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Sustainable Forest Bioenergy Development Strategies in Indochina: Collaborative Effort to Establish Regional Policies

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Abstract: We conducted a feasibility study in Indochina (Cambodia, Laos, Myanmar, Thailand, and Vietnam) with the aim of promoting biomass and bioenergy markets, technology transfer, rural development, and income generation. Policy development is guided by the International Union of Forest Research Institutions (IUFRO) Task Force "Sustainable Forest Bioenergy Network". In this paper, we highlight the achievements up to now and present results of a multi-stakeholder questionnaire in combination with a quantitative analysis of the National Bioenergy Development Plans (NBDPs). We found a gap between official documents and working group assessments. NBDPs are focused on the market development, technology transfer, and funding possibilities of a regional bioenergy strategy, while the respondents of a questionnaire (working groups) favored more altruistic goals, i.e., sustainable resource management, environmental protection and climate change mitigation, generation of rural income, and community involvement, etc. We therefore suggest the following measures to ensure regulations that support the original aims of the network (climate change mitigation, poverty alleviation, sustainable resource use, and diversification of energy generation): (i) Consideration of science-based evidence for drafting bioenergy policies, particularly in the field of biomass production and harvesting; (ii) invitation of stakeholders representing rural communities to participate in this process; (iii) development of sustainability criteria; (iv) feedback cycles ensuring more intensive discussion of policy drafts; (v) association of an international board of experts to provide scientifically sound feedback and input; and (vi) establishment of a local demonstration region, containing various steps in the biomass/bioenergy supply chain including transboundary collaboration in the ACMECS region.

Keywords: ACMECS; Indochina; bioenergy network; regional collaboration; bioeconomy; biomass

1. Introduction

In the face of a growing demand for energy and an increased concern about environmental impacts, several countries of Southeast Asia are planning a transition from traditional energy systems to a diversified bioeconomy. Despite the currently low prices for fossil energy due to a number of geopolitical reasons, these governments are exploring ways to substitute biomass for fossil fuels in future energy generation and to increase the efficiency with which traditional forest, farm, and urban biomass materials are used for industrial, community, and domestic processes. One of the most prominent reasons for the need to redesign the global energy economy is to mitigate the negative anthropogenic impact that continued fossil fuel use has on our climate. This threatens global ecosystems, rural and coastal communities [1], energy security [2], and even national security [3,4]. Decentralization and diversification of energy systems can greatly contribute to increased resilience against disturbances of various origins [5]. The socioeconomic implications of such a transition can be beneficial in terms of livelihoods, especially in rural areas, because energy supply diversification is associated with more opportunities, including "green jobs" [6].

Wind and photo-voltaic energy systems are widely deployed, but they only produce electricity and are intermittent and hence they struggle to satisfy society's steady demand for many types of energy [7]. Strategies to solve wind and solar power's intermittency include linking generation over large geographic areas or storing the power in batteries or some other form of chemical or mechanical potential energy. Sometimes, renewable sources are paired with other systems that consume fossil or nuclear fuels. In this way, they can reduce the demand from the companion system.

Biomass is nature's sustainable energy storage system. Unlike the intermittent energy sources like wind and/or solar, biomass can deliver that energy on demand and do so in a continuous way. Biomass is the only source of renewable carbon-based feedstock. It is diverse and abundant and can be converted into heat, electricity, liquids, and gases, as well as advanced and traditional bioproducts. While it is less energy dense than fossil fuels (which are essentially just buried biomass), sustainably produced biomass has the advantage of containing atmospheric rather than fossil carbon and so has a smaller carbon footprint when it is used [8]. Deploying advanced biomass-based energy systems has been identified as a key way to reliably and sustainably satisfy the future development needs of the countries in Southeast Asia.

Southeast Asia has a subtropical to tropical climate. Thailand's mean annual precipitation is approximately 1200 mm, with some regions may receive more than 4000 mm. Average seasonal temperatures range from 23.1 °C in winter to 29.6 °C in summer [9]. These favorable environmental conditions coupled with fertile soils support high ecosystem productivity and biodiversity in the Indo-Burma region, which ranks among the world's top 10 biodiversity hotspots [10]. The river basins in this region were subject to early deforestation to create space for the production of agricultural crops, especially rice. In dryer regions, common crops are still *Hevea brasiliensis* (Müll.) Arg. (rubber tree), introduced at the end of the 19th century [11], and *Manihot esculenta* Crantz (cassava), introduced at around the same time [12]. Other fast-growing tree species such as Acacia spp. or Eucalyptus spp., were introduced around the 1940s [13], but became widely cultivated after 1970, mainly for extracting industrial feedstock raw materials (e.g., pulp), and recently, increasingly for bioenergy. The natural forests of the region were suffering from the highest rate of deforestation among all major tropical regions in the past, with disastrous consequences for the rich biodiversity [14]. In order to accommodate and expand upon the long tradition of using raw biomass and charcoal for energy [15] while mitigating the negative effects of a changing global climate, a number of initiatives to promote bioenergy were recently implemented through national energy-related policies within this region.

The Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy (ACMECS) was initiated by the Thai Prime Minister Thaksin Shinawatra in 2003 [16], with the objective of improving economic collaboration between Cambodia, Laos, Myanmar, Thailand, and Vietnam. Thailand was expected to provide funds to reduce the development gaps between the ACMECS countries [17], which have a human development index (HDI) ranging from 0.726 in Thailand to 0.536 in Myanmar [18] (see

Table 1). During the third ACMECS summit meeting in 2008, studies on bio-energy feasibility [19]. Five years later, the Thailand International Cooperation Agency (TICA) approved a project proposal submitted by Kasetsart University (Bangkok, Thailand) in 2013, which should finally address the potential for joint bioenergy development in the ACMECS region (see Figure 1). Three ACMECS regional bioenergy workshops were held under this project that led to the development and discussion of National Bioenergy Development Plans (NBDP). Following the first meeting (held in Bangkok in 2013), the International Union of Forest Research Organizations (IUFRO) approved a proposal for a scientific Task Force (TF) titled "Sustainable Forest Biomass Network (SFBN)", which was finally installed in April 2015 [20]. One of the key objectives of this TF is to provide scientific support and guidance at the ACMECS workshops as the NBDP were being developed.

This paper summarizes the activities and results of this project, including activities at the three workshops and the resulting NBDP documents. It further describes the process followed to solicit perceptions and visions of all stakeholders involved in the project, in order to identify gaps between official documents and issues highlighted as important during more open discussions at the project workshops. Finally, elements that might form a regional synthesis plan were identified in an effort to provoke a differentiated dialogue in the ongoing policy development that includes a thorough analysis of potential benefits and risks in order to ensure a sustainable implementation of bioenergy in the ACMECS countries.

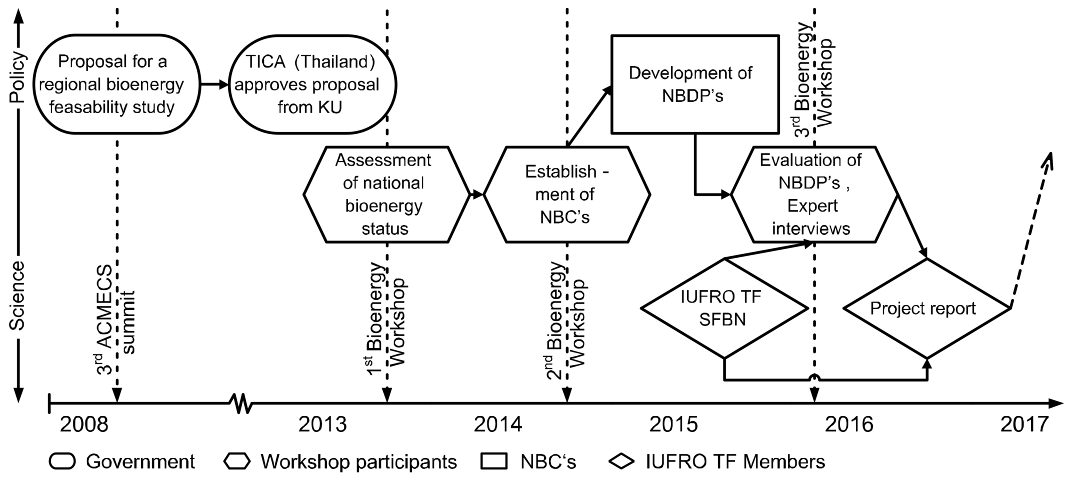

Figure 1. Schematic diagram of the key milestones of the regional bioenergy network development in the ACMECS countries. ACMECS = Ayeyawady-Chao Phraya-Mekong Economic Cooperation Strategy; TICA = Thailand International Cooperation Agency; KU = Kasetsart University, Bangkok, Thailand; NBC = National Bioenergy Committee; NBDP = National Bioenergy Development Plan; IUFRO TF SFBN = Sustainable Forest Biomass Network Task Force of the International Union of Forest Research Organizations.

Table 1. Basic facts on land-use, current share of bioenergy, and bioenergy commodities in the ACMECS countries.

	HDI [1]	Land Area					Bioenergy [4]	Bioenergy Commodities Production [5]			
		Total [2]	Forest [3]		Agriculture [2]						
		10^7 m^{-2}	10^7 m^{-2}	%	10^7 m^{-2}	%	% of Total Renewable Energy Production	Fuelwood [10^6 m^{-3}]	Charcoal [10^3 t]	Woodchips [10^3 m^{-3}]	Pellets [10^3 t]
Cambodia	0.555	17,652	9457	54	5455	31	99.89	7.78	37.06	no data	no data
Laos	0.575	23,080	18,761	81	2369	10	no data	5.89	23.34	no data	no data
Myanmar	0.536	65,308	29,041	44	12,645	19	96.70	38.29	174.79	no data	no data
Thailand	0.726	51,089	16,399	32	22,110	43	97.09	18.81	1,448.76	2080.00	40.00
Vietnam	0.666	31,007	14,773	48	10,874	35	90.70	20.00	414.00	3312.00	1060.00

[1] Source: [18], 2014 data; [2] Suitable for terrestrial biomass production, Source: [21], 2014 data; [3] Source: [22], 2015 data; [4] Source: [21], 2009 data; [5] Source: [21], 2015 data.

2. Materials and Methods

2.1. Establishment of a Collaboration Platform and Development of National Bioenergy Development Plans (NBDP)

Principles of Participatory Action Research [23] were implemented in early project stages and when drafting agendas for the kick-off workshop. The aim of the first ACMECS bioenergy workshop was to invite key stakeholders representing the policy making process from the ministerial level, NGO's, and academia, as well as private entities. National representatives were asked to prepare presentations to describe the current status of bioenergy development in their countries with a focus on relevant policies, major challenges, and opportunities, as well as practical insights. Key elements that would ultimately constrain or, alternatively, might foster the development of bioenergy systems in the region were identified:

- A great amount of heterogeneity existed among countries, in terms of the current status of bioenergy development, relevant policies, and regulations, as well as technological development and infrastructure.
- Energy consumption profiles differed considerably between rural and urban populations.
- There was a general lack of policy enforcement and consequently it led to illegal logging.
- The advantage of regional collaboration on various levels (research institutions, policy making authorities, NGO's etc.) was keenly recognized.
- Jointly developing international markets (with focus on South Korea and Japan due to existing strong trade relationships in biomass commodities).

The workshop participants were furthermore asked to propose key national stakeholders that were not yet part of the process, as a continuing effort to broaden the input from a wider range of experts. The Kasetsart Agricultural and Agro-industrial Product Improvement Institute (KAPI) of Kasetsart University (KU) was appointed the coordinating function for all further activities. Representatives of responsible ministries were involved to avoid risks which could have meant that the concept for the regional bioenergy network might otherwise not have been fully accepted during the policy making process. During the second workshop, it was agreed that assessing how biomass was presently being used throughout the region would be an important activity [15]. Biomass use was only minimally regulated at present, and poorly quantified. A large majority of the rural population was known to rely on biomass (either raw wood or charcoal) for cooking and other purposes. A successful policy framework should therefore encourage activities that increase efficiency and decrease pollution and other negative side effects associated with the open burning of biomass. It was highlighted that sustainable feedstock sources will need to be increased to accommodate this and future feedstock demand. The second workshop concluded as each country agreed to establish a national bioenergy committee (NBC) composed of key persons from a variety of stakeholder groups. The aim of the NBC was to coordinate national activities including correspondence with national policy making authorities and external stakeholders from industry, research institutions, and local communities. Based on the respective country's current development status, the NBCs were asked to draft a National Bioenergy Development Plan (NBDP; see Table 2 and Figure 1). A coarse structure was introduced and provided to all NBCs in order to ensure compatible plans capable of developing further regional strategies. The key function of the NBDP was to present the current bioenergy development status in each country while identifying challenges and opportunities for further development, including a set of key success indicators, such as human resources, governmental support, technology development, and others [24].

Table 2. Basic structure of the National Bioenergy Development Plan (NBDP). Items are presented according to their sequence in the NBDPs.

Item	Description of Contents
Introduction	Concise description of the purpose of the document, development of the ACMECS bioenergy network, and existing transnational frameworks.
Basic information	Country-specific information on the national energy supply and demand, including trade, energy portfolio, and potential sources of energy in total numbers and specifically for biomass. Included is a listing of governmental bodies (ministries, agencies) that are involved in energy issues. Two sub-sections on "National energy profile" and "National bioenergy profile" are included.
SWOT Analysis	This includes a classical SWOT analysis on further bioenergy development in each country. Topics covered are of social nature (e.g., policy development, implementation, acceptance, socioeconomic consequences, market development, trade), environmental (e.g., sustainability in biomass production, soil conservation, biodiversity, land use change), and technical issues (e.g., technology transfer and development). Key strategic issues (<10) are listed with a brief description, with the aim to address findings of the SWOT analysis.
Strategic plan for biomass energy development	The strategic plan briefly elaborates on actual proposed activities, including indicators, with the aim to enable efficient controlling mechanisms. A more abstract vision is described and subsequently specified in detail by defining a goal and the key success indicators (KSI). KSI's are linked to actual activities and critical success factors, and key performance indicators are defined accordingly.
Links to national energy policies	Here, the nexus between the NBDP with existing (renewable or bio-) energy regulations and frameworks is described. Where appropriate, potential regulations that can be included/amended are listed.
Follow-up and evaluation process	This section identifies potential evaluation approaches and briefly elaborates on reporting and documentation requirements.

This framework was used by all countries with the hope of facilitating the further development of a common regional strategy. This should enable the NBCs to identify both gaps and potential synergies in science, policy definition, and technical cooperation within ACMECS countries and beyond, for instance via technology transfer. An interim meeting was held in September 2015 so that members of all five NBCs could harmonize the NBDPs while still accounting for the specific national development status, including socioeconomic conditions, land-use structure, policy infrastructure, and biomass potentials, etc.

Drafts of the harmonized NBDPs were presented during the 3rd ACMECS bioenergy workshop in December, 2015. During the workshop, we first identified issues that were common among countries and discussed each issue to confirm that it could be considered representative for the entire ACMECS region. In a second step during the same workshop, we explored the relative significance of each issue and sought any other issues that might apply to the entire region rather than a single country. A team of outside technical experts from the IUFRO SFBN Task Force participated in these discussions.

2.2. Analysis of NBDPs

To visualize information in the NBDPs, we used an approach based on co-term analysis. It highlights the frequency and co-occurrence of a set of terms, directly from the NBDPs. It provides a quick and quantitative overview on individual terms that frequently appear throughout the entire document, and their relationship to other terms. This method has gained increasing attention in the last decades, specifically for developing public policy [25]. We used the VOSviewer software (www.vosviewer.com), which produces a distance-based map of key terms [26] occurring in the NBDPs. The VOS mapping technique produces a similarity matrix which is subsequently displayed as a map containing nodes (terms) and connections (links). This enabled us to identify key topics and concepts, as well as their relevance and connectivity to each other. All NBDPs were pooled for analysis in order to derive a regional informative network analysis.

2.3. Post-Workshop Questionnaire

The involvement of stakeholders in a policy development process can be achieved by various means, including questionnaires [27–29]. A questionnaire was developed by the SFBN Task Force during the third workshop (Figure S1), in order to gain insights from key stakeholders who had been unable to otherwise participate fully. This questionnaire was sent to 70 stakeholders who had been involved in one or more aspects of the three-workshop series. The third workshop brought together key experts in biomass and bioenergy and representing academia, governmental institutions, and NGO's in the ACMECS region, who were willing to contribute. Technically, the questionnaire was designed using Google Forms because it is a flexible and convenient solution. Pre-determined answer choices for each question were presented in a random order for every survey where applicable to minimize systematic bias. The questionnaire consisted of 10 sections, with the first representing an introduction and a disclaimer, stating that no personalized information would be published. Part 2 assessed demographic and personal information and parts 3–9 contained the topical questions. Responses to questions involved either (1) scoring questions from a high level of agreement to a low level of agreement; (2) estimating percentages; or (3) choosing from among a list of predefined answers. Multiple answers were allowed, and an "other" category was added where applicable, to allow for a wider and more comprehensive expression of opinions. In the final section, respondents were asked to submit any thoughts in an open text area.

3. Results

3.1. Analysis of NBDPs

The NBDPs provided a very insightful overview on the current bioenergy status of the respective countries. For instance, it was shown that bioenergy is by far the most important resource of renewable energy, between 91 and nearly 100% (Table 1), despite significant investments in other renewable sectors, such as hydropower and wind energy [30]. The most important bioenergy commodities are traditional (fuelwood and wood charcoal), followed by woodchips and pellets, which are currently only in widespread use in Thailand and Vietnam. While biomass is the most important source of primary energy in some less developed countries (e.g., Myanmar and Cambodia), it still plays an important role in sustaining the livelihood of rural populations in more developed nations, such as in Thailand and Vietnam.

The National Bioenergy Development Plans (NBDP) developed by each of the five ACMECS countries contained a "Strengths, Weaknesses, Opportunities, and Threats" (SWOT) analysis. A meta-review of these SWOT analyses [24] was carried out and a synthesis was recently published [31]. The aim was to identify the most common and universal items in each SWOT category. Table 3 lists the main conclusions and can be viewed as the SWOT matrix for the entire region. The synthesis of the individual national SWOT analyses confirms that the region has vast and diverse resources and a great potential for biomass production. There is also a rising regional and international demand for biomass. However, it turned out that a further development of these resources must carefully consider environmental and land tenure issues. A missing policy framework and political instabilities should be jointly addressed to minimize an investor's risks. Research is needed to establish a sound database on biomass data, especially since spatially explicit information is largely missing.

3.2. Results of Co-Therm Analysis

Visualization of similarities (VOS) (Figure 2) revealed that key terms, such as biomass energy development, needs (expressed as "lack" in the documents), power (generation), efficiency, system (represents a more holistic approach, e.g., "energy system"), and indicator occur relatively often in the NBDPs. The cluster including biomass energy development includes elements of the SWOT analysis and is distant from the biomass feedstock cluster. "Lack" is an item that is well connected and centered, indicating a prominent position of needs in the NBDPs, across topics. The cluster "efficiency" is strongly linked to alternative energy and its development. It is also obvious that the cluster dominating on economics includes all business scales, from farmers to enterprises, as well as community. Topics, such as sustainability and climate change, as well as sustainable development and resource use, or technology transfer, are not prominently positioned, although they are defined as key targets in the proposed regional network.

Table 3. SWOT meta-analysis of all NBDPs. Source: [31].

Strengths	**Weaknesses**
• Abundant biomass resources • Great biomass variety • Experience in (traditional) biomass production and utilization	• Lack of advanced technology • Limited expertise • Missing biomass related data and statistics • Scattered feedstock availability
Opportunities	**Threats**
• Large demand for biomass in this region, increasing international demand • Chance of technology transfer • Income for rural people	• Degradation of natural forests • Political and policy instability—missing policy framework • Increasing poverty and environmental degradation • Land-use conflicts

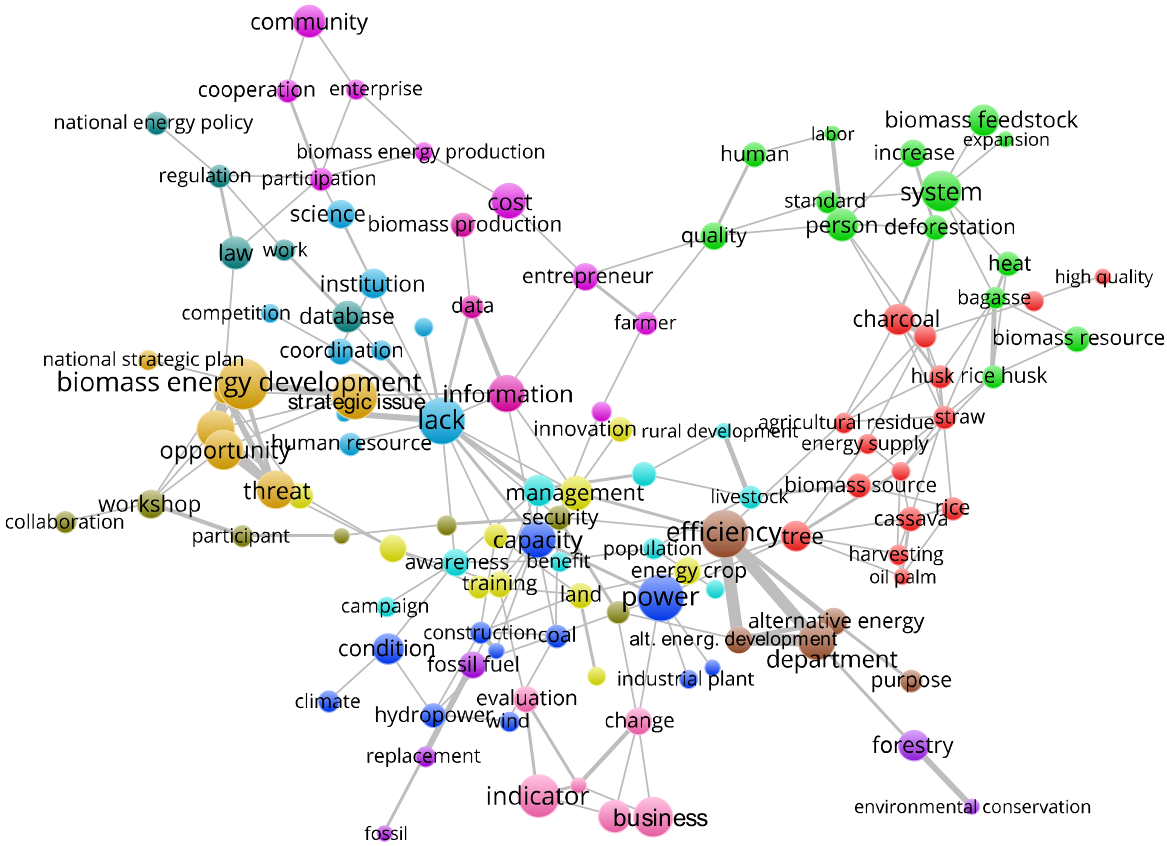

Figure 2. Key items (circles, n = 115) displayed in a term map with 15 clusters (represented by different colors) and 201 links (lines). The size of the circles represents the occurrence and the width of the connecting lines the link strength. The distance between items represents their topical distance in the NBDPs. The cluster color represents a topical focus area. Data source: authors' compilation 2017.

3.3. Summary of the Post-Workshop Survey

In total, 52 responses were received (recovery rate of 74%). A total of 24 contained personal contact information and the rest were submitted anonymously. Two respondents did not provide information on their country of origin and these were omitted from analysis. Respondents were grouped according to the country they represent within ACMECS (country groups), as well as their professional background (stakeholder groups), as defined in van Dam and Junginger [28]. The stakeholder groups were identified as:

1. Research (University or research institute) (42.3%)
2. Governmental institution (Ministries, policy-making institution, chambers) (26.9%)
3. Non-Governmental Organizations (NGO's) (11.5%)
4. Private companies (Consulting, biomass or bioenergy business) (19.3%)

Values in square brackets indicate the share of total respondents within the respective stakeholder group. Overall, most respondents were associated with a research institution (42.3%) followed by a Governmental institution (26.9%), Private companies (19.2%), and NGO (11.5%). The distribution of responses among the country groups was relatively even: Cambodia (18%), Laos (16%), Myanmar (18%), Thailand (28%), and Vietnam (20%). The representation of stakeholder groups within countries was not equal. For instance, most respondents from Myanmar belonged to the NGO stakeholder group, whereas in Thailand, most were Researchers, and in Cambodia, most were from Governmental institutions. Participation from Laos and Vietnam was more balanced, with about 50% of the respondents from Research and the other half from the remaining groups. This represents the active bioenergy research and development institutions in each nation. Questionnaire responses were analyzed using IBM SPSS Statistics 23 and Microsoft Excel, using statistics based on ranks [32], such as the Kruskal-Wallis-Test and the Friedman test for related samples.

3.4. Trends in Biomass Resources and Commodities over the Next 25 Years

We asked where biomass supplies would come from during the next 25 years. We found a common expectation that the contributions from natural forests would decrease (except in Thailand), while the contribution from both forest plantations and the agriculture sectors are expected to increase (Figure 3). Respondents from Thailand, Cambodia, and Laos generally expected plantations to contribute more than their counterparts from Vietnam and Myanmar. We found no significant difference between stakeholder groups in most cases, except for biomass provision in natural forests at current ($\chi^2(3) = 12.256$, $p = 0.007$) and in 25 years ($\chi^2(3) = 11.247$, $p = 0.010$). In both cases, the group "Research" rated the provision generally lower than other groups, in particular the group "Governmental institution".

To distinguish private from industry biomass consumption, we asked respondents to evaluate the importance of different feedstocks now and in 25 years separately for the private and the industry sector. The majority of respondents classified the current use of wood charcoal (84%) and fuelwood (82%) as "very important" or "important" in the private sector. Yet, these values are expected to decrease to 68% and 54% in this sector in the future. According to the expert's opinion, woodchips, pellets, and liquid biofuels will play a more important role, but will remain behind traditional fuels, such as fuelwood and charcoal. The situation appears somewhat different in the industry sector, where woodchips (62%), pellets (48%), and fuelwood (42%) were currently seen as the main sources for bioenergy, even in countries with low significance, where FAO data are missing (Table 1). The stakeholders concurred that woodchips (92%) would be the most important industrial feedstock in 25 years from now, followed by pellets (84%) and liquid biofuels (40%). We observed a tendency of higher fuel wood use in the private sector in countries with a lower HDI, but not in the industry sector. Within the traditional bioenergy sources, countries with a lower HDI generally use higher shares of fuelwood and more developed countries use charcoal instead. For Thailand, we found a strong correlation $r(s) = 0.629$, $p < 0.05$ between the estimation of the current importance of fuelwood in the private and industry sector.

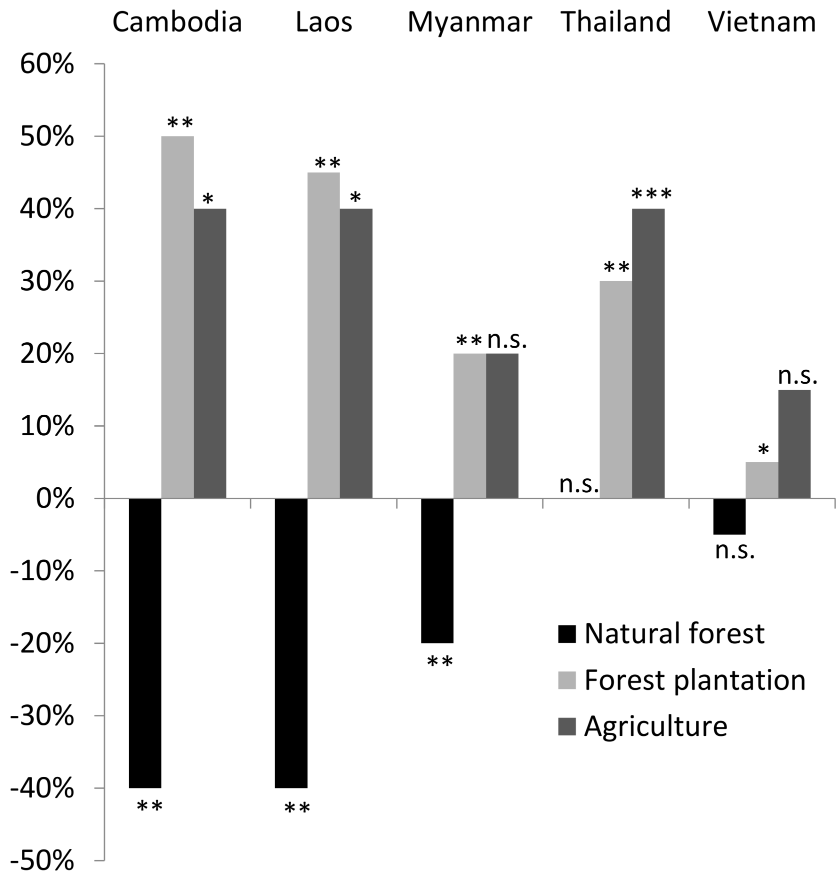

Figure 3. Expected development of major biomass resources within 25 years in the ACMECS countries. A positive value indicates an increase relative to today's values, whereas negative values indicate a decrease, relative to the current amounts sourced from the respective categories. Statistical significance is presented as n.s. = not significant, * = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$ using the Friedman test statistics for related samples, and indicates the coherence of individual answers. Data source: post workshop survey, authors' compilation 2017.

3.5. Responsible Institutions for Bioenergy Policy

We asked the experts which institutions are currently responsible for the development of bioenergy policy. In all countries, the Ministry of Energy was the most frequent answer, followed by the Ministry of Industry and the Ministry of Agriculture. Ministries responsible for the environment, trade, and science are less often involved. The situation seems to be perceived as rather stable, as nearly the same situation is expected in 25 years, except in the case of Myanmar, where the ministries for science and environment are expected to play a more important role.

3.6. Perceived Impacts of ACMECS Bioenergy Network

The impact of the network seems to depend on the development status and the biomass potentials of the respective ACMECS countries. However, in various presentations and summaries made during the three major workshops, it became clear that sustainable development and environmental concerns were on the minds of participants. Curiously, this was not strongly reflected in the formal NBDPs presented. We asked the experts where they expect the largest impact of the proposed network (Table 4) based on the discussions during the previous meetings. A common conclusion at the workshops was that there are a range of issues where such a network can provide a positive impact. Climate Change mitigation was cited as the top impact, followed by sustainable resource use and technology transfer. Economic impacts were thought to be lower than these others.

Table 4. Expected impact of the proposed network among the ACMECS countries, where 1 = very important, 2 = important, 3 = good to have, and 4 = unimportant, ranked median according to importance score from top to bottom. Background colors represent classes 1-4.

	Cambodia	Laos	Myanmar	Thailand	Vietnam
Climate change mitigation	2	1	1	1	1
Sustainable resource use	1	1	1	3	1
Technology transfer	1	3	1	2	1
Foreign investments	2	3	1	2	1
Improvement of access to affordable energy	2	1	1	3	2
Income generation for local communities	1	2	2	2	2
Reduced dependence of fossil fuel imports	2	3	2	2	1
National investments	3	4	1	2	1

3.7. Preconditions to Successful Adoption of National Bioenergy Development Plans

A key challenge facing any effort to install a regional bioenergy network and the supporting policy framework in an environment where a diversity of feedstocks is available, is understanding development stages and perceptions, as well as different responsibilities at the ministerial level. Consequently, we asked for preconditions that need to be met to successfully implement suggestions coming from the network and to ensure that the coordinated efforts lead to a coherent product.

Governmental incentives, support in planning of renewable energy systems, and a political commitment to bioenergy were seen to be very important by all countries. A suitable financing environment, strong energy markets, and a well-trained workforce were also seen to be important. Table 5 summarizes general data, such as biomass inventories, availability (accessibility) ranked in the middle, followed by various levels of collaboration and more specific data, as well as public acceptance. The most important factors tended to be identified consistently by various country and stakeholder groups. Consensus was more difficult to identify for other factors like improved resource inventory or land use data.

Table 5. Requested preconditions for a successful network implementation as expressed by respondents, expressed by the ranked median values. 1 = highly needed, 2 = needed, 3 = not essential. Background colors represent classes 1-3.

	Cambodia	Laos	Myanmar	Thailand	Vietnam
Governmental incentives taxation, subsidies	1	1	1	1	1
Support in planning of renewable energy systems	1	1	1	1	1
Political commitment to bioenergy	1	1	1	1	1
Access to capital/investments	2	1	1	1	1
Data on biomass market supply	1	1	2	1	1
Human capital	1	1	2	1	1
Government support for community involvement	2	1	2	1	1
Education and capacity building	1	2	1	3	1
Collaboration among ACMECS countries	1	2	1	3	1
Data on biomass production constraints	2	3	2	1	1
Supporting data on land use	2	3	1	1	3
Biomass inventory data	2	3	2	2	1
Biomass availability on spatial scales	2	3	2	3	1
Collaboration among national institutions	2	3	2	3	1
International collaboration	2	3	2	3	1
Public acceptance for a bioenergy network	2	3	2	3	2
Theoretical biomass potentials in spatial scales	2	3	2	3	2
Spatially explicit soil data	2	3	2	3	3

3.8. Most Significant Financing Mechanisms

Financing was highlighted by workshop attendees as one of the most crucial predictors of success, so we explored this by asking which would be the most significant financing institutions (Table 6).

Development banks were most commonly rated as being very important investors, followed by private firms and commercial banks. Country-specific scoring was observed. Thai respondents favored private rather than governmental institutions. Myanmar respondents favored a combined strategy with development banks for larger projects and microcredit models for smaller projects. Private corporations, development banks, and commercial banks are seen as the most important capital providers for the long-term. Activities within the United Nations program of reducing emissions from deforestation and forest degradation (UN-REDD+) are expected to provide a substantial amount of funds over the long-term, but not in the short-term. Respondents affiliated with NGOs identified development banks as critical, while Researchers thought private firms would be more important going forward. The role of development banks is perceived significantly differently between stakeholder groups, for the short-term ($\chi^2(3) = 9.827$, $p = 0.020$) and the long-term ($\chi^2(3) = 11.832$, $p = 0.008$), where respondents with a background at NGO's identified these as more important. Members of the stakeholder group "research" were responsible for a significantly different view regarding the role of private firms in both short-term ($\chi^2(3) = 9.014$, $p = 0.029$) and long-term ($\chi^2(3) = 17.865$, $p = 0.000$) scores.

Table 6a. Short-term financing instruments of the proposed network, expressed by the ranked median values. 1 = very important, 2 = important, 3 = can be useful, 4 = not important. Background colors represent classes 1-3.

	Cambodia	Laos	Myanmar	Thailand	Vietnam
Development banks *	1	1	1	2	1
Private corporations	1	1	2	1	1
Commercial banks	2	2	2	1	1
international large-scale investors	2	3	2	2	2
Small-scale and microcredit models	2	3	1	2	3
REDD+	2	4	3	3	3
NGO's	3	4	2	3	3

* Governmental institutions with specific development aims

Table 6b. Long-term financing instruments of the proposed network, expressed by the ranked median values. 1 = very important, 2 = important, 3 = can be useful. Background colors represent classes 1-3.

	Cambodia	Laos	Myanmar	Thailand	Vietnam
Private corporations	1	1	1	1	1
Development banks	1	1	1	1	1
Commercial banks	1	1	1	1	2
REDD+	1	1	2	2	1
NGO's	2	2	1	2	1
International large-scale investors	1	2	2	2	2
Small-scale and microcredit models	2	2	2	2	3

3.9. Risk Categories Effecting Successful Development of the Bioeconomy

Biomass and land, which produces it, are vulnerable to various kinds of risks ranging from natural disturbances to political and/or societal issues. We asked the experts to rank a number of pre-defined risks according to their likelihood of becoming a threat to the developing bioeconomy of the region.

The majority of respondents agreed that all of the pre-defined categories represent a moderate to high risk of disrupting the developing bioeconomy of Southeast Asia (Figure 4). Monetary issues (decline or lack of funding) were seen as the category with the highest risk potential, followed by the degradation of natural resources and market price fluctuations. Thailand and Laos seemed to be more concerned about monetary and political stability and market price fluctuation than Vietnam and Myanmar. No significant differences were found between stakeholder groups.

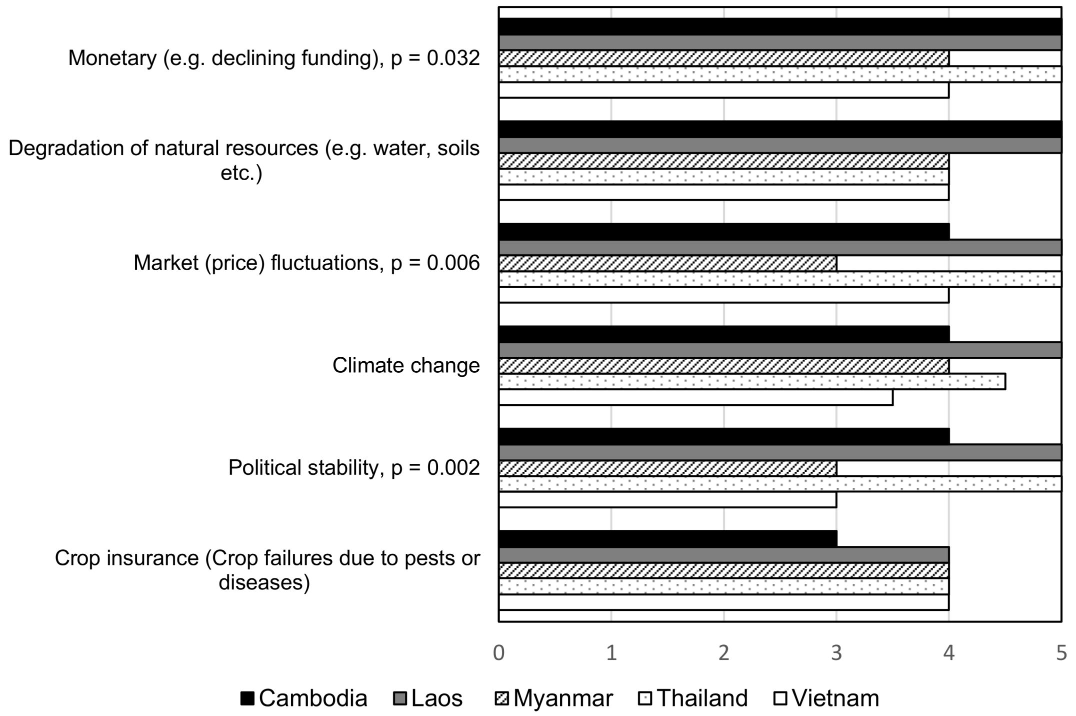

Figure 4. National scores (median) of risk potentials for the regional bioenergy network (1 = unlikely a risk, 5 = likely a risk). Significant differences between all country groups are indicated by the respective p value ($\chi^2(4)$). Data source: post workshop survey, authors' compilation 2017.

Degradation of natural resources was identified as a major risk, especially in Cambodia and Laos. However, an associated risk, Climate Change, ranked behind other more immediate risks, such as funding security and market price fluctuations. Risks associated with environmental factors were recognized more in the questionnaire than they had been in the NBDPs developed prior to the third workshop. This may have resulted from the attention paid to these things during that workshop.

4. Discussion

4.1. Regional Heterogeneity

We found a strong regional heterogeneity of current development stages of bioenergy, which corresponds to the general economic development of the countries and their respective HDI. In addition, natural biomass resources are diverse and characterized by regional availability, even within countries. Hence it is not surprising that expertise is fragmented and technology transfer as well as capacity development was claimed to be an important strategy for bioenergy development. On the contrary, traditional use of biomass is a common practice in all countries, but the development stage determines if fuelwood (less developed) or charcoal (more developed countries) is the main feedstock. With regard to feedstocks mainly used for industrial purposes and trade, such as woodchips and pellets, reasonable numbers on national production capacities are only available from Thailand and Vietnam (Table 1). This is in agreement with our assessment of importance of different feedstocks for household and industrial applications within the next 25 years. While it is expected that the demand for traditional feedstocks, such as fuelwood and charcoal, sharply decreases in countries with a lower HDI, the effect is less significant in countries with a higher development (Figure 5). This indicates a future convergence of development stages in the ACMECS region, which could be beneficial in view of poverty alleviation.

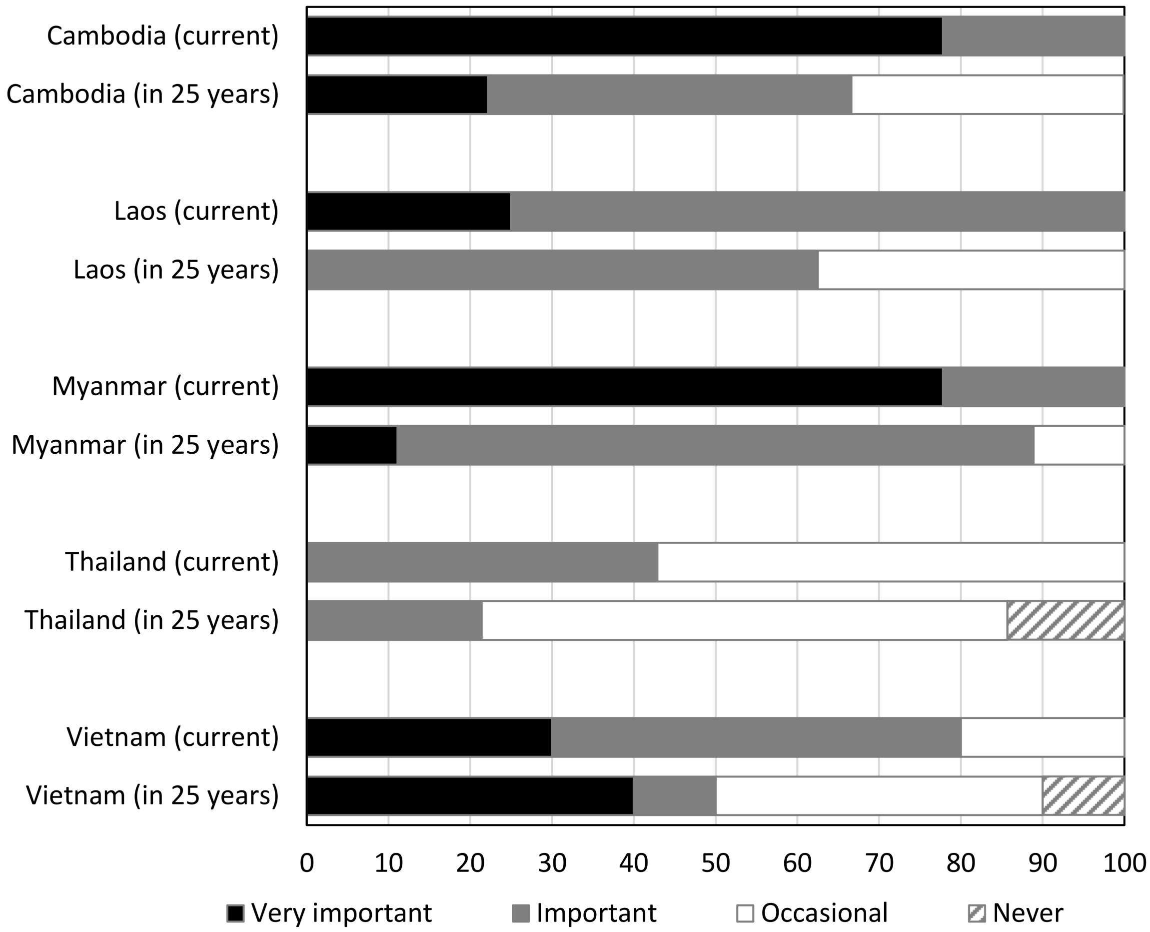

Figure 5. Importance of fuelwood, the most commonly used bioenergy feedstock for private use, currently (solid bars) and in 25 years (dashed bars). Values represent the percentage (share of all responses in each category). Data source: post workshop survey, authors' compilation 2017.

The composition of involved stakeholders and their institutional background is reflected by the diverse governance structures that interfere with biomass topics across the ACMECS region. This becomes obvious for instance in Table 6, where only Myanmar ranked microcredit models as a very important tool for a successful bioenergy development, interestingly only in the short-term. This is likely based on the fact that NGO's, playing an important national role, are among the leading institutions developing microfinance models since the 1990s [33], although the main problem in Myanmar is a lack of trust in financial systems [34]. The perception of risks strongly reflects the current political situation in the respective countries (e.g., Thailand), as political stability turned out to be a key factor in countries with stability issues in recent years.

4.2. Perceived Versus System-Immanent Risks

Climate change is definitely one of the key sources of risks for the successful network operation and beyond, affecting the entire energy industry. A lack of precipitation, for instance, not only greatly limits the capabilities for biomass production, but also for hydropower generation. Droughts are usually associated with elevated temperatures, which cause peak energy demands from air conditioning [35]. It is expected that periods of drought and extreme weather events will generally increase, although models also predict an overall increase of precipitation amounts [36]. Groundwater resources are consequently also decreasing, especially in regions with high agricultural production [37]. Intensive land management affects habitats for plant and animal species and despite a few exceptions, e.g., managed coppice woodlands [38], it typically decreases habitat quality and diversity, being a threat to the exceptionally rich biodiversity in this region. A recent study revealed that in view of biodiversity conservation, selective logging in natural forests is the better choice over land conversion to plantations, which has a strong negative impact [39].

Risks were perceived differently among countries. This is not surprising given the heterogeneity of political, environmental, social, and economic conditions among them. Another paper assessed the impacts of stringent emission reduction levels and concluded that Thailand and Vietnam would be among the most affected countries [40]. This could represent an additional risk and interfere with implementation. The authors suggest that renewable electricity generation can play a key role in meeting emission targets, but markets need to be de-risked in some way. For example, creating a common regional electric market could reduce the risk of fluctuating prices in local markets. Understanding and mitigating against a variety of risks is clearly necessary for the success of implementation of the NBDPs.

4.3. Limitations of This Study

Since one of the key aims of the network is sustainable development, including rural development, climate change mitigation, and ecosystem maintenance, future assessments should include stakeholders which are directly affected by these matters. Potential hurdles and opportunities can be identified in a very early planning stages and it has been shown that involvement of stakeholders in the policy process can increase public acceptance in environmental management [41]. Results presented in Table 5 illustrate this situation very well. While political support and funding are mentioned as key factors for successful policy implementation, public acceptance ranked least important in our survey. The diversity of experts assembled here can be well justified by the fact that the potential and core conceptual architecture of such a network needs to be discussed on an expert level. However, the broader public, including smallholders, must be included at some point in the near future.

An additional point of concern is the heterogeneous responsibility for bioenergy development among countries. While the development is directed by mostly governmental (ministerial) expertise in some countries (Laos), the focus is on NGO's in Myanmar, for instance. Thailand is represented by a nearly balanced composition of academia, private entities, and governmental representatives. The mixed responsibility, especially in governmental vs. non-governmental institutions, may become a problem that needs to be overcome.

The timing of the survey likely introduced an important effect. We distributed the questionnaire after the 3rd ACMECS bioenergy workshop, which was the first workshop where the SFBN Task Force was formally involved. Consequently, global issues of climate change mitigation, sustainable development, poverty alleviation, and international collaboration were highlighted in a number of presentations and in the discussion. As a result, these issues may have been fresh on the minds of respondents to the questionnaire and thus factored more prominently in their answers. While this may have influenced given answers, it could be seen as a successful intervention by the SFBN-TF in awareness-raising of sustainability among the stakeholder groups.

A general concern is data availability and quality with respect to forest-based commodities (i.e., bioenergy commodities). For consistency reasons, the authors decided to provide—whenever possible—official FAO data, being aware of the potential disagreement with other data sources.

5. Conclusions and Policy Implications

We expect a rising demand for energy and consequently for its renewable generation in the Indochina region. Investment in intermittent energy sources, in particular wind power generation, has sharply increased in the area in recent years [42], with the support of favoring political frameworks [43]. Bioenergy can help to provide a continuous source of renewable energy and therefore reduce the vulnerability of increasing shares of intermittent sources. It was shown that the region is capable of producing various kinds of biomass in large amounts due to its geographic location and resulting favorable climate. Increased biomass production and consequently management of land has the potential of generating rural income. However, there are great risks associated with unsustainable use of resources followed by land degradation. A rising population, coupled with changes in diets, requires increasing amounts of food and feed production which may be a main issue in some regions [44,45], and therefore needs to be carefully balanced with bioenergy production based on local assessments. The Asian Development Bank (ADB), among others, therefore supports studies to assess the nexus between sustainable bioenergy generation and food production [43].

Further Steps

Based on the conclusions drawn from the 3rd Workshop [31] and the questionnaire analysis, we propose a roadmap for further development of the ACMECS bioenergy network. The first project phase focused on setting up an expert network of stakeholders involved in biomass research and development, identification of knowledge gaps and the current status of biomass production and use, assessment of the development status and the need for capacity building, and identification of potential domestic and international markets. It was crucial to invite different stakeholder groups to jointly shape the network, in particular representatives of national ministries and other governmental institutions as the network has political weight from the beginning. Workshop participants agreed that this is essential for successful implementation. The academic counterpart, stakeholder group "Research", ensures the provision of scientific background information and knowledge-based guidance of the network. The collaboration between policy-makers and scientists together with private companies and NGO's was successful and necessary. This is well-demonstrated by the questionnaire results, where we found different perceptions between these stakeholder groups as demonstrated above in the disagreement over how much biomass will come from natural forests versus plantations. Researchers tend to be more reserved while policy makers (group "Governmental institutions") see natural forests as a more important resource for biomass.

Bioenergy development plans must be guided by science, but also workable within social constraints. Strategic planning documents developed during workshops may not necessarily include all the issues necessary for "good policy." Although the NBDPs developed here are a first and important step towards a regional network, issues such as climate change, sustainable development, and poverty alleviation were surprisingly not among the key issues initially identified. They were identified by a larger group of experts who subsequently answered the questionnaire. This suggests that the process must be evolutionary and inclusive. The fact that these issues surfaced after the SFBN formally joined the process suggests that engaging outside observers can sometimes lead to a more nuanced view of the problem and to more comprehensive solutions. Allowing anonymous input (as with this questionnaire) may also allow individuals to express views that may not be the same as those of the agencies for whom they work. It is necessary to place more emphasis on the nexus between bioenergy development and long-term environmental, economic, and social sustainability targets in future versions of these NBDPs and bioenergy guidelines and plans, particularly in the context of the forthcoming regional strategy. This might be more easily facilitated by independent stakeholder groups, such as researchers and NGO members, for instance.

We believe that this effort has provided new insights on differences, as well as commonalities and challenges, related to bioenergy development in Southeast Asia. An important outcome is the identification of deficits in knowledge, technology, and political frameworks, particularly those related to sustainability. VOS analysis showed that knowledge deficits are among the central issues in various topics. Based on these findings, we suggest the following further steps, which should be seen as integrative actions, i.e., although a temporal sequence is suggested, it contains a range of parallel tasks.

1. Baseline assessment and organization (Environmental, political and market information; consolidation of national committees; participatory approaches in rural areas).
2. Policy development and promotion (Development of national harmonized bioenergy policies; promotion of investment and financing strategies; standardization of commodities; development

of domestic and international markets; political lobbying and improved collaboration among involved deciding institutions, such as ministries).
3. Implementation and development (Development of renewable energy systems at local scales; best management practices and guidelines; integration of policies into a regional strategy across country borders; policy enforcement strategies, development of a regional supply chain).
4. Evaluation and monitoring (Development of monitoring systems with feedback cycles; impact assessment; assessment of links to international carbon markets and emission reduction schemes; financial support by international schemes, e.g., REDD+).

We hope that this effort has added to our understanding of how a regional and coordinated network for bioenergy might advance in the next decades. However, there are still major challenges in ensuring a successful network implementation and efforts are being undertaken in all involved countries and among a diversity of stakeholders. The installation of the SFBN under the umbrella of IUFRO likely raised awareness of sustainability issues and therefore achieved its anticipated aims. We suggest further guidance of an interdisciplinary and international scientific board, such as IUFRO task forces and other initiatives with expertise in sustainable bioenergy development. Currently, a major shortcoming of the policy development process is the lack of broad participation, which is necessary to ensure public acceptance. If a major aim of the network addresses sustainable rural development, stakeholders need to be included to learn about specific demands and potential solutions in view of a regional network. Tools and infrastructure to install community management need to be provided, as well as funding sources, especially in the initial phase. We found that main issues in official NBDPs do not coincide with important issues discussed during the workshops and rated as being crucial by the involved experts. Consequently, we can conclude that future efforts need to place more emphasis on sustainable development and environmental quality, and there is a need for more intensive collaboration between stakeholders. Meetings and workshops were identified as being very successful instruments in shaping the agenda towards sustainability issues, partly by international expertise. We strongly suggest initiating project phase 2 with additional external funding to ensure ongoing development of this process. This includes the installation of a cross-boundary technology demonstration region where both new technologies and supply chains can be tested and adapted to local conditions. Over the long-term, it would have the potential to greatly contribute to energy security, sustainable development, and the reduction of poverty in rural areas in the ACMECS region.

Supplementary Materials: The following are available online at http://www.mdpi.com/1999-4907/9/4/223/s1, Figure S1: ACMECS Bioenergy 2015 Workshop Survey.

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References

1. Morton, J.F. The impact of climate change on smallholder and subsistence agriculture. *Proc. Natl. Acad. Sci. USA* **2007**, *104*, 19680–19685. [CrossRef] [PubMed]
2. Jewell, J.; Cherp, A.; Riahi, K. Energy security under de-carbonization scenarios: An assessment framework and evaluation under different technology and policy choices. *Energy Policy* **2014**, *65*, 743–760. [CrossRef]

3. Brown, O.L.I.; Hammill, A.; McLeman, R. Climate change as the 'new' security threat: Implications for Africa. *Int. Aff.* **2007**, *83*, 1141–1154. [CrossRef]
4. Barnett, J.; Adger, W.N. Climate change, human security and violent conflict. *Polit. Geogr.* **2007**, *26*, 639–655. [CrossRef]
5. Sovacool, B.K. Evaluating energy security in the Asia pacific: Towards a more comprehensive approach. *Energy Policy* **2011**, *39*, 7472–7479. [CrossRef]
6. Chua, S.C.; Oh, T.H. Green progress and prospect in Malaysia. *Renew. Sustain. Energy Rev.* **2011**, *15*, 2850–2861. [CrossRef]
7. Cavallo, A.J. Energy storage technologies for utility scale intermittent renewable energy systems. *J. Sol. Energy Eng.* **2001**, *123*, 387–389. [CrossRef]
8. Lunnan, A.; Stupak, I.; Asikainen, A.; Raulund-Rasmussen, K. Introduction to sustainable utilisation of forest energy. In *Sustainable Use of Forest Biomass for Energy: A Synthesis with Focus on the Baltic and Nordic Region*; Röser, D., Asikainen, A., Raulund-Rasmussen, K., Stupak, I., Eds.; Springer: Dordrecht, The Netherlands, 2008; pp. 1–8.
9. Thai Meteorological Department. The Climate of Thailand. Available online: http://www.tmd.go.th/en/downloads.php (accessed on 22 March 2016).
10. Weerapong, D. Iucn and Cepf Launch New Funding for Indo-Burma Biodiversity Hotspot. Available online: http://www.iucn.org/news_homepage/news_by_date/?13539/IUCN-and-CEPF-Launch-New-Funding-for-Indo-Burma-Biodiversity-Hotspot (accessed on 23 March 2016).
11. Priyadarshan, P.M.; Hoa, T.T.T.; Huasun, H.; de Gonçalves, P.S. Yielding potential of rubber (hevea brasiliensis) in sub-optimal environments. *J. Crop Improv.* **2005**, *14*, 221–247. [CrossRef]
12. Onwueme, I.C. Cassava in Asia and the pacific. In *Cassava: Biology, Production and Utilization*; Hillocks, R.J., Thresh, J.M., Eds.; CABI: Wallingford, UK, 2001; pp. 55–66.
13. Midgley, S.J.; Turnbull, J.W.; Pinyopusarerk, K. Industrial acacias in Asia: Small brother or big competitor. In *Eucalyptus Plantations: Research, Management and Development: Proceedings of the International Symposium*; Wei, R.-P., Xu, D., Eds.; World Scientific Publishing Co. Pte. Ltd.: Singapore, 2003; pp. 19–36.
14. Sodhi, N.S.; Koh, L.P.; Brook, B.W.; Ng, P.K.L. Southeast Asian biodiversity: An impending disaster. *Trends Ecol. Evol.* **2004**, *19*, 654–660. [CrossRef] [PubMed]
15. Haruthaithanasan, M.; Sae-Tun, O.; Lichaikul, N.; Ma, S.; Thongmanivong, S.; Chanthavong, H. The role of biochar production for sustainable development in Thailand, Lap PDR and Cambodia. In *Biochar: A Regional Supply Chain Approach in View of Climate Change Mitigation*; Bruckman, V.J., Liu, J., Uzun, B.B., Apaydın-Varol, E., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA; Melbourne, Australia, 2016.
16. Sucharithanarugse, W. Concept and function of the acmecs. *South Asian Surv.* **2006**, *13*, 285–294. [CrossRef]
17. Pongsudhirak, T. World War II and Thailand after sixty years: Legacies and latent side effects. In *Legacies of World War II in South and East Asia*; Koh, D., Hock, W., Eds.; Institute of Southeast Asian Studies (ISEAS): Singapore, 2007; pp. 104–116.
18. United Nations Development Programme. Human Development Reports, Table 1: Human Development Index and Its Components. Available online: http://hdr.undp.org/en/composite/HDI (accessed on 20 April 2018).
19. VNS. Third Acmecs Summit Meeting a Platform for More Co-Operation. Available online: http://vietnamnews.vn/politics-laws/182139/third-acmecs-summit-meeting-a-platform-for-more-co-operation.html (accessed on 22 March 2016).
20. Bruckman, V.J.; Haruthaithanasan, M. Sustainable Forest Biomass Network. Available online: http://www.iufro.org/science/task-forces/forest-biomass/ (accessed on 23 March 2016).
21. Food and Agriculture Organization of the United Nations. Faostat. Available online: http://www.fao.org/faostat/en/?#data/RL (accessed on 20 December 2016).
22. World Bank. The World Bank ibrd/ida-data. Available online: http://data.worldbank.org/indicator/AG.LND.FRST.ZS?end=2015&locations=TH-KH-LA-MM&start=2015&view=map&year=2015 (accessed on 20 December 2016).

23. Bradbury-Huang, H. What is good action research? *Action Res.* **2010**, *8*, 93–109. [CrossRef]
24. KAPI. Future Development of Acmecs Bioenergy: Regional Plan and Standardization. In Proceedings of the 3rd ACMECS Bioenergy Workshop, Ubon Ratchathani, Thailand, 8–11 December 2015; Haruthaithanasan, M., Thanapase, W., Thammincha, S., Thaiutsa, B., Pinyopusarerk, K., Sridurongkatum, P., Luangviriyasaeng, V., Eds.; Kasetsart University: Ubon Ratchathani, Thailand, 2015.
25. Jacobs, N. Co-term network analysis as a means of describing the information landscapes of knowledge communities across sectors. *J. Doc.* **2002**, *58*, 548–562. [CrossRef]
26. van Eck, N.J.; Waltman, L. Software survey: Vosviewer, a computer program for bibliometric mapping. *Scientometrics* **2010**, *84*, 523–538. [CrossRef] [PubMed]
27. Gronalt, M.; Rauch, P. Designing a regional forest fuel supply network. *Biomass Bioenergy* **2007**, *31*, 393–402. [CrossRef]
28. van Dam, J.; Junginger, M. Striving to further harmonization of sustainability criteria for bioenergy in europe: Recommendations from a stakeholder questionnaire. *Energy Policy* **2011**, *39*, 4051–4066. [CrossRef]
29. Turcsanyi, R.Q. Central european attitudes towards chinese energy investments: The cases of poland, slovakia, and the czech republic. *Energy Policy* **2017**, *101*, 711–722. [CrossRef]
30. International Energy Agency. *Southeast Asia Energy Outlook 2015*; International Energy Agency: Paris, France, 2015.
31. Bruckman, V.J.; Haruthaithanasan, M.; Kraxner, F.; Miller, R.; Darabant, A.; Choumnit, G.; Thongmanivong, S.; Ko Ko Gyi, M.; Lan Houng, H.T.; Suphamitmongkol, W. Acmecs bioenergy 2015: Three years of effort towards a regional bioenergy network. *KIOES Opin.* **2016**, *5*, 1–24.
32. Conover, W.J.; Iman, R.L. Rank transformations as a bridge between parametric and nonparametric statistics. *Am. Statist.* **1981**, *35*, 124–129.
33. Duflos, E.; Luchtenburg, P.; Ren, L.; Chen, L.Y. *Microfinance in Myanmar—Sector Assessment*; CGAP: Washington, DC, USA, 2013.
34. Bah, E.-H.M.; Cooper, G. Constraints to the growth of small firms in northwest Myanmar. *J. Asian Econ.* **2015**, *39*, 108–125. [CrossRef]
35. Winter, T. An uncomfortable truth: Air-conditioning and sustainability in Asia. *Environ. Plan. A* **2013**, *45*, 517–531. [CrossRef]
36. Hijioka, Y.; Lin, E.; Pereira, J.J.; Corlett, R.T.; Cui, X.; Insarov, G.E.; Lasco, R.D.; Lindgren, E.; Surjan, A. Asia. In *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group ii to the Fifth Assessment Report of the Intergovernmental Panel of Climate Change*; Barros, V.R., Field, C.B., Dokken, D.J., Mastrandrea, M.D., Mach, K.J., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., et al., Eds.; Cambridge University Press: Cambridge, UK; New York, NY, USA, 2014; pp. 1327–1370.
37. Asoka, A.; Gleeson, T.; Wada, Y.; Mishra, V. Relative contribution of monsoon precipitation and pumping to changes in groundwater storage in India. *Nat. Geosci.* **2017**, *10*, 109–117. [CrossRef]
38. Bruckman, V.J.; Terada, T.; Fukuda, K.; Yamamoto, H.; Hochbichler, E. Overmature periurban quercus–carpinus coppice forests in austria and japan: A comparison of carbon stocks, stand characteristics and conversion to high forest. *Eur. J. For. Res.* **2016**, *135*, 857–869. [CrossRef]
39. Wilcove, D.S.; Giam, X.; Edwards, D.P.; Fisher, B.; Koh, L.P. Navjot's nightmare revisited: Logging, agriculture, and biodiversity in Southeast Asia. *Trends Ecol. Evol.* **2013**, *28*, 531–540. [CrossRef] [PubMed]
40. Ruamsuke, K.; Dhakal, S.; Marpaung, C.O.P. Energy and economic impacts of the global climate change policy on Southeast Asian countries: A general equilibrium analysis. *Energy* **2015**, *81*, 446–461. [CrossRef]
41. Heldt, S.; Budryte, P.; Ingensiep, H.W.; Teichgräber, B.; Schneider, U.; Denecke, M. Social pitfalls for river restoration: How public participation uncovers problems with public acceptance. *Environ. Earth Sci.* **2016**, *75*, 1053. [CrossRef]
42. Ölz, S.; Beerepoot, M. *Developing Renewables in Southeast Asia—Trends and Potentials*; International Energy Agency: Paris, France, 2010; p. 164.
43. Asian Development Bank. Energy Policy. Available online: https://www.adb.org/sites/default/files/institutional-document/32032/energy-policy-2009.pdf (accessed on 6 January 2016).

44. Sheng Goh, C.; Teong Lee, K. Will biofuel projects in Southeast Asia become white elephants? *Energy Policy* **2010**, *38*, 3847–3848. [CrossRef]
45. Phalan, B. The social and environmental impacts of biofuels in Asia: An overview. *Appl. Energy* **2009**, *86* (Suppl. 1), S21–S29. [CrossRef]