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SPECIAL FEATURE: NOTE AND COMMENT

Developing Sustainable Bio-Energy Systems in Asia

Sustainable bioenergy deployment in East and South East Asia: notes on recent trends

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Abstract
The use and trade of solid biomass for modern bioenergy have grown rapidly in Asia. In September 2018, IEA Bioenergy organized a workshop in Tokyo to address these ongoing developments. The policies in Japan and South Korea have triggered a more import-oriented development, while bioenergy in Malaysia, Indonesia and China is closely linked to agriculture and rural policies. Four major points were raised and discussed: balancing local supplies and international trade, switching from fossil to renewable infrastructure, addressing sustainability concerns and tackling regulatory uncertainty. This workshop showed a clear need for more information exchange between countries through platforms like IEA Bioenergy.

Keywords Biomass · Bioenergy · Sustainability · Asia · Trade

Background and aim

While much later than those in Europe and North America, many East and Southeast Asian countries recently see rapid development in the use and trade of solid biomass for modern bioenergy (Goh et al. 2013). Apart from using domestic biomass, Japan and South Korea have started to import large volumes of biomass (wood pellets and palm kernel shells) for co-firing with coal from countries in the Pacific Rim (Aikawa 2016). Meanwhile in Southeast Asia as well as in China, the trade and use of the modern use of solid agriculture residues and fast-growing wood species for combustion, as well as anaerobic digestion of agro-waste effluents, are increasing rapidly, facilitated by conducive support frameworks (AIM 2013; Clare et al. 2016).

To highlight these ongoing developments, chart future prospects, discuss possible risks and bottlenecks of increased deployment, and enable knowledge exchange, in September 2018, IEA Bioenergy organized an international workshop in cooperation with New Energy and Industrial Technology Development Organization (NEDO) and the Ministry of Economy, Trade and Industry (METI), with support from Renewable Energy Institute (REI) and United Nations University-Institute for Advance Sustainability Studies (UNU-IAS) in Tokyo, Japan (see Box 1). This paper aims to both summarize and discuss the main outcomes of the workshops in two sections: recent trends and future perspectives, focusing on six countries presented in the workshop, i.e., Japan, South Korea, Malaysia, Indonesia, China and New Zealand. It is based on a more comprehensive summary as well as the individual presentations (available at IEA Bioenergy website). All estimates, analyses and observations are based on anecdotal statements made during the workshop.

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Box 1 IEA Bioenergy Workshop, Tokyo, 2018

This workshop focussed on potential technical and organizational improvements to biomass supply chains, including pre-treatment technologies, bio-refineries, logistics/trade, final conversion/end-use and overarching topics such as sustainability assurance frameworks and policy support options. The workshop provided technical information to decision makers in Asian member countries, but also demonstrated how IEA Bioenergy can support these countries in their development. The event was attended by approximately 70 industrial stakeholders as well as policy-makers, academics and local biomass associations from Japan and other countries in Southeast Asia. The organization of this workshop was led by IEA Bioenergy Task 32 (Biomass Combustion and Cofiring) and Task 40 (Sustainable Biomass Markets and Trade) and the IEA Bioenergy Executive Committee, in cooperation with NEDO and METI, with support from REI and UNU-IAS, and additional inputs from other IEA Bioenergy members on the Pacific Rim (Korea, Australia, New Zealand and Canada). Practical local organization (hosting) of the event was provided by NEDO and METI. More information and presentations can be found here: https://www.ieabioenergy.com/publications/international-workshop-future-perspectives-of-bioenergy-development-in-asia/

Recent trends

Six countries in the focus show different characteristics and trends. The policies in Japan and South Korea have triggered a more import-oriented development, while bioenergy in Malaysia and Indonesia is closely linked to agriculture (especially oil palm). China also looks at agricultural residues in rural areas, primarily for heating to substitute coal. New Zealand, on the other hand, has a potential to export woody biomass, but struggling to achieve competitive logistic chains.

In Japan, renewable energy production has reported to become rather expensive, amongst others because of a lack of grid interconnectivity, higher costs and a relatively large share of solar PV. Dispatchable bioenergy solutions could, therefore, help in reducing generation costs and help cope with integrating intermittent wind and solar power. Since the introduction of the feed in tariff (FIT) scheme in 2012, renewable energy was strongly stimulated, particularly solar PV, but biomass power was introduced more slowly. As of today, there are 20 coal fired power plants with plans for biomass co-firing with a total capacity of about 1 GW. The policy target for biomass power in 2030 is about 5 GW, including 4 GW of wood-fired power plants. It is expected that plans for several new smaller-scale coal-fired power plants will be changed to dedicated biomass, as the Japanese authorization body announced that they were going to ban low-energy-efficiency coal plants development even with biomass cofiring. In 2017, Japan imported 0.5 million tons wood pellets and 1.4 million tons of palm kernel shells (PKS). The speculation is that wood pellet imports will increase to more than 5 million tons in 2023.

Similarly, in South Korea, cofiring with mainly wood pellets has seen a large growth after 2012 due to the attractive FIT tariff. Comparing to Japan, South Korea has imported even more in 2017, amounted to 2.4 million tons of pellets. A large fraction of these imports comes from Vietnam and Thailand. However, there are public concerns with particulate matter emission from co-firing, leading to a proposed phase-out of subsidies for co-firing. Very likely, South Korea will follow the trend in Japan in the near future—wind and solar PV are expected to see the largest growth rates, while bioenergy is expected to remain steady. In both countries, there is also strong promotion of local unused biomass, especially forest residues, but mobilization of this biomass is very challenging in terms of logistics (cost) and labor force. The general sentiment among the two countries is that the CO_2 reduction from imports may be slightly less than that of domestic biomass, but it is considered as still acceptable by policy-makers.

China, the much larger country, demonstrates different trends compared to its neighbor. Bioenergy currently only covers less than 1% of the energy mix. Technically, the biomass potential is estimated as high as 460 million tons of standard coal equivalent (tce), but only < 10% is used. Agricultural residues and forest residues are the predominant feedstocks used so far. It was reported that the wood pellet production capacity has already reached 10 million tons, with some of these wood pellets produced in China were exported to Japan and Korea due to the higher prices paid there. Recently, however, clean heating policies in China provided a significant impetus to the use of domestic pellets for local use, which is now the predominant type of use. The main rationale behind this is actually more about rural revitalization; this includes policies on heating, green rural biogas, and bioethanol use. While there are policies to support biomass power plants, co-firing of biomass with coal is currently just beginning demonstration. Similar to the other countries, logistic constraints (collection of residues) remain the main barriers, but lack of standardized/high quality heating equipment in the rural area is also another difficult challenge.

Further to the south, bioenergy development in both Malaysia and Indonesia are closely linked to their agricultural sector, especially oil palm. They are the two largest palm oil producers in the world, which accounted for more than 85% of the total production in 2018. This implies that a large quantity of oil palm residues is also being generated. In Malaysia, a detailed analysis by the government shows that the technical potential of biomass residues can be over 90 million tons, while Indonesia reported that in

terms of potential power capacity at 32 GW. PKS, which can be directly collected from palm kernel crushing mills, is the most traded type of biomass with high demand from Japan and South Korea, but local demand is also growing. However, the other field residues are far less competitive due to high logistic cost to mobilize them. Another high potential option would be biogas production from palm oil mills effluents (POME). Currently, it is still under-utilized in both countries. The design and enforcement of environmental regulation that require all mills to treat their POME are still slow in action.

While Malaysia also exports some PKS, the emphasis is clearly on developing the local bio-economy and adding value domestically, aiming to produce (and export) higher-value products. Empty fruit bunches and fronds are targeted as a main resource for biochemical productions. The government has made strategic plans for biomass utilization in the two pioneer states, Sabah and Sarawak, aiming to mobilize 6 and 5 million tons of biomass, respectively, for use in biorefineries and for electricity production. In Indonesia, the policy tries to secure affordable energy supply. Up till now, there is about 1.8 GW of biomass power in use but largely off-grid—only 0.2 GW is connected to grid. Slightly more than half of this is contributed by pulp and paper mills, while a quarter by palm oil industry. In the near future, sustainability aspects for upstream biomass production may become more important as buyers like those from Japan have been facing pressure from NGOs to clarify the environmental benefits of importing biomass in large scale.

New Zealand, a country that has close trade relations with East and Southeast Asian countries, especially on agriculture and forestry products, was also discussed in the workshop. It exports a large volume of logs to East Asia, especially China. The country has a high share of biomass in industrial and residential heat, but very limited use for electricity. Bioenergy development is considered as a component of forestry policy, which largely focuses on afforestation, aiming to double the number of trees in 10 years' time. Currently, there are only two wood pellet mills and no pellet exports. It was estimated that about 3.9 million tons of woody biomass residues can be made available if logistics can be handled properly.

Challenges and opportunities for further bioenergy deployment

Balancing local supplies and international trade-establishing regional markets

Many of the countries described in the previous section have seen (strong) growth in bioenergy deployment, some based on domestic biomass, and others mainly based on imports of biomass. In many cases, this has also sparked the debate whether local use should be preferred over imports, e.g., to limit import dependency and increase local job creation. However, securing biomass feedstocks has been a problem in most countries. To develop bioenergy successfully, a holistic view is needed, i.e., bioenergy as part of the bio-economy where the added value of locally available biomass is maximized. A careful screening is required to understand which feedstocks are available, and which products (e.g., chemicals, heat, electricity, biofuels) can be viable.

Interestingly, the examples of China and Indonesia show that the creation of exports markets (e.g., wood pellets in China and PKS in Indonesia) may actually create local awareness of the availability of this resource and trigger local use. Ultimately, it is also the experience in, e.g., many European countries that a balance of domestic resources and biomass trade often works best. Biomass trade can help to reduce costs, and at the same time act as a buffer when local supply should diminish (e.g., due to weather-related events). It also typically allows for large industrial applications, which cannot be fuelled solely with local biomass. The advent of commodities such as wood pellets (and possibly in the future also torrefied pellets) has increased this flexibility.

Switching from fossil to renewable infrastructure

As in the United Kingdom, Belgium, Denmark and the Netherlands, Japan and Korea have chosen to convert a substantial part of their coal-based assets into biomass. For example, in Japan, about 20 co-firing plants are operating at the moment; most of them have a relatively small capacity (below 112 MW). Co-firing percentages are typically up to 10% for the larger plants (1 GW), while some smaller plants co-fire up to around 50%. Estimates for the biomass requirements vary between 8 and 20 million tons of domestic wood supply for energy in Japan; substantial imports will, thus, be required on the long run. The experience in the European countries has shown that for co-firing, this is possible up to a 100% conversion rate. Yet, the situation in East Asia (with many investments still to be realized) may also allow for a different strategy, e.g., going for torrefied pellets or steam explosion pellets, which could allow substantially lower investment costs (as, e.g., storage does not need to be covered). However, as the number of suppliers of torrefied and steam exploded pellets is still limited, this may also pose a certain supply risk.

There is, however, a big difference between the large coal users in the region, i.e., Japan, South Korea and China, in terms of biomass use. The largest coal consumer, China, does not perceive biomass as substitutes for coal in power plants, but aim for utilization for residential heating. Even though coal is still by far the largest source of residential heating, the share of biomass has been growing. Biomass

fuels costs are reported to be quite competitive, with costs of delivered heat very close to that of coal. Thus, this use may for the specific Chinese situation be both more economically interesting and provide more local benefits in both urban and rural areas as well. A clear example is the opportunity for biomass-fired district heating networks in Chinese cities. Meanwhile in Japan, heats produced from biomass do not earn incentives like power from the FIT scheme. This has significantly limited the growth of bioenergy in the country as the potential use of biomass-fired combined heat and power (CHP) plants has been largely overlooked. CHP plants may be a more economically feasible option when it is applied in biomass-rich region with decentralized systems. The experience in Sweden shows that the production of biomass-based heat and electricity in winter time can be very attractive to complement solar-based electricity in summertime using district heating networks.

Addressing sustainability concerns

Not only cost competitiveness is a key aspect for bioenergy development, but also sustainability has become a necessary component to be taken into account. For example, neglected sustainability aspects in the biodiesel sector in Malaysia, particularly related to conversion of forest to palm oil plantation, have resulted in a very negative perception of this option, making all investments in biomass- and bioenergy-related technologies very difficult in the past years. Also, the ambitious targets in Japan and Korea are a reason for concern, as it is quite unclear how much biomass may still be obtained from the region in a sustainable manner. For example, large-scale removal of agricultural residues for energy use may potentially trigger unwanted soil carbon depletion, if the entire system is not managed properly. Optimistically, the western part of Canada may still offer substantial amounts of woody biomass residues from sustainably managed forests, provided that the required price levels can be met. This illustrates that such issues need to be addressed upfront, e.g., which certification system to use for the feedstock.

In this aspect, Asian countries may benefit from the experience gained in Europe and North America, such as the development of sustainability criteria and certification schemes, e.g., the Sustainable Biomass Program (SBP) to demonstrate compliance with national legislation and the upcoming implementation of the Renewable Energy Directive 2 (RED2). The actual implementation of these schemes is currently ongoing in pioneering countries like the Netherlands—this could provide valuable lessons for countries also relying on biomass imports, e.g., on how to stimulate sustainable forest management, balance the use of biomass for material and energy purposes, and avoid biomass use with a high risk of long carbon payback times.

Tackling regulatory uncertainty

Regulatory uncertainty has been regarded as a key challenge for sustainable bioenergy development in the region. This is actually not new in Europe—changes in feed-in tariffs (or support mechanisms altogether) have frequently occurred in many European countries in the past decade. The recent regulatory changes in Korea indeed fit this pattern. Ultimately, bioenergy will have to be able to compete on its own under with other renewables and fossil energy under, e.g., a fossil carbon tax or carbon trading system, which would allow for a more level playing field and possibly long(er)-term security. A long-term supporting market introduction of bioenergy with ambitious policy targets and comprehensive supporting frameworks, the economics of bioenergy may become more feasible and eventually operating on its own without subsidies and taxes due to technological learning. For example, in Denmark and Sweden, production costs of most biomass fuels have now come down to a lower level than most fossil fuels without financial support, and thus can outcompete oil and liquified natural gas (only coal is cheaper on a per GJ basis in some cases).

Meanwhile, regulatory uncertainty linked to sustainability could be placed in a larger regional context as large-scale international trade is involved. It is of key importance that sustainable cooperation between Asian (and North-American) countries is established, to also achieve reforestation and other sustainable benefits.

Final remarks

This IEA Bioenergy workshop showed that there is a clear need for more exchange of information between countries to ensure sustainable bioenergy deployment in East and Southeast Asia. Unlike their European and American counterparts, such a discussion at international level, especially concerning cross-border issues like trade and sustainability, is still rare among the Asian countries. International exchange and collaboration could be very important in addressing broader topics such as the creation of successful bioenergy markets, development of sustainability governance systems, stable support schemes and many technical issues. In the near future, the following specific topics may be the crucial ones for the region:

- the ability of bioenergy to balance wind and solar power
- the development of bioenergy heat infrastructure
- new financing mechanism for bioenergy, e.g., crowd funding
- long-term roadmaps for bioenergy development.

We hope that next to Korea and Japan, more Asian countries will be able to join international discussion on the development of bioenergy, especially surrounding the themes mentioned above. Platform such as the IEA Bioenergy Technology Collaboration Programme can improve the exchange of knowledge and views between countries to better ensure the sustainable development of bioenergy in a broader regional or global perspective, especially when it involves international trade and sustainability standards. As concluded from the workshop, there is a significant potential for increased deployment of biomass for energy and materials in the Asian region to transition to low-carbon economy. A continued dialog on the topics discussed above would certainly aid and help to guide this process.

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