 5	Oil palm and cassava intercropping; Jatropha	Pakse, Champassak, **Southwestern Lao PDR**
Case study 6	Oil nuts (Jatropha)	Shan state and Mandalay, **Myanmar**

This chapter puts forward that despite the policy frameworks in the Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS) and ASEAN, regional governance of the agricultural sector—land, water, trade, and investment policies—is fundamentally *lacking in practice* in the Mekong. That is why an alternative policy approach, the *Small is Smart* option, is advanced to integrate small-scale farmers into a broader framework for agro-energy production and use. It envisages smallholders as spearheading sustainable resource management and tackling energy poverty. Moreover, it envisages the incorporation of smallholder efforts into a coordinated regional agro-energy supply chain.

Thailand's Bioenergy Strategies: Why Bioenergy?

Economic growth is propelling significant increases in energy production, primarily based on conventional sources (coal, natural gas, oil, and large-scale hydropower). It is estimated that energy demands in the Mekong will triple by 2030 (ADB 2015). As the world's largest exporter of tapioca and rice, and second largest sugar exporter, Thailand has significant capacity to produce feedstocks to generate bioenergy (Chanthawong and Dhakal 2016; Samai 2016).

Thailand's bioenergy sector is more advanced than other countries in Asia as a whole for several reasons. First, Thailand's dependence on petroleum imports to stimulate its export-led growth has provided an incentive to develop alternative energy sources. Over the past several decades, Thailand has spent approximately 10% of its annual gross domestic product (GDP) on oil imports. Already in the 1980s, Thailand began investing in research and development to decrease oil dependence by converting its abundant agricultural biomass into biofuels

(Achawangkul 2015). Thailand's energy intensity in relation to GDP has been rising since the early 1980s to a relatively high level. For each percent increase in GDP, there is a resulting increase of 1.4% in energy consumption. The majority of energy is consumed in the industrial (37.1%) and transport (35.4%) sectors (DEDE 2015b). The consequences of these dramatic increases will continue to be unprecedented in terms of regional livelihoods, ecosystems, and greenhouse gas emissions (WWF 2016; Greater Mekong Forum on Water, Food & Energy 2015).

Second, in light of the volatile world price of oil, bioenergy offer a means to diversify fuel sources, thereby increasing energy security (Bruckman et al. 2016; Achawangkul 2015; Apichart 2015; Tharakan et al. 2012; ADB 2009b, c, d; Bundit 2009). In this respect, the vast majority of respondents (82%) in the research survey ranked energy security as the main driving force behind bioenergy development in the Mekong, with only one respondent referring to climate change as a driver for the development of the sector.

Third, developing the bioenergy sector represents an opportunity to add value to the agricultural sector and stimulate rural development. Smallholders have the possibility to meet their energy needs and to contribute to the agricultural value chain (Tharakan et al. 2012; FAO 2012b).

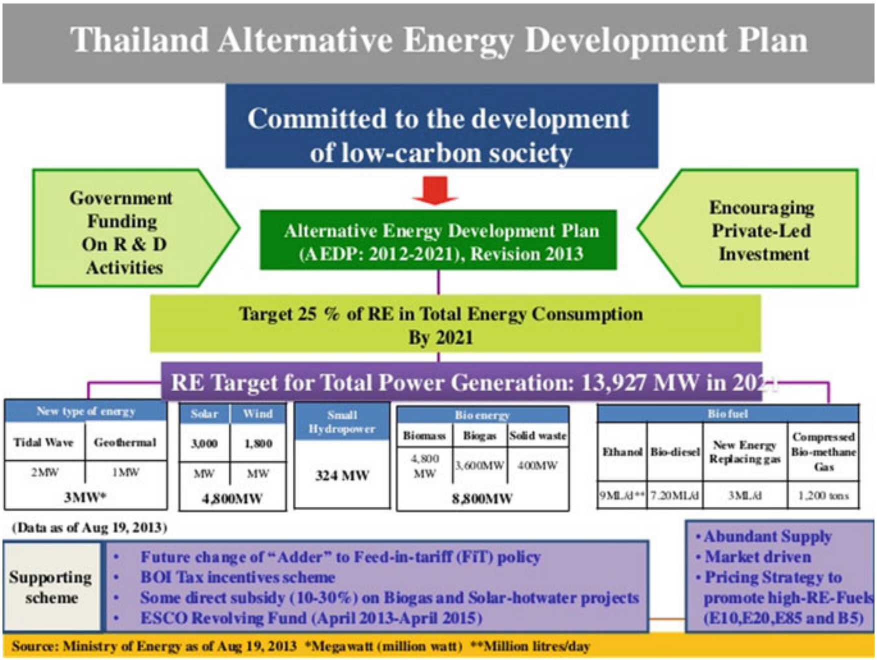

Fig. 3.1 Thailand's Alternative Energy Development Plan. *Source* Ministry of Energy DEDE (2013)

Fourth, bioenergy may help to reduce greenhouse gas emissions, thereby contributing to addressing climate change. Studies are ongoing to calculate the net energy balance of various biofuel feedstocks (ECOFYS 2016; Johnson and Seebaluck 2012; Guariguanta et al. 2011; ADB 2009c; FAO 2009b; SEI 2008). More efficient use of agro-processing waste materials and water effluents also is reforming the sustainability of the agricultural sector (e.g., for tapioca and oil palm processing mills) (Sombilla et al. 2009; Segschneider 2008; Surapong 2008).

Based on this combination of diverse policy objectives, Thailand's ambitious Alternative Energy Development Plan (2012–2021) includes targets for ethanol of 9 million liters/day and for biodiesel of 5.97 million liters/day by 2021. The mandate for B5, instituted in 2012, was increased to B7 (provisionally decreased to B4 in 2014). As outlined in the Fig. 3.1, Thailand's goal is to supply 25% of national energy consumption with renewable energy by 2021 (compared with 9.4% in 2015) (DEDE 2015a).

Prospects for Trade in Biofuels

Thailand aims to increase the production of bioenergy primarily to meet domestic targets in the transport sector. Transport fuel currently blends ethanol with gasoline in two ways: E20 (a blend of 20% ethanol and 80% gasoline) and E85 (a blend of 85% ethanol and 15% gasoline). Over the past decade, its strategic plans for gasohol and biodiesel have established blending targets. Driving these targets are plans to increase sugar plantations from 10 million rai in 2015 to 16 million rai by 2026, with the intention of encouraging rice farmers to switch to higher value crops, such as sugarcane and oil palm.[4]

The overall aim is to diversify Thailand's renewable energy matrix. In the context of increasing economic integration, rising regional investment and mandated renewable energy targets in other countries, come opportunities for bioenergy trade with Mekong countries, ASEAN, and beyond. Diversifying cropland for bioenergy becomes appealing. At the same time, there is concern about the environmental and social consequences of increasing the contribution of agricultural feedstocks for use as fuel. In particular, concerns about the impact on food security have been strongly voiced (Fullbrook 2013; UNESCAP 2009; FAO 2008). On the other hand, there is research indicating that use of bioenergy—under the appropriate conditions, may generate economic, environmental, and social benefits (Tharakan et al. 2012; Johnson and Seebaluck 2012; FAO 2012b).

Over the past few decades, Thailand has increased significantly its production, consumption and export of ethanol. More recently, there has been a slow but steady

[4]The Thai Government has recently approved 25 licenses to boost sugar factories raising them to 79 in total. See *25 New licences Sweeten Sugar Output,* Bangkok Post, 7 Sept, 2016. http://www.bangkokpost.com/business/news/1080080/25-new-licences-sweeten-sugar-output Accessed 15 Sept, 2016.

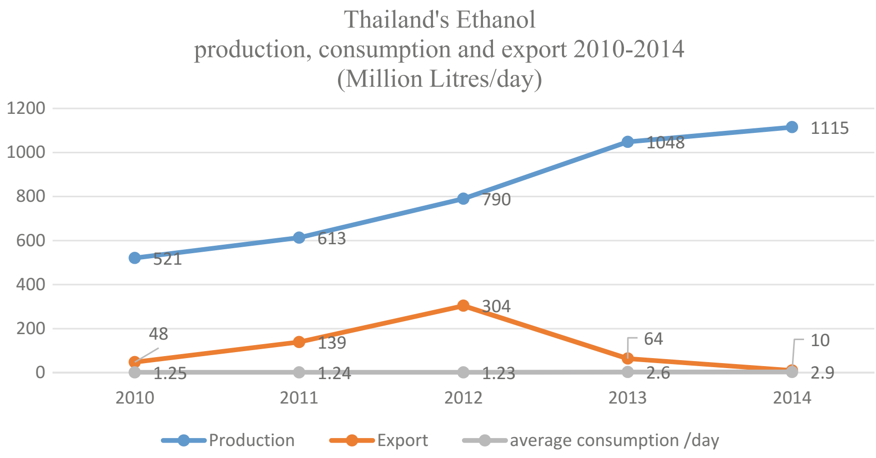

Fig. 3.2 Thailand's ethanol production, consumption, and export (2010–2014). (Million liters per day) *Source* DEDE Ministry of Energy (2015a)

increase in the use of ethanol in the domestic fuel mix in the transportation sector. Correspondingly, more of what is produced is used domestically. Figure 3.2 shows these three trends.

Only 21 of the 47 licensed ethanol plants are in operation, with a capacity of 3.7 million liters per day (see Fig. 3.4). Figure 3.3 sets out the location of the plants and the clusters of distribution. Notably, these clusters are in close proximity to borders with Cambodia, Lao PDR, and Myanmar, as well as Malaysia to the south, positioning Thailand as a bioenergy hub for the region (Samai 2016; Chantankome 2016). In 2016, the government approved licenses for 25 more ethanol plants, bringing the total to 79 plants by 2021, with a capacity of 5.4 million liters per day (Bangkok Post 2016).

Since 2014, exports of ethanol have declined significantly mainly due to increasing domestic demand. In 2014, Thailand exported only 8 million liters, primarily to the Philippines. In contrast, Thailand exported 167 million liters of ethanol in 2011 and 303 million liters in 2012 to a range of countries, including Australia, Japan, the Netherlands, the Philippines, Singapore, and Taiwan (See Fig. 3.5; DEDE 2015a).

Ethanol exports are constrained by the fact that export licenses must be secured from at least three government agencies. In addition, the Cane and Sugar Act (1984) does not differentiate sufficiently between alcohol production for beverage use and for fuel.[5] The Thai Ethanol Manufacturers Association argues that the regulatory framework should be revised to reflect this distinction to facilitate exports. Moreover, it would increase the economic viability of the sector to permit ethanol to

[5]The categorization of ethanol as an agricultural product or an industrial good is an issue that also needs to be clarified in the World Trade Organization.

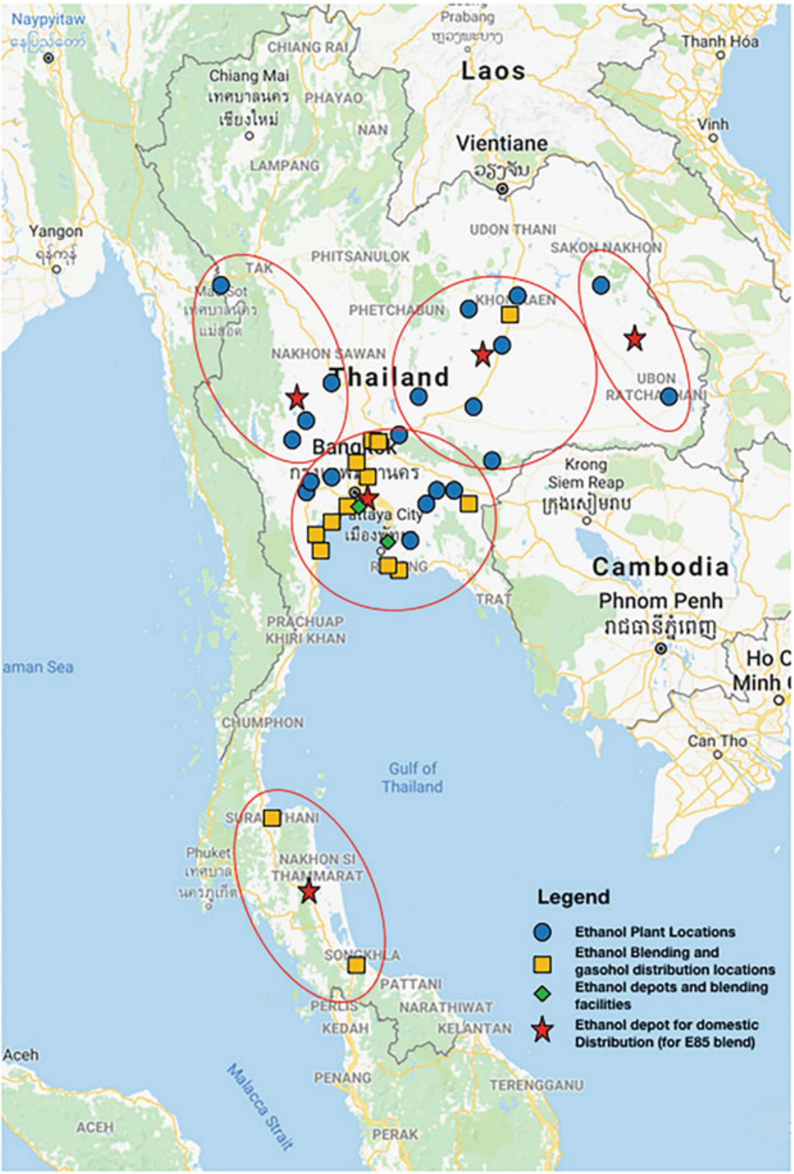

Fig. 3.3 Clustering of ethanol distribution in Thailand. *Source* Chantankome (2016)

be produced directly from sugarcane juice (as opposed to molasses) and allowing market dynamics to drive the degree of substitution between sugar and ethanol production. In this respect, the majority of respondents (68%) in the research survey considered that the main challenge to the development of the ethanol sector is a

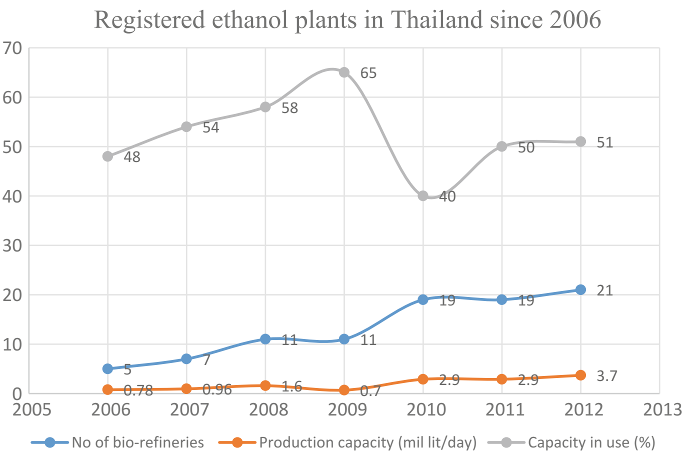

Fig. 3.4 Thailand's registered ethanol plants since 2006. *Source* DEDE (2015a); Kumar et al. (2013)

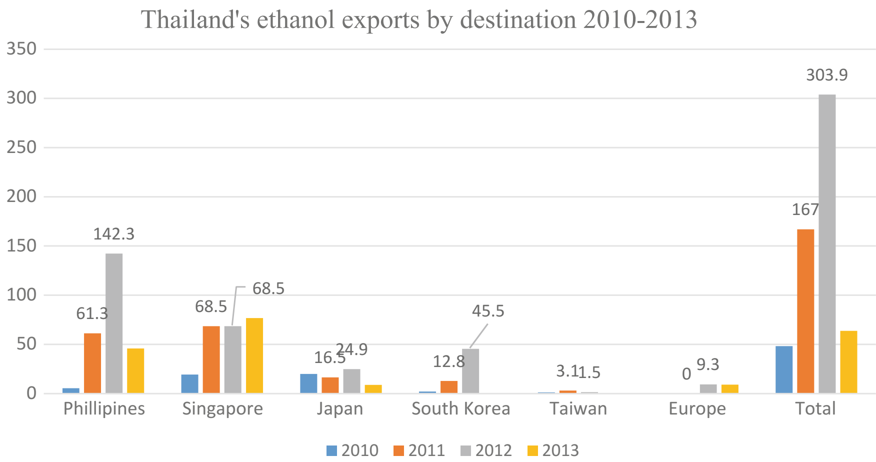

Fig. 3.5 Thailand's ethanol exports by destination 2010–2013. *Source* DEDE (2015a)

combination of a consistent policy framework and policy implementation, as opposed to improving crop yields, harvesting techniques or processing technologies.

In contrast to the scenario for the ethanol sector, there is insufficient domestic supply of *crude palm oil* to meet the national target. The target is to increase biodiesel production capacity to meet the target of 1.25 billion liters of B100 in 2016. There are 10 producers in operation in registered biodiesel plants with an estimated total production capacity of 5.4 million liters per day (1.63 billion liters per year) (Fig. 3.6) (Samai 2016). Exports of biodiesel amounted to 1,870 metric

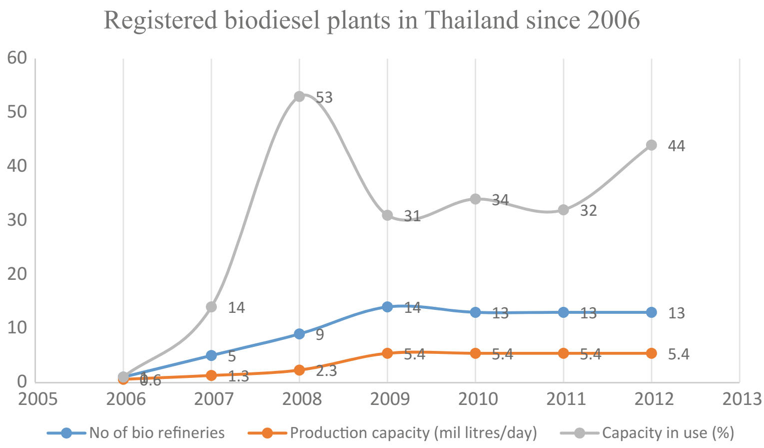

Fig. 3.6 Registered biodiesel plants in Thailand since 2006. *Source* DEDE (2015a)

tons in 2014, with imports reaching 2,810 metric tons. The target is to reach 7.2 million liters per day by 2021.

Since 2007, it has been mandatory in Thailand to blend diesel initially with 2% biodiesel and 98% diesel (so-called B2) and increasing, incrementally, through B3, B4, and B5 to reach B7 as of January 2016 (with fluctuations) (Samai 2016). To meet these blending requirements, Thailand has put in place a series of plans to increase the area of oil palm plantations to 5.5 million rai (880,000 ha) by 2021. Average yields are expected to reach 3.2 million tons per rai (30 MT/ha) by 2021, with crude palm oil crushing rates attaining over 18%. Thailand's planned acreage and production of palm oil indicate its domestic consumption in the food sector and potential for exports. Noncommercial, small-scale biodiesel production and use are also being promoted in nearly 500 communities to enhance local energy sufficiency.

The majority of respondents (72%) in the research survey considered that the main challenge to biodiesel development is a combination of a consistent policy framework and policy implementation, as opposed to the need to improve crop yields, harvesting techniques or processing technologies. The government is supporting biodiesel R&D to promote energy crops such as *jatropha curcas* and microalgae, diesohol (blending of ethanol and diesel), and oil conversion technology, such as bio hydrofined diesel (BHD) and biomass to liquid (BTL).[6] The target for commercial production of these sources is 2 million liters per day by 2018, reaching 25 million liters per day by 2021 (Samai 2016).

There are four key points related to trade in bioenergy that must be kept in mind. First, Thailand's expansion of bioenergy capacity initially needs to be supported by

[6]Thai Oleochemicals, a subsidiary of PTT, introduced a BHD product on the market in 2013, with total sales of bio hydrofined diesel reaching 50,000–80,000 L per day.

a policy and regulatory framework that establishes a secure domestic market (Shaw 2009). Second, the removal of regulatory barriers to trade would facilitate exports in the region. Third, the development of high-quality performance standards[7] for biofuels at the regional level would encourage an integrated bioenergy market in the Mekong. Since 2008, Thailand established dual product quality standards for biodiesel (community and commercial) and another for ethanol. The Roundtable for Sustainable Biomaterials (RSB) and the Roundtable for Sustainable Palm Oil (RSPO) are among the standards bodies developing sustainability indicators for biofuels (RSPO 2016; RSB 2011).

Fourth, Thailand's main trading partners, the European Union, the United States, and Japan are enacting strict sustainability regulations for biofuel imports. This means that any future development of trade in biofuels may depend on certifying the sustainability of the supply chain for these different regulatory regimes. Ethanol producers are motivated to certify for sustainable practices by the demand for certified ethanol for land transport in the EU market (Potts et al. 2014).[8] A controversial element of the EU policy mandates the use of biofuels lead to a 35% saving of greenhouse gas emissions calculated during the life cycle of the project.[9] In 2015, the EU legislation on biofuels was amended to address the risk of indirect land use change and to prepare the transition to advanced biofuels (EC 2015).

Developing Energy Crops in the Mekong

Developing the bioenergy sector will have a significant impact for Thailand as well as the predominantly agriculture-based Mekong economies as a region. Agriculture serves to underpin rural incomes, food supply, and increasingly, feedstocks for the expanding bioenergy sector. The contribution of the agricultural sector to GDP and exports in Thailand has decreased significantly since the mid-1980s as the labor force has been employed in the industrial and services sectors. Nevertheless, the contribution of agriculture to employment remains at 40% (Fig. 3.7).

While the contribution of the agricultural sector has been declining in Thailand, it continues to contribute 55–75% in other Mekong countries. Consequently, the

[7]Standards depend on the crop and are set by the Roundtable for Sustainable Biofuels (RSB), RSPO and Bonsucro.

[8]The EU Directive 2009/28/EC (adopted in 2003 and revised in 2009) sets out that 10% of the transport fuel of each member country come from renewable sources such as biofuels by 2020. Fuel suppliers are also required to reduce the greenhouse gas intensity of the EU fuel mix by 6% by 2020 in comparison to 2010 (EC 2009).

[9]The EU has outlined a set of sustainability criteria to ensure that the use of biofuels (in transport) and bioliquids (for electricity) provides carbon savings and protects biodiversity in fulfiling renewable energy targets. To be considered sustainable, biofuels must achieve greenhouse gas savings of at least 35% throughout the life cycle in comparison to fossil fuels, rising to 50% in 2017 and to 60% in 2018 for new production plants.

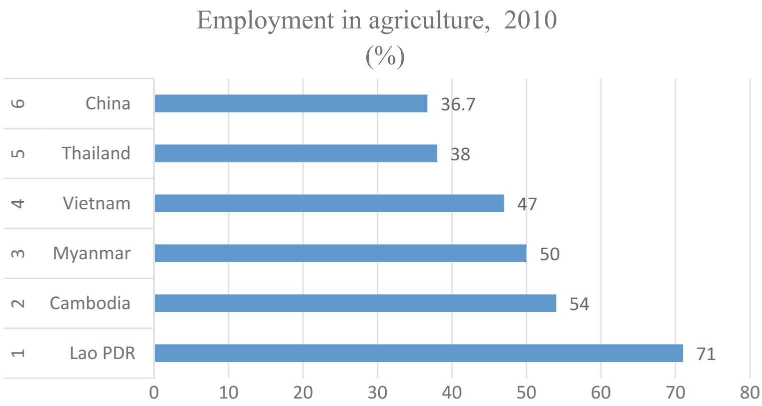

Fig. 3.7 Employment in agriculture in Mekong countries, 2010 (%). *Source* World Bank database available at http://data.worldbank.org/indicator/SL.AGR.EMPL.ZS Vietnam 2012 data; China: http://www.statista.com/statistics/270327/distribution-of-the-workforce-across-economic-sectors-in-china/

input of agriculture to GDP and exports is also declining. In 2014, agriculture contributed 8.4% to Thailand's GDP and 8% to exports. By contrast, agriculture continues to contribute between 20% and 45% to the GDP of other Mekong economies and remains responsible for a significant contribution to domestic food supply.

As illustrated in Fig. 3.8, Thailand's annual expenditure on fuel imports has been rising exponentially relative to agricultural exports since the turn of the century. There are opportunities to add value to agricultural production through developing energy crops. In a region, in which a significant majority of the population still works in the field, adding value to the agricultural value chain is recognized as vital to improving sustainable livelihoods. In Thailand, for example, the vast majority of oil palm growers are independent smallholders, in contrast to the large-scale plantations in Malaysia and Indonesia. Nevertheless, several

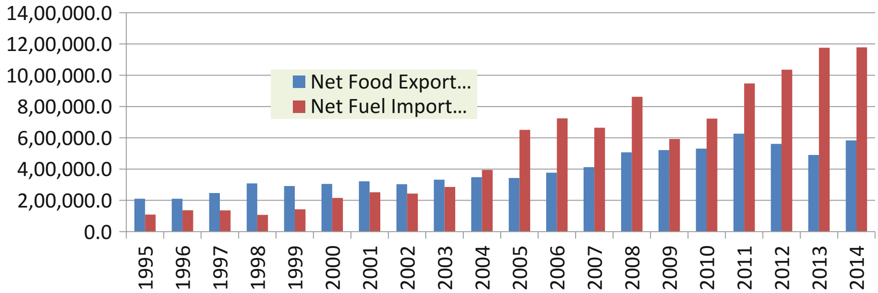

Fig. 3.8 Fuel Imports and Agricultural Exports, 1995–2014. *Source* Samai (2016) based on latest data from the Thai National Statistics Office and the Ministry of Energy

challenges to agro-energy development are identified in the literature, primarily related to food security and environmental sustainability (Tharakan et al. 2012; Pimental 2009; FAO 2008; World Bank 2008).

With countries in the Mekong region considering renewable energy targets, investment in bioenergy is increasing at a rapid pace in response to target mandates set out in regulatory regimes (Table 3.4). Notwithstanding these efforts, policies promoting sustainable bioenergy are perceived to be lacking, with all respondents of the survey undertaken for this research overwhelmingly indicating that information and coordination need to be improved.

There are a multitude of initiatives underway to promote agro-energy cooperation in the Mekong, such as the ACMECS and the ASEAN Free Trade Area (AFTA). In the context of the latter, Thailand is providing assistance for energy crop contract farming along border areas with Lao PDR, Cambodia, and Myanmar and to allow tariff-free imports of certain agricultural products. This has led some experts to contend that the current contract-farming model for agro-energy has shifted the paradigm in agricultural development in the Mekong region (Fullbrook 2007). For Thailand, contract farming in neighboring countries offers a means to effectively expand agricultural production. It is expected to contribute 1 million rais (160,000 ha) to oil palm acreage in the region by 2020. As the second largest ethanol producer after China in the Mekong, Thailand is likely to increase production and exports of ethanol with the liberalization of trade under AFTA, potentially relying on feedstock from neighboring countries to meet blending mandates.

Exploring the Policy Options: Energy, Food Security, and Climate Adaptation

Strategies to increase the contribution of bioenergy to Thailand's energy mix have to take into account several related issues, notably the consequences for food security and the environment. First, Thailand has initiated a coordinated national debate on how to balance food and fuel requirements from agriculture. To ensure that a rising demand for energy crops does not negatively impact production for food, the agricultural sector is being zoned and restructured (Samai 2016).

Second, given Thailand's position among the world's leading producers and exporters of rice, sugar, and tapioca, the issue of food security acquires an international dimension and Thailand's production not only impacts domestic supply, but also the global food supply chain (Yang et al. 2009). What is crucial here is that a switch from food to fuel cultivation, if not properly managed, would adversely impact global food supply (Fullbrook 2013; Shaw 2010). In this respect, there is a growing body of evidence examining the impact on food security and the socio-environmental impacts of agro-energy. A study by Silalertruksa and Gheewala (2012) on ethanol in Thailand confirms that greenhouse gas

Table 3.4 National Bioenergy Policies in the Mekong Region

Country	Agro-energy crops		Targets in transportation (% share of total fuel consumption)		Policy and fiscal incentives	Import/Export Tariff rates
	Biodiesel	Ethanol	Biodiesel	Ethanol		
Cambodia	Oil palm Jatropha	Cassava Sugarcane	*Proposed 5% by 2016*		Tax exemptions; investment incentives; Biodiesel Development Fund	Benefits from General System of Preferences (GSP) and EU Everything But Arms Initiative
China	Jatropha	Corn Wheat Sorghum Cassava Sugarcane	10% by 2020 (Renewable Energy Law) ethanol 12 million Liters by 2020 Biodiesel 6 million Liters by 2020		Tax exemptions; blending credits; low-interest loans; R&D funding; ethanol production subsidies	Biodiesel applied tariff 9% Denatured ethanol: ad valorem 80% Undenatured ethanol: 100%
Lao PDR	Oil palm Jatropha	Sugarcane Cassava	E10 by 2015 E20 by 2020		Investment promotion	GSP and EU Everything But Arms Initiative
Myanmar	Jatropha Oil palm Soybean Sesame	Sugarcane Sorghum Cassava Maize, potato	E5 and E15 B5 to B20		Demonstration projects	Benefits from GSP and EU Everything But Arms Initiative
Thailand	Oil palm Jatropha Cooking oil	Sugarcane Cassava	B5 mandated since 2001 1,643 million Liters by 2022	Gasohol (E20) available nationwide 3,285 million Liters by 2022	Price guarantees; blending credits; tax incentives for gasohol vehicles; R&D funding; investment promotion	Tariff rate quota regime for imports of Crude Palm Oil Biodiesel: ad valorem 5% Denatured ethanol: 21-22 Baht/L
Vietnam	Fish oil Jatropha Cooking oil	Sugarcane Sorghum Cassava	E5 128 million Liters by 2020	5% of total fuel demand in transport sector by 2020 684 million Liters by 2020	R&D funding; investment promotion	Benefits from GSP and EU Everything But Arms Initiative

Source Compiled based on Samai (2016); DEDE (2015a); USDA (2016); Thakaran et al. (2012)

(GHG) emissions depend on the management of crop residues and, especially if there is direct land use change and conversion of tropical forest to cropland, can result in a loss of biomass and increased CO_2 emissions. Silalertruksa et al. (2012a) assess the impacts of indirect land use change (ILUC) of Thai ethanol production to find that the displacement of the cultivated area of other crops (sugarcane) could result in a larger impact on GHG emissions mainly due to the potential change in biomass and soil carbon stock.

Agro-energy production can also be expected to have significant impacts on water resources (UNEP 2011). Given that the water footprint is sensitive to location, Kumar et al. (2013) emphasize the importance of local studies to construct a larger picture of sustainability impacts. To this end, a study of the water footprint of biofuels in the Khlong Phlo watershed in central Thailand found that production and land use change would impact water quality (Babel et al. 2011). Studies are also ongoing to examine the socioeconomic impacts of the AEDP targets for ethanol and biodiesel, some forecasting that bioenergy can contribute to employment and GDP (Malik et al. 2009), while others signal concerns over elements of sustainability (Silalerstruksa et al. 2012a; Salvatore and Damen 2010).

Third, and consequently, one of the reasons why Thailand has recognized the urgency to address climate change is its potential impact on agricultural productivity. Agricultural systems are dependent on imported fossil fuels and are vulnerable to climate change. The need to adapt to climate change has strengthened Thailand's projects for community bioenergy. Fourth, the Clean Development Mechanism (CDM) of the Kyoto Protocol is stimulating renewable energy projects. As of 2016, Thailand has approved 280 CDM projects, including 110 for biogas operations (mainly from tapioca and oil palm processing wastewater) and 60 for biomass operations (mainly from rice husks) (TGO 2016; ECOFYS 2016). The increase in CDM projects is driving greater awareness since the survey was conducted for this research, in which few respondents (1%) indicated that climate change mitigation was a driving force for bioenergy development in the Mekong. Further research is necessary to determine the extent to which this profile has changed in the region.

Opportunities and Challenges for Thailand's Bioenergy Sector

Finding the appropriate balance between energy security, energy efficiency, and agro-energy trade and development presents challenges as well as opportunities (Table 3.5), which require policy coordination, technological and productivity innovation and sustainable resource management. The impacts of natural resource-led development in the Mekong increasingly are being explored as interlinked systems of water, food, and energy (Greater Mekong Forum on Water,

Table 3.5 Prospects for Trade in Bioenergy in the Mekong

Opportunities	Challenges
To add value to agricultural production; to use efficiently agricultural waste residues	Need for well-defined bioenergy policies and targets at the national and regional level
To shift dependence from petroleum to enhance energy security	Need to address food security concerns and balance competing claims for land
To gain from the Mekong's diversity of energy crops for ethanol and biodiesel	Need for economic incentives to deliver sufficient feedstocks; need to enhance awareness and information on the bioenergy market
To develop small-scale community bioenergy production and use to build resilience to external shocks; create local energy sufficiency; stimulate rural development and reduce input costs from petroleum and fertilizers	Need to balance large-scale commercialized agro-industrial development of bioenergy for the transport sector and for export
To make use of low cost of production (land, labor, and water)	Need to address land use changes and labor migration within the region resulting from bioenergy development; need to ensure transparent, equitable investment and safeguard land rights
To develop infrastructure in a dynamic region	Need to enforce strategic impact assessments to address social and environmental consequences of bioenergy plans and projects
To operationalize the Clean Development Mechanism (CDM), gain carbon credits, and stimulate investment and technological innovation in second-generation bioenergy	Need to guide private sector investment through enforcing socio-environmental regulations (air, water, land, and labor laws)
To develop the potential to export bioenergy production	Need to facilitate exports and secure market access and meet sustainability criteria

Source Compiled by the authors

Food & Energy 2015; Foran 2013; Smajgl and Ward 2013) to address resource scarcity (Allouche et al. 2015).

In large part, due to the fact that demand for bioenergy is driven by regulatory mandates, with production costs subsidized by governments, there are valid concerns about economic efficiency and socio-environmental sustainability (IISD/GSI 2012). Reports on the biofuels sector in various countries highlight the risks inherent in subsidizing fuel: subsidies increase consumption and discourage more efficient resource use (IISD/GSI 2015; ADB 2015; Lopez and Laan 2008; Steenblik 2007). Moreover, the impacts of converting 'marginal lands' to feedstock production are highly dependent on local circumstances. Indeed, many aspects of sustainability are context-specific, requiring a complex assessment of the net balance of greenhouse gas emissions due to indirect land use change from shifting to agro-energy crops (what is referred to as ILUC in the climate change discourse) (Tilman et al. 2009).

Water, its management and scarcity are essential elements that affect the future of agro-energy in the Mekong region (ADB 2013; FAO 2011). In the case of sugarcane, for example, most production in Thailand is located in rain-fed areas, with only 10% in irrigated zones (Kumar et al. 2013). Increasing the efficiency of water use to avoid shortages needs to be supported by proper pricing of water to reflect its scarcity.

The focus of international standardizing bodies, such as the ISO, has been to further life cycle analysis of bioenergy crops and sustainability assessments of agro-energy systems. To date, evidence from life cycle assessments in Thailand indicates that there are significant opportunities to adopt new technologies to increase energy efficiency in biofuel conversion and to use agricultural waste residues (Kumar et al. 2013; ADB 2009c; Huang et al. 2009; Nguyen et al. 2008; Jitsanguan 2001). To illustrate the variations in the results of sustainability assessments, depending on the perspective, consider the following. Recognizing that its ambitious 5.75% target for biofuels in the transport sector requires considerable imports, the EU Sustainability Directive stipulates that this target must be met with biofuels that fulfil sustainability criteria. To meet the EU criterion to reduce greenhouse gas (GHG) emissions by 35%, one study examined the GHG emissions of indigenous Irish rapeseed and imported Thai palm oil (Thamsiriroj and Murphy 2009). Given that palm oil generates more biodiesel per hectare than rapeseed and demands less fertilizer and fuel inputs, a reduction in GHG emissions of 29% and 55% were calculated for Irish rapeseed and Thai palm oil systems, respectively. In other words, it appears to be more climate-friendly for Ireland to meet the EU biofuel target by importing palm oil from Thailand.

Transforming Rural Development: Small is Beautiful

Globalization and market liberalization are changing global agricultural production, with the risk of excluding smallholder farmers in developing countries from adding value to their production. The scale of production is a key element in assessing the contribution of bioenergy to sustainable development. Large-scale biofuel systems are facing several challenges that do not paint a picture of sustainability, particularly in developed countries (Giampietro and Mayumi 2009). Moreover, large-scale, energy-intensive mono-cropping plantations are deemed to be one of the main causes of deforestation, soil erosion, and the increased use of chemical fertilizers and pesticides, with impacts on water quality and quantity (FAO 2012a; USAID 2009; Pimental 2006).

Conversely, more efficient use of biomass at the rural level is an attractive alternative to enable a shift to a more sustainable energy matrix. The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD 2009)—a multi-stakeholder United Nations report commissioned by the World Bank and the FAO—critiques conventional industrial agriculture. The report calls for a fundamental change in farming practices to better address increasing food prices, food insecurity, and environmental crises. It reflects a growing consensus among scientists and many governments that the old paradigm of industrial energy and chemical-intensive agriculture is an outdated concept (FAO 2012a). It also points to the role of small-scale farmers and agro-ecological methods in providing a way forward for sustainability in the face of water shortages, soil erosion, and climatic change. The conclusion is that past emphasis on increasing production and yields—the Green Revolution—brought about important benefits, however, these gains occurred at the expense of environment and social equity. The report concludes that more emphasis is required to address the local needs of developing country farmers, including improved access to markets, and infrastructure and financing to integrate into global and regional agricultural value chains.

Small-scale community biodiesel production and use have the potential to empower small landowners with energy sufficiency, thereby lowering their energy input costs and increasing their income (FAO 2012a; Shaw 2010; Altieiri 2009; Penunia 2009; WWF and SNV 2009;FAO 2009a). Such an agricultural transformation positions farmers as frontline environmental stewards with the local knowledge and resilience to contribute to sustainable resource management (Gotsch 2016; Hodbodt and Tomei 2013). In this respect, Thailand's community biodiesel programs have the potential to put into practice local energy sufficiency, whilst simultaneously adding value to the agricultural supply chain and decreasing input expenditures on petroleum and chemical fertilizers and pesticides.

An ADB review (Malik et al. 2009) concludes that biofuels have a significant role to play to meet the Mekong's energy demand, particularly in the transport sector, but that bioenergy expansion will likely impact crop and food prices, both directly and indirectly. Importantly, the extent of the contribution and the environmental impacts will depend on the type of production system pursued. Use of the industrial-scale plantation model would quickly lead to several interrelated social–environmental–political problems that have been observed elsewhere in and outside Asia, namely food versus fuel conflicts, land grab, destruction of forests, and detrimental impacts on soil and water quality (Malik et al. 2009). However, use of a model based on smallholder production, emphasizing nonfood crops and second and third generation technologies will facilitate sustainable bioenergy development in the Mekong. According to Malik and others, this Schumacherian "small is beautiful" approach requires strategic policy interventions and support to the agricultural sector, which have proven to be both controversial and costly (IISD/GSI 2012, 2015).

Market Access and Sustainability Criteria for Land and Water Hungry Crops

Agricultural trade liberalization has always been a critical component of multilateral trade negotiations at the World Trade Organization (WTO). First, commodity-exporting developing countries, in particular, would benefit from greater market access for agricultural products (energy crops) and biofuels (UNCTAD 2008). This would serve to increase revenues for research and development of sustainable production practices and technologies. Second, as a major agricultural exporter, Thailand would gain from agricultural trade liberalization to remove export subsidies in key developed countries, such as Japan, the EU, and the US. As noted in an early Brazilian proposal to the WTO (Brazil 1998), agricultural export subsidies in developed countries distort market access for biofuel exports from developing countries. Notwithstanding price support schemes, for example, for sugar, rice, cassava, and palm oil, Thailand's agricultural sector is considered to be competitive on the world market.

Third, trade trends will be affected by the definition of biofuels as industrial, agricultural or environmental goods. The harmonized system of tariff classification used in the WTO classifies ethanol as an agricultural product with no distinction between its use for fuel or other purposes, whereas biodiesel is classified as an industrial product (Echols 2009: Abdel Motaal 2008; Brazil 2005).

One way to address the social and environmental impacts of bioenergy is to establish and enforce *sustainability criteria*. This is the path forward for biofuels charted by many governments, international organizations, and nongovernmental efforts to address rising concerns (Guariguata et al. 2011). Most criteria to assess sectoral sustainability take into account the socio-environmental effects of *direct* biofuel production, with respect to the land and production processes employed. However, as emphasized by the Dutch Cramer Commission (2007) and World Wide Fund for Nature (WWF) reports (Dehue et al. 2007), the most serious sustainability issues are those related to the *indirect* impacts of large-scale biofuel production, mainly the displacement of other agricultural activities and subsistence farming, as well as changes in land use from forests or grass to crops (Searchinger 2009). Criteria developed to address these impacts by the Roundtables for Sustainable Biofuels (RSB) and Sustainable Palm Oil (RSPO) and other international standards bodies, include lifecycle greenhouse gas emissions, biodiversity, agricultural practices, and social impacts.

Certification of sustainability represents, at the same time, a valuable marketing tool and a costly nontariff barrier to trade, especially for developing countries (Zarrilli and Burnett 2008). It is a tool that is being widely used to address sustainability in ethanol and oil palm biodiesel supply chains in Thailand (Silalertruksa et al. 2012a, b; Silalertruksa and Gheewala 2012). Thailand is by far the leader in the region on environmental standards and regulations. The Thai private sector is adopting environment-related standards developed by the International

Organization for Standardization (e.g., ISO 14000 environmental management standards) to gain market access for its exports. The private sector is also implementing Corporate Social Responsibility (CSR) independently and through Thailand's Business Council for Sustainable Development.

One study on EU–ASEAN trade relations estimates that around 20–25% of EU biofuel consumption by 2020 will be derived from imports. Sustainability criteria agreed by the EU in March 2009 will determine Thailand's market access for palm oil and ethanol exports to the European Union (ECOFYS 2009). In this regard, Argentina, Brazil, Malaysia, and Indonesia are among the key biofuel exporters who have challenged the EU at the WTO.

Sustainability throughout the production of agro-energy and responsible supply chain management will affect trade and have implications, particularly for developing countries (Opijnen and Oldenziel 2011). Compliance with the guidelines developed by voluntary standards-making bodies, such as the Roundtable on Sustainable Biomaterials (RSB) and the Roundtable on Sustainable Palm Oil (RSPO), provide incentives to address socio-environmental impacts (Charnovitz et al. 2008). As with the evolution of eco-labeling and certification over the past several decades, sustainability criteria are deemed to be central and controversial aspects of trade in biofuels (Zarrilli and Burnett 2008). As predominantly voluntary instruments applied to the production process, sustainability certification schemes do not necessarily address macro-level impacts, such as increased food prices and the displacement of food for fuel crops.

Evidence of the sustainability of agro-energy in Thailand is mixed. Since 1990, Thailand's carbon dioxide emissions have increased faster than every other country in the world but one. According to the Global Carbon Atlas (2017), Thailand is the 20th largest carbon polluter in the world (out of 216 countries). A recent review of Thailand's biodiesel prospects concludes that it is arguable whether palm-based biodiesel is economically and environmentally feasible in the long term. This is due primarily to the potential local effects on food supply and prices, as well as changes in land use and agricultural practices related to fertilizer inputs with high-embodied energy costs (Siriwardhana et al. 2009). Moreover, Thailand is developing biofuels to contribute to a domestic demand stimulated by mandated blending requirements for ethanol and biodiesel in the transportation sector. While there is insufficient palm oil to meet domestic demand, exports of ethanol began in 2007. This differs from Malaysia and Indonesia's well-established palm oil capacity predominantly for export. Malaysia and Indonesia account for nearly 90% of global exports of palm oil, primarily to the EU.

Thailand's sugar regime is also adjusting to a new era, with the Sugar Act of 1984 under revision and challenged at the WTO.[10] Moreover, implementation of the ASEAN Economic Community, which came into force in December 2015,

[10]In March 2016, Brazil launched a challenge at the WTO to Thailand's support to sugar producers.

opens up the market, making the outlook for agro-energy in Thailand more complex.

The Way Forward: Results from the Field

Thailand's three-decade experience in managing its sugarcane, cassava, and palm oil industries is worthwhile exploring as it relates to bioenergy to add value to the agricultural production supply chain. The evidence emerging from the survey conducted for this research indicates the need for greater coordination of agro-energy policies in the Mekong to transition to climate-smart agriculture.

In order to achieve the benefits of bioenergy, whilst avoiding potentially harmful consequences, the majority of survey respondents for this research recognized the need to enhance information on bioenergy to enable informed policymaking. This research concludes that bioenergy development in Thailand has the potential to contribute to more efficient use of agricultural biomass. However, there are several constraints from a regional perspective. Agriculture is at a crossroads in the twenty-first century mainly due to mismanagement of trade and environmental policies (IAASTD 2009). It is evident from this research that the increasing demand for agricultural feedstock is placing an unsustainable burden on the natural resource base in the Mekong region. A lack of sufficient political will to coordinate trade and investment policies, particularly in the agricultural sector, continues to be a significant impediment to sustainable resource management. The political panorama may be forced to reform with the likelihood of increasing scarcity of water and land, as Thailand's neighbors open up for the first time to the global economy and regional integration is strengthened.

The hypothesis for this research posited that the prospects for Thailand's trade in bioenergy in the Mekong region are favorable. First, the research supports the conclusion that Thailand's trade in biofuels is likely to increase. Based on an assessment of the current state of play, Thailand is likely to increase exports of ethanol. The main driver of this expansion is Thailand's requirement for blending ethanol and biodiesel in the commercial fuel mix in the transportation sector and increased incentives to feed into the electricity sector. There is likely to be more imports of agro-energy feedstock to meet the blending targets for ethanol. In addition, more imports of palm oil will likely be needed to meet blending requirements for biodiesel, given the lack of sufficient domestic supply of crude palm oil. While domestic consumption at present primarily feeds into the domestic supply of ethanol, trade in the region is likely to grow in ethanol. Moreover, this trade is likely to increase with the commercialization of second-generation biofuels.

Second, based on the current policy framework, the initial hypothesis was put forward that increased trade in bioenergy is likely to have negative implications for sustainable development in Thailand and the Mekong region. The research supports this conclusion as a general point. Nevertheless, a distinction should be made between small-scale bioenergy initiatives (to some extent for tapioca-based ethanol but predominantly for biodiesel) and the commercialized production of biofuels (mainly for sugarcane (molasses)-based ethanol). The conclusion flowing from the field evidence to inform this claim is mixed. The case is cautious in several respects, but generally strong and positive for the development of biofuels in Thailand as supported by the data collected during this research. This is not necessarily the case for the Mekong region as a whole if the current policy framework remains.

On the one hand, the case narratives illustrate the main hypothesis that based on the current policy framework, increased trade in bioenergy is likely to have negative implications for sustainable development in the Mekong region. On the other hand, the outcome could be beneficial if a shift is made toward the *Small is Smart* scenario. As the research suggests, there are bright spots in Thailand that illustrate *Small is Smart*, where smallholder agro-energy is contributing to improving livelihoods, farming practices, and energy efficiency. However, there is insufficient regional coordination of these efforts to bring about a tipping point in renewable energy use or sustainable resource management.

To the extent that an expansion of agro-energy crops displaces forests or biodiversity, the negative consequences of Thailand's current policies are likely to impact more significantly on neighboring countries for two reasons. First, Thailand's land frontier is considered to have closed in the 1980s—there are simply few forests left to destroy. In the rest of the Mekong, however, the land being opened for agriculture is increasing and domestic and foreign investment in that land has increased significantly. Second, as a direct result, Thailand and others foreign investors are extending their natural resource grasp into neighboring Mekong countries, thereby externalizing the socio-ecological costs of modernization. These costs in the agro-energy context are being borne for example by Cambodia, Lao PDR, Myanmar, and Vietnam. As is amply demonstrated in the literature, the proliferation of large-scale land concessions for agricultural commodities is increasingly cause for concern.

Moreover, Thai agro-energy investment in Cambodia, Lao PDR, and Myanmar, in combination with plans to increase transportation links in the Mekong region, has already resulted in a shift in production patterns and agricultural land and water use intensity. While creating some opportunities for the local economies in neighboring countries, this research suggests that the current *business as usual* model of Thai agro-energy investment is serving to export the socio-ecological costs of production to neighboring countries.

The third objective of the research was to identify Thailand's policy options to provide alternative scenarios toward a regional interpretation of modernity in the Mekong. In this respect, four aspects are highlighted from the interviews, focus group discussions, and case narratives. First, the shift to cultivating agro-energy crops is already underway in Thailand and the Mekong region. The significant growth in agro-energy crops is illustrated in Thailand (cases 1–4), Champassak, Lao PDR (case 5), and Shan state, Myanmar (case 6). Second, assessment of the *socio-ecological* sustainability of this shift is growing and urgently required.

Without a comprehensive and evidence-based analysis of the impacts on land and water availability and use in the agricultural sector in general—not only for agro-energy crops—the Mekong region is likely to face serious social unrest and environmental consequences in the period ahead. This research indicates that sustainability must be embedded in the policy choices concerning agricultural development in general, including for agro-energy crops. This is the unequivocal message emanating from the field interviews and focus group discussions conducted during the course of this research.

Third, these developments are transpiring in the context of a global agricultural sector that is significantly distorted. These agricultural distortions persist despite ongoing multilateral negotiations in the World Trade Organization (WTO) to discipline agricultural subsidies in OECD countries and improve market access for developing countries. Critics point to the fact that the WTO has yet to make sufficient progress in removing harmful agricultural subsidies that act to both distort international trade and harm the environment. Nor has the WTO been able to secure sufficient market access for developing countries in OECD markets. Moreover, market access is further constrained in practice by technical and phytosanitary barriers. That is to say that, in principle, Thailand can export to the European market, but these exports are subject to a range of technical and phytosanitary standards and regulations. These non-tariff barriers are likely to be extended to cover the carbon footprint of traded products, further necessitating attention to the way in which products are produced, not only the characteristic of the traded products themselves. As a trading nation, Thailand's exports are impacted significantly by these measures, including based on its production and processing methods. That is one reason why the energy efficiency gains in the production process from better use of agricultural residues are an important trade issue for the Thai agricultural sector as a whole.

Fourth, the groundwork has been laid to enable greater economic integration at the Mekong regional level, with the potential to engage local level stakeholders and private sector actors in trade and investment. The portfolio of policy options outlined reflects the need to engage the policymaking process to counter the trend at all levels—local, national, regional, and multilateral to manage the natural resource base more sustainably and equitably. This is an argument for regulation, quality control, and enforcement, while simultaneously tackling lack of transparency and endemic corruption. This is why this research argues for a mechanism for policymaking to assess the overall regional landscape for agro-energy taking into account agro-ecological zones. Targeting policies to address the ecological sustainability of these zones would represent a step forward.

To date, growth and development have been solely conceived of in terms of gross domestic product. However, strategies to sustainably develop land and natural resources in the Mekong need to go beyond this classical measurement of growth, it is argued in this research, to encompass the many aspects of the overall agro-energy picture. From this perspective, the economic consequences of climate change also serve to encourage governments in the Mekong to find ways to improve resilience and decrease vulnerability in the agricultural sector. Thailand's leadership is needed to guide the Mekong region through the maze of development hurdles to better consolidate economies that are at the same time post-industrial and rural.

The Global–Local Nexus: Seeking Common Ground at the Regional Level

If past practices are deemed to be unsustainable, an alternative sustainable path forward is less clear-cut. There is, however, great promise emerging from a refocus on the agricultural sector and from rebalancing small-scale, bottom-up approaches to development. This is the lesson emerging from the case narratives elaborated in this research. Field research for this thesis in central, northeastern, and southern Thailand has illuminated a wealth of opportunities in those areas for smallholder palm oil and cassava. The narratives include farmers shifting from heavily fertilized and irrigated fruit orchards in Rangsit to less chemical and water-intensive oil palm cultivation; a community cooperative in Aoluk, Krabi being able to improve local incomes through oil palm. It reveals smallholder cassava farmers using local oil nuts to fuel local water pumps and small-scale agricultural machinery in Vanghinlad, Chumpae. These narratives illustrate that the bioenergy debate would benefit from more nuance to offer realistic opportunities to developing countries to tackle agricultural development, energy poverty, and sustainable natural resource management.

In this respect, the agricultural sector is of prime importance to generate incomes in the Mekong, while suffering from the greatest trade discrimination in the global marketplace. This is why a renewed focus on the agricultural sector is so vital to socio-ecological sustainability. This research lends weight to arguments made in the literature that global responses are not working and local solutions may be insufficient to bring about a paradigm transformation to sustainability (Halle and Raskin 2010). From this perspective, regional alternatives are emerging as a potential way to bridge the policy gap between sustainable development policy and practice.

Local narratives need to take heed of the lessons learned from agro-energy. These lessons have been clearly enunciated since the 2008 food–fuel crisis and need to be reflected in national and regional debates on the direction of agro-industry trade and investment. Notably, there has yet to be a sufficient national debate on agro-energy in Thailand and certainly not in neighboring countries. Moreover, the interviewees indicated uncertainty about agro-energy linked with policy coordination amongst the diverse ministries and levels that inform the decision-making process. This is one of the reasons why the majority (57.3%) of respondents to the survey questionnaire conducted for this research considered that their country's bioenergy policy is not heading in the right direction and that there was a lack of sustained political leadership.

There are three interlinked considerations raised by the respondents during the research. First, two-thirds of Thailand's sugar production is exported in a raw or refined state, leaving significant potential to *add value* to the supply chain through refining sugar and cassava into fuel (Fig. 3.6). Second, as the agro-energy sector grows, the share of surplus production available for fuels will also grow. Therefore, with projections for surplus ethanol production over the next several years and vague deadlines for mandated gasohol, there is a need for regulatory change to allow flexibility to export. Third, incorporation of sustainability standards to address socio-environmental aspects of bioenergy along the supply chain is facilitating greater resource efficiency. These predominantly voluntary standards and CSR are enabling a transition to a more sustainable agro-energy future in the Mekong region.

The following issues emerged from the survey undertaken for this research:

(a) Thailand has in place a visionary plan to develop renewable energy. Whether this plan succeeds in capturing the opportunities depends, to a great extent, on the institutional setting and implementation. This is why the majority of respondents (68%) in the research survey considered that the main challenges to the development of the agro-energy sector are a combination of a *consistent policy framework* and *policy implementation*, as opposed to improving crop yields, harvesting techniques or processing technologies.
(b) As a major exporter of food, Thailand's agro-energy policies have implications beyond its borders for the global supply of food. This is a complex issue that needs to be studied further.
(c) The local context matters. In the Mekong, the substantial number of small-scale farmers involved in agriculture has created a distinct narrative.[11] Agro-energy has a role to play in generating energy and employment in a region in which the vast majority are smallholders.
(d) The development of first-generation biofuels (ethanol, and biodiesel from agricultural crop biomass, such as sugar, cassava, and palm oil) can assist in the transition to a more sustainable low-carbon energy scenario if sustainability criteria are developed and implemented. To this end, South–South cooperation can stimulate knowledge building and technology transfer (e.g., with Brazil through the G20 initiative).[12]
(e) The alternative development strategy, "small is smart", put forward based on the data collected for the research survey, is to build on the synergies between small-scale initiatives and enhanced agro-energy sustainability. Small-scale community biodiesel production and use has the potential to

[11]The Mekong narrative for agro-energy is well documented in LaoFAB, an information network, moderated by Andrew Bartlett, between practitioners and academics in the region and beyond. LaoFAB is a forum for sharing information about agriculture, rural livelihoods and natural resource management in Lao PDR. The forum consists of a Google discussion group, an online library, a Facebook page, and a Linkedin group See https://www.facebook.com/LaoFAB/info/?tab=page_info.

[12]The agro-ecological (no-till, intercropping) model of Altieiri and Ernst Gotsch is bearing fruit. Fazenda da Toca in the state of São Paulo in Brazil is scaling up successful practices. See the video at https://www.youtube.com/watch?v=gSPNRu4ZPvE&feature=share. Accessed August 10, 2016.

empower smallholders with energy sufficiency, thereby lowering their energy input costs and increasing their incomes by adding value to agricultural production. This is the preferred model indicated by discussion respondents for this survey to promote bioenergy investment in the Mekong. To date, however, Thai agro-energy investment through contract farming in the region has tended to outsource environmental degradation to neighboring countries (e.g., Cambodia, Lao PDR, and Myanmar).

(f) Improving infrastructure in the Mekong region will contribute to enhancing agricultural yields and lowering production and transportation costs (e.g., water systems, energy grids, and roads). However, the results of the survey for this research indicate that policy support is required to integrate small-scale agricultural holders in the bioenergy supply chain.

(g) Governance is a vital element in addressing socio-environmental sustainability. To assist in the development of a coherent policy framework, Thailand benefits from a central body, the National Biofuels Committee, to coordinate involvement of the many ministries and private and public sector actors.[13] An institutional architecture at the Mekong regional level would facilitate integrated bioenergy development and contribute to diversifying the region's energy mix, while coordinating a regional transition toward climate-friendly agriculture and low-carbon economies.

(h) Policy space is needed to design policies that work for the region so that policymakers can assess the explicit trade-offs between water, energy, and food systems.[14] The process will be complicated increasingly by the consequences of climate change (e.g., the Mekong experienced one of the worst droughts to date in 2015).

Conclusion: Global Trends, Local Definitions

There are fish in the water and rice in the fields

Famous adage on the 13th century stele of King Ramkhamhaeng

The challenges of the twenty-first century for Southeast Asia, in particular, will be to satisfy rising demand for food and energy with less of a carbon and water

[13]During the formative years (2000–2006), the National Biofuels Committee played a crucial role in policy setting, with representation from all branches of the government, independent institutions, the private sector and academia. The Committee was abolished by the Surayuth government and the issues were delegated to several departments, with the Ministry of Energy's DEDE as a coordinating agency.

[14]To this end, since its establishment in 2011, the Greater Mekong Forum on Water, Food & Energy (2015) is exploring these linkages and trade-offs.

footprint. The quote above from King Rambkhamhaeng invoked the bounty of nature at the time of the formation of the new state of Siam in the thirteenth century. This bounty has been fundamentally altered, transforming not only Thailand, but also the Mekong from a region of resource abundance to one in which resources are "finite, threatened and fragile" (Pasuk 2000). It is also a region that is vulnerable to the impacts of climate change. Thailand ranked 9 out of 187 countries most affected by extreme weather events between 1995–2014, while Vietnam ranked 7, and Myanmar ranked 10 (Global Climate Risk Index 2016).

In the face of the urgency of climate change, there is evidence that small-scale bioenergy in the Mekong has the potential to shift the agricultural sector away from high-input, energy-intensive agriculture towards more sustainable practices. In order to do so, smallholders require an enabling policy architecture to empower local communities to generate their own energy for consumption both on and off the national grid. In this respect, the Clean Development Mechanism (CDM) has added economic viability and environmental motivation to bioenergy initiatives. It is stimulating investment and innovation in energy from first-generation sources (crop residues and biogas) and second-generation cellulosic biofuels.

Over the coming decades, the world economy will change radically as markets move to reflect scarcities in food and fuel. As a major contributor to the global supply of agricultural products, Thailand faces a complex range of factors in implementing its vision for a low-carbon economy. Thailand has the potential to move beyond past inefficiencies and take up a leadership role in developing renewable energy in the region. If the current stimulus to produce and use first-generation biofuels brings about a transition to more technologically complex second-generation systems (e.g., bagasse, algae), there is likely to be less competition between fuel and food production.

Given that demand for bioenergy is driven largely by regulatory mandates, with production costs subsidized by governments, there are valid issues raised relating to their economic efficiency and socio-environmental sustainability. Concerns related to the commercialization of biofuels alongside small-scale initiatives warrant more deliberate attention, particularly at the regional level. Evidence from the fieldwork conducted for this research suggests that the model of developing energy from biomass at the community level may be a sufficiently solid basis to allow Thailand to take the lead in orchestrating a regional shift to low-carbon economies.

However, we find gaps between the mounting evidence of bioenergy practices and policies for the dual track development of community and commercial bioenergy systems. In other words, whilst the development of bioenergy may be beneficial for Thailand, the implications for sustainable agricultural practices in neighboring Mekong countries are not necessarily as favorable. The challenge is to bridge this gap to enable the transition toward a more sustainable energy future for the Mekong region.

Thailand's experience with agro-energy may serve, in turn, to assist neighboring countries in the Mekong region to enhance their renewable energy development options. Whilst national debate invariably ends on an optimistic note concerning the prospects for renewable energy in general, it is worthwhile noting that there has yet to be a sufficiently rigorous debate in the Mekong on the merits of agro-energy. This may explain why the majority of respondents (57.3%) in the survey undertaken for this research considered that the bioenergy sector is *not* developing along the right path. To this end, all the 143 respondents surveyed and many interviewees felt the government could benefit from more information and improved coordination between ministries in formulating biofuels policies. This is particularly the case given the need for complex trade-offs needed to formulate sustainable agro-energy policies. Moreover, our research revealed that consideration of climate change as a driver for changes in policies and practices was lacking. It is crucial to verify if this continues to be the case.

This chapter has argued that there is policy space to define local narratives in response to global problems. By the same token, it bears emphasizing that these narratives need not repeat mistakes learned in other countries, for example, with respect to subsidizing biofuels, nor need they ignore conventional wisdom. The experience of the United States has been subject to criticism for the abundant use of subsidies given to the corn ethanol industry (Koplow 2007), as has the European Union for subsidies to rapeseed (Jung et al. 2010). It has been well-documented that these subsidies have distorted markets and increased production (IISD/GSI 2015; Steenblik 2007) to the detriment of the environment and led to an extensive application and over-use of pesticides, contaminating water supplies and depleting the soil of nutrients over time (IISD/GSI 2012; Searchinger 2009).

This leaves us with a fundamental question underlying this research relating to the policy space for countries to determine policies. To what extent is Thailand positioned to reap the potential benefits of developing a viable bioenergy sector; or, will it repeat the mistakes of those countries that have put in place burdensome subsidies and allowed agro-industrial production to crowd out smallholder agricultural production? Further evidence is needed to determine whether the future agro-energy narrative for the Mekong can be built on locally-driven initiatives such as the ones studied in this research. Beyond the Mekong, many developing countries in Africa and Latin America are also exploring the potential synergies from linking climate mitigation and adaptation with innovative agro-energy initiatives.

Significant improvements in policy and practice are required to reconfigure agricultural production and land use in order to meet the global demand for food and fuel in a way that contributes to food security, energy generation, greenhouse gas emissions reduction, and biodiversity conservation. In this regard, we would like to underscore four important points that arise out of the above analysis in relation to the context for bioenergy development. The first involves the scale of biofuels development. The second involves the objectives underlying biofuel development. The third is linked with the actors involved in biofuel production relating to the distinction between commercial and community biofuels. The fourth and, arguably the most important element, concerns policy space and governance capacity. Effective governance of the policy space, in turn, will impact the other elements; Simply put, how much, for whom, by whom, and how.

These four caveats are fundamentally important when considering the way forward for agro-energy in the Mekong. The regional energy narrative is currently being formulated, with trade in bioenergy an option under consideration. The driving factors behind the current development of bioenergy are open to narrower and broader interpretations depending upon the context in which they are advocated. While it is necessary to improve the economics and monitor environmental sustainability, the argument of bioenergy proponents in the Mekong and other developing countries, notably Brazil, is that the basket of benefits outweighs the constraints—at least in the transition to a low-carbon economy.

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