Chapter 3

Towards Extending the ERIA WG Methodology

Sustainability Assessment of Biomass Utilisation in East Asia Working Group

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CHAPTER 3

Towards Extending the ERIA WG Methodology

The sustainability indicators currently employed in the ERIA WG methodology are summarized in Appendix I. Since the development of the ERIA WG methodology in 2009 (Sagisaka, 2009), the WG has been trying to improve the methodology so that it could be practically applied to a variety of biomass utilization projects, from small to large scale biomass projects, and in both ex-ante and ex-post assessments.

This chapter first explains the current direction of the ERIA WG methodology and then outlines the updates of sustainability indicators of environmental, economic and social aspects. In the final section of this chapter, the latest discussion about presentation of results is summarized.

4. Direction of the ERIA WG Methodology

A variety of initiatives on sustainability of biomass utilization have emerged worldwide in recent years. Although intensive discussions on sustainability are currently underway around the world, it is not an overstatement to say that the countries of East Asia are not at forefront of those discussions in spite of abundant biomass resources to be utilized in this region. In this context, the task of the WG aims at development of a methodology to assess the sustainability of biomass utilization, taking into considering the context of the East Asian countries.

The WG methodology is neither to establish certification systems for verifying the sustainability of biofuels, nor to propose vast and comprehensive ideas that cover all the considerable sustainability elements for biomass utilization. The ERIA WG methodology was designed to support decision making with the aid of scientifically-sound and practical indicators that quantitatively measure the degree of sustainability of biomass utilization projects. The indicators have been carefully selected from existing ones so that they could be applied to sustainability assessment from community to national level biomass utilization projects being planned or in operation.

The users of the assessment results are expected to be those who are in a position to make a decision on whether a project should proceed, or which technology or biomass feedstocks among several potential candidates should be chosen in terms of long term sustainability. The people who make such decisions could be policy makers rather than business managers.

This decision making situation is faced by policy makers not only when checking the sustainability of on-going policies or projects, but also, and perhaps more often in East Asian countries, when planning a new national biomass policy or a new biomass project. Although the WG conducted pilot studies to check the applicability of the ERIA WG methodology in existing biomass projects (ex-post assessment), the methodology has not yet been applied to biomass utilization projects being planned (ex-ante assessment). The WG has therefore started preparing a "decision support tool" for ex-ante assessments. The WG has established the basis of the framework of the tool, and then tested it in a case study. This tool and the case study are discussed in the next chapter.

5. Environmental Aspect: Soil Quality

The WG recognized from the outset the importance of other environmental impact categories that are currently not considered in the ERIA WG methodology. The previous report (ERIA, 2011) summarized some of those categories, which include impacts on air, water and soil quality, and biodiversity. Among those categories, the WG looked into soil quality to explore a possible indicator to be considered in the ERIA WG methodology. This is summarized in Appendix II.

6. Economic Aspect: Production Approach for TVA

In the ERIA WG methodology, the economic aspect is represented by Total Value Added (TVA). As in national accounting, TVA is calculated as output minus intermediates:

$$TVA = \textit{Output value} \text{ (or } \textit{Gross revenue}\text{)} - \textit{Cost of intermediates}$$
$$= \sum \textit{Price} \times \textit{Output quantity} - \textit{Cost of intermediates}$$

where gross revenue is simply the product of price and quantity (applies to both main product and by-products), and intermediates include goods and services, other than fixed assets, used as inputs into the production process using biomass produced elsewhere in the economy or imported. This is equivalent to the production approach for measuring GDP.

Generally, intermediate goods are: material inputs (fertilisers, seeds, pesticides, purchased energy), manufacturing fees excluding VA (Value Added) items, sale fees excluding VA items, management fees excluding VA items, and interest. VA items are costs paid to labor (including wages, salary, benefits, employee insurance, tax) and depreciation. From this calculation, it can be seen that TVA can be closely approximated by return to labor (Total Labor Expense), return to capital (Operating Profit before Depreciation), and payment to government (net tax, i.e. taxes minus subsidies), which is an income approach as proposed in the ERIA WG methodology (Sagisaka, 2009).

As a comparison, in the income approach TVA is equivalent to Revenue less Outside Purchases (of materials and services). It is very closely approximated by Total Labor Expense (including wages, salaries, and benefits) plus "Cash" Operating Profit (defined as Operating Profit plus Depreciation Expense, i.e. Operating Profit before Depreciation). The first component (Total Labor Expense) is a return to labor and the second component (Operating Profit before Depreciation) is a return to capital (including capital goods, land, and other property).

In the income approach, indirect taxes have to be counted as a part of TVA. It must be noted that apart from income tax, the government may also levy other kinds of taxes during the production process, which will be deducted from the profits. Therefore, government indirect tax should also be counted as a part of TVA. However, such taxes could be levied on companies that provide intermediate goods and cannot be easily counted.

7. Social Aspects: Employment and Access to Modern Energy

The pilot studies conducted as a part of the WG activities revealed that although Human Development Index (HDI) is an appropriate indicator that takes into account three essential end-point components of the social aspect, there were some difficulties in implementing the methodology for assessment. For example, estimation of HDI was data intensive, requiring inputs on a wide array of parameters. However, the pilot studies found that such data were not readily available at village or district level. In addition, it was difficult to dissociate the social impact of a biomass project from the impact of other activities, particularly at community level. This is because HDI is more suitable for large scale assessment of social development and for the purpose of ranking countries.

The data demands of the HDI pale in comparison with the full requirements of social impact assessment following the GBEP and RSB methodologies. GBEP is in the process of field-testing their sustainability guidelines in selected countries, while RSB has been used to certify biofuel projects in developed countries. It remains to be seen if their social indicators could be applied in developing countries and regions of poverty wherein the data required for the assessment may not be available.

Recognizing the difficulty in calculating HDI, other social indicators such as job creation or employment and access to modern energy were proposed which may prove to be more fitting to capture local impacts of small-scale bioenergy projects in developing countries and regions of poverty in Asia. Looking at the GBEP and RSB social indicators, employment and access to modern energy are placed high as “core” indicators complementing other indirect impacts. Keeping in view the trend in other sustainability guidelines and limitations of applying HDI at project / community level, the WG decided to use “Employment” and “Access to Modern Bioenergy” as the two indicators for assessing the social impact of bioenergy projects at community level, as explained in the following paragraphs.

7.1. Employment

7.1.1. Employment in Biomass Utilizations

Bioenergy programs are important for employment generation and may assist in poverty alleviation and sustainable development. A study conducted in Malawi indicates that with the current estimated wood energy consumption in sub-Saharan Africa, approximately 13 million people could be employed in commercial biomass energy (Openshaw, 2010).

The type of bioenergy crop to be used may be objective-specific and maximizing one objective (say, employment generation); this may impact other objectives of the bioenergy promotion as found for the European Union (EU). For example, while climate change mitigation proposes the use of lignocellulosic biomass in the stationary sector, employment generation requires biofuels for transport based on traditional agricultural crops (Berndes and Hansson, 2007).

Many of the jobs are expected in feedstock production, which could invigorate rural development and the agriculture sector. Agriculture remains the backbone of developing countries for sustainable attainment of food security, employing a significant part, ranging from 30 to over 50 percent, of the total work force. However, bioenergy development may not directly translate into creating new jobs. In some cases the benefits are indirect yet equally important. It may enhance "market reliability" as the bioenergy industry could be an additional viable market for farmers seeking to get a better price for their produce, resulting in increased income or enhanced "job security" for employees of processing plants.

7.1.2. Quantification of Employment

Employment is calculated as a ratio of the employed people to the total labor force of the economy; children and dependent people in the population are not considered in the labor force. The concept of under-employment, the employment of a person below his/ her capacity, is also used in the literature. For example, a person wants to/can work for more than eight hours a day but he/ she can only find paid work for 2 hours a day. This kind of employment is considered under-employment. But he/she will still be considered as employed and not unemployed.

Measurement of the total labor force and the employed labor force of an economy is complex, and may be country-specific and based on several other factors. In India, for example, it is the availability and the willingness of a person to work/join the labor force. In the US, the term "labor force" refers to the number of people of working age (above 16 years) and below retirement age who are actively participating in the work force or are actively seeking employment. The number excludes people who are active-duty members of the U.S. Armed Forces, are in institutions such as jail, or are younger than 16 years of age. In the previous WG report (ERIA, 2011), employment had already been discussed and to some extent it was also quantified. For example, the person-days employed per hectare of bioenergy crop plantation or per ton of feedstock processing were calculated. The number of people employed in the bioenergy supply chain was also quantified.

Rather than expressing the absolute number of people employed, it would be better to calculate the percentage of people employed in various stages of the bioenergy supply chain. With the above definition of employment, quantification of employment in the bioenergy chain could be as follows.

Total Labor Force of the Village/ Community = *TLF*
(Number of people willing to work)
Number of People Employed in All Activities = *NPE*
Employment Rate (%) (EMP) = *(NPE/TLF)*100*
Number of People Employed in Bioenergy = *NPEB*
Employment (%) in Bioenergy Sector (EPB) = *(NPEB/ TLF)*100*

7.2. Access to Modern Energy

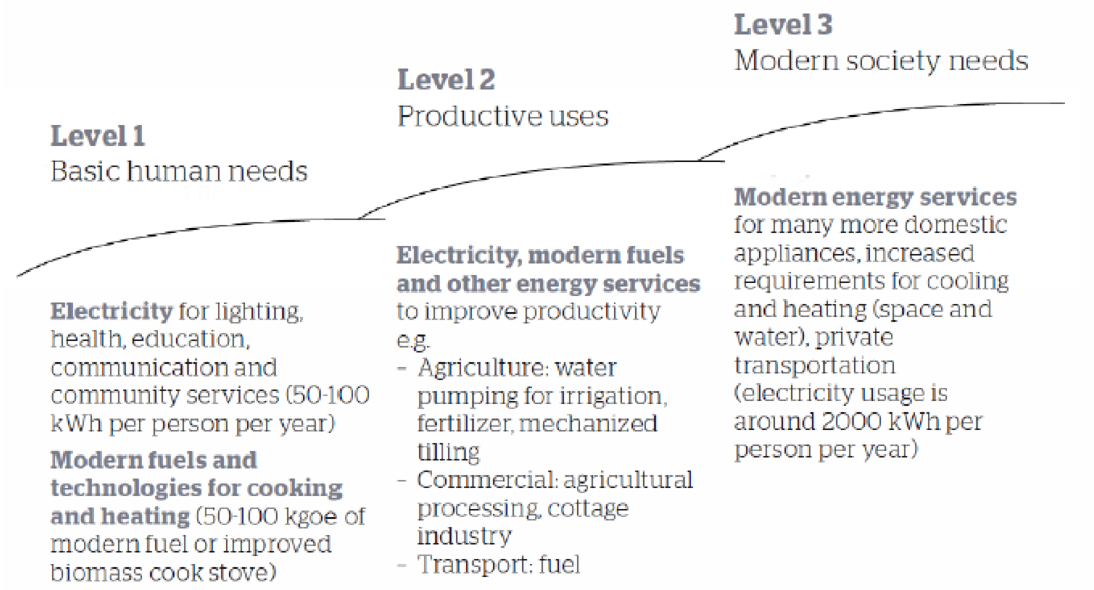
7.2.1. Access to Modern Energy in Biomass Utilizations

The term "Energy services" refers to the services that energy and energy appliances provide, and includes lighting, heating for cooking and space heating, power for transport, water pumping, grinding, and numerous other services that fuels, electricity, and mechanical power make possible.

Modern energy services are crucial to human well-being and to a country's economic development. Yet, globally, over 1.3 billion people are without access to electricity, and 2.7 billion people are without clean cooking facilities. More than 95% of these people are either in sub-Saharan Africa or developing Asia, and 84% are in rural areas (IEA, 2011). The United Nations declared the year 2012 as the "International Year of Sustainable Energy for All."

Figure 1 illustrates the incremental levels of access to energy services. Bioenergy development in rural areas is expected to bring a significant change in access to modern energy, either in the form of electricity or as modern fuels for cooking, heating and mechanical power to improve productivity.

Figure 1: Incremental Levels of Access to Energy Services (AGECC, 2010)



Different forms of clean and modern energy, which can be generated by utilization of biomass, are liquid biofuels, heat, electricity and gas. In many East Asian countries, for example in India, access to biogas generated through anaerobic digestion of biomass, is quite an "old" application, and people in rural areas have been using biogas since the early 1970s. However, heat and electricity generation through thermal gasification of biomass has been historically used by only a few companies, and their use by the general public is comparatively new. Access to modern energy services is defined as household access to electricity and clean cooking facilities. Modern bioenergy is provided through utilization of biomass for energy, such as clean cooking fuels and stoves, advanced biomass cooking stoves and biogas systems, bio-power, etc.

*7.2.2. Quantification of Access to Modern Energy*The percentage of households of the total population using modern energy services is considered as the ratio of population (number of households) accessing modern energy services. People using traditional biomass energy sources are not considered to have access to modern energy services

With the above definition, the quantification of access to modern energy could be as follows.

Total Number of Households in Village/ Community	*= TNHH*
Number of Household with any Modern Energy	*= NHME*
Household (%) with Modern Energy	*= (NHME/TNHH)*100*
Number of Households with Modern Bioenergy	*= NHBE*
Household (%) with Access to Modern Bioenergy	*= (NHBE/TNHH)*100*

8. A Way of Presenting Results, and Methods of Integration

The development of indicators for the three aspects of sustainability – environment, economy and society has been discussed in the previous sections. Much effort has gone into the identification and refinement of appropriate sustainability indicators to evaluate biomass utilization systems in East Asia. Scientific discussions among researchers were conducted over several years for identifying and then field-testing and finally refining the indicators to arrive at a robust set that could be used for assessing biomass utilization at large, as well as small scale initiatives. However, it must be remembered that these indicators have been developed to assist policy makers in the region, not all of whom are scientists. Care must therefore be taken to present the results to them in a way that helps them understand the issues being considered in assessing the sustainability of biomass utilization initiatives.

Decision-making would be much easier if there were only a single index that would somehow include all the aspects of sustainability. Comparison of the sustainability of systems would almost be trivial should such an index exist. However, as seen in the earlier sections, a suite of indicators has had to be developed for assessing the environmental, economic and social aspects of sustainability for biomass utilization initiatives. The development of a single index integrating all the identified indicators would thus require a systematic method of aggregation. As the different indicators for environmental, economic and social aspects of sustainability are in widely varying units, integration would first require some form of normalization to bring the indicators to the same unit, followed by weighting to allow for the difference in relative importance/seriousness of the various indicators, after which they could be aggregated into a single index.

Many methods for normalization exist as summarized in Table 1. Also, a number of weighting techniques exist; some are derived from statistical models, such as factor analysis, data envelopment analysis and unobserved components models (UCM), or from participatory methods like budget allocation processes (BAP), analytic hierarchy processes (AHP) and conjoint analysis (CA). Regardless of which method is used, weights are essentially value judgments. While some analysts might choose weights based only on statistical methods, others might reward (or punish) components that are deemed more (or less) influential, depending on expert opinion, to better reflect policy priorities or theoretical factors. Weights may also be chosen to reflect the statistical quality of the data. Higher weights could be assigned to statistically reliable data with broad coverage. However, this method could be biased towards the readily available indicators, penalizing the information that is statistically more problematic to identify and measure.

Table 1: Examples of Methods for Normalization (OECD, 2008)

Method	Equation
1. Ranking	$I_{qc}^{t} = Rank(x_{qc}^{t})$
2. Standardisation (or z-scores)	$I_{qc}^{t} = \frac{x_{qc}^{t} - x_{qc=\bar{c}}^{t}}{\sigma_{qc=\bar{c}}^{t}}$
3. Min-Max	$I_{qc}^{t} = \frac{x_{qc}^{t} - \min_c(x_q^{t_0})}{\max_c(x_q^{t_0}) - \min_c(x_q^{t_0})}$.
4. Distance to a reference country	$I_{qc}^{t} = \frac{x_{qc}^{t}}{x_{qc=\bar{c}}^{t_0}}$ or $I_{qc}^{t} = \frac{x_{qc}^{t} - x_{qc=\bar{c}}^{t_0}}{x_{qc=\bar{c}}^{t_0}}$
5. Categorical scales	Example: $I_{qc}^{t} = \begin{cases} 0 & \text{if } x_{qc}^{t} < P^{15} \\ 20 & \text{if } P^{15} \le x_{qc}^{t} < P^{25} \\ 40 & \text{if } P^{25} \le x_{qc}^{t} < P^{65} \\ 60 & \text{if } P^{65} \le x_{qc}^{t} < P^{85} \\ 80 & \text{if } P^{85} \le x_{qc}^{t} < P^{95} \\ 100 & \text{if } P^{95} \le x_{qc}^{t} \end{cases}$
6. Indicators above or below the mean	$I_{qc}^{t} = \begin{cases} 1 & \text{if } w > (1+p) \\ 0 & \text{if } (1-p) \le w \le (1+p) \\ -1 & \text{if } w < (1-p) \end{cases}$ where $w = x_{qc}^{t} / x_{qc=\bar{c}}^{t_0}$
7. Cyclical indicators (OECD)	$I_{qc}^{t} = \frac{x_{qc}^{t} - E_t(x_{qc}^{t})}{E_t(\lvert x_{qc}^{t} - E_t(x_{qc}^{t})\rvert)}$
8. Balance of opinions (EC)	$I_{qc}^{t} = \frac{100}{N_e} \sum_{e}^{N_e} \text{sgn}_e(x_{qc}^{t} - x_{qc}^{t-1})$
9. Percentage of annual differences over consecutive years	$I_{qc}^{t} = \frac{x_{qc}^{t} - x_{qc}^{t-1}}{x_{qc}^{t}}$

Note: x_{qc}^{t} is the value of indicator *q* for country *c* at time *t*. $\bar{C}$ is the reference country. The operator *sgn* gives the sign of the argument (*i.e.* +1 if the argument is positive, -1 if the argument is negative). N_e is the total number of experts surveyed. P^{i} is the i-th percentile of the distribution of the indicator x_{qc}^{t} and *p* an arbitrary threshold around the mean.

One of the normalization techniques, "Min-Max" (No. 3 in Table 1) was attempted earlier on for bringing the indicators into the range [0,1] so that they could be visually presented as a radar diagram (ERIA, 2009). However, after initial testing and discussions in the WG, this method was discarded (ERIA, 2010). One of the major reasons for discarding it was the increase in number of indicators from the initial three due to the inclusion of sub-indicators. The normalization techniques developed for the initial three indicators were already somewhat arbitrary, because they were not comparable amongst themselves. This limitation would actually be true for any normalization scheme. Additional indicators would only compound this shortcoming. It was therefore decided to revert to a simple tabular presentation of results, since it provided all necessary information to decision makers without introducing any bias from researchers.

The WG considered one possible process to normalize the indicators which could hold appeal especially for non-scientists, namely monetization of all the indicators. However, finding monetary equivalents for environmental and social externalities would be a significant challenge. Even for a commonly used indicator such as greenhouse gas (GHG) emissions, there are several values used internationally, which means that it would be difficult to select a unique value. For other indicators, such monetary values do not even exist. Much resource and time would be required to develop such a scheme for use with the indicators selected for assessing the sustainability of biomass utilization initiatives. And even such a scheme would still suffer from uncertainty and subjectivity, as with other normalization methods.

A tabular presentation therefore remains the preferred choice. Future efforts may look at providing some reference values for each indicator that may help the reader somehow get a sense of the relative magnitude of the numbers. This would also indirectly be a kind of normalization effort, even though the normalized values would not be calculated. Intensive discussions in the WG would be needed following any investigation in this direction.