# Bioenergy, strategy for diverse markets in ASEAN countries.

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## ABSTRACT

*To utilize bioenergy, at first, the difference between the types of energy is crucial. Exergy is the most comprehensive measure to distinguish the quality of energy. Then, referring the success story of precedent countries, how to use heat is crucial to developing bioenergy use. In the case of ASEAN, air conditioning with other than electricity would be a promising opportunity. Moreover, heating and hot water supply also will conform to a new market for biomass in northern mountain region. For mid and long term perspectives, with intensified biomass gathering system and heat/by-product distribution scheme, a large-scale biorefinery will be able to operate.*

Keywords**:** Bioenergy, Forest, Land use, Renewable Energy Source

## INTRODUCTION

After the oil shock in1979, several countries, mainly European countries, have succeeded to develop bioenergy utilization. There seems to exist careful strategy. Two third of renewable energy comes from biomass. Asian countries are more or less late comers in this field. Biomass, its supply is strictly restricted by climate and soil conditions. Also, its demand is closely related to their cultural heritage and also to income level. At first, I would like to refer on the primary classification. Then energy carriers of bioenergy will be examined. Very essential issue is which region and vegetation have to receive and convert solar radiation into biomass.

## BIOENERGY, from Where, to Whom

### The quality of energy

By Georgescu-Roegen,"it is not easily understood even by physicists." It is not easy to explain the quality of the energy. Researchers of thermodynamics like to use "Entropy" and engineers like "Exergy". Roughly these two terms are inverse each other.

The conversion from high exergy material to merely low exergy form brings no energy loss, but at the same time, it creates massive exergy reduction. Exergy, or "available energy" means energy which can be used for the concrete purpose. (Fig 1)

High-temperature steam can create kinetic energy, and then it has high exergy. However, low-temperature water can produce almost no electricity. Nonetheless, these exergy can be preserved when used in appropriate and efficient process. Also Georgescu-Roegen reported that temperature measures "the usefulness" of heat. The difference of temperature is a rough index of the usefulness of the hotter heat. It means that the difference with room temperature shows the quality of heat energy. So if room temperature stays at 25-degree, 45-degree heat and 5-degree cold have similar value.

Electricity generation, from the energy/exergy point of view, 60 percent of energy goes to waste heat. Only 40 percent remains in electricity, but significant exergy stay in electricity. The rest 60 percent is still usable for low-

temperature purpose. (Fig. 2) In the case of heat use, if the source is electricity, the loss of exergy is very large compared with combustions of fuels. Heat by burning fuel loses exergy but not so much as electricity. (Fig. 3) Additionally, if fuels are fossil origin, inner combustion engines can use it. Biomass, however, is not yet available with these engines. So, the opportunity cost of fossil fuel is more expensive than biomass. Economically, biomass is considerably suitable fuel for heat purposes via direct combustions.

Electric boiler is the worst method to miss use electricity. In Thai, by the lack of gas distribution network, even in the metropolitan Bangkok area, hotels usually have electric boilers in their rooms for the guests. (Fig. 4)

## Bioenergy what for?

Biomass has not only relatively higher exergy but also complicated organic material, lignin and erosive ashes. Difficulties to remove these materials and to clean up, make it unable to use like gas or purified oils.

Countries that have succeeded to expand biomass as source of energy use biomass primarily for heat, mostly by direct combustion with boilers. Electricity production is developing not so fast but steadily. Biofuel is still searching for effective strategy, because bioenergy is by far cost competitive in heat sector. Electricity becomes competitive if electricity producers also have infrastructure for heat utilisation. They can improve their profitability by selling not only electricity but heat.

The most effective way to use biomass as a substitute to fossil fuel is direct combustion with boilers. Another sophisticated way to use biomass is not yet available. In these countries, biomass is fired to produce hot water for families, municipalities and factories. As for the regional economy, these countries employ many workers to produce and transport biofuel. Moreover, the manufacture of combustion equipments brings additional employments.

Heat use is fortunately energy efficient and also low cost. Combustion is all in one process. Different materials, such as cellulose and lignin, are mixed with air and finally become $H_2O$ and $CO_2$. In order to avoid air pollution, equipments become slightly complicated but still not so expensive.

EU countries, especially, Finland, Sweden and Austria, have attained the outstanding reduction of their carbon emission by biomass use. (Fig. 5) Now their share is more than 20 percent in Finland and Sweden, and around 1/8 of their total primary energy in Austria. This reduction has promoted not only by their central government but also by local Authorities and farmers' cooperatives. Sweden is famous for de-centralized administration system. Their municipalities are very conscious to environmental issues. Moreover, there are several cooperatives of forest owners with strong intention to sell woody biomass.

In general, ASEAN countries belong to tropical region, but not all area is always hot. Along the border with China, altitude reaches to 2000m high. In northern mountainous part, rice is grown only once a year because of coldness. In this region, temperature goes down below zero and sometimes it snows. (Fig. 7) As mentioned before, making hot water by electric heater is the most inefficient energy use. However, in May Hong Song or Sapa, famous tourism destination, hotels, except for expensive ones, are equipped with electric boiler, too. Now many guest houses are introducing hot water supply to attract tourists. This would be a promising market for woody biomass from forests in highland. (Fig. 8)

In Japan, the climate is unique, freezing in winter as northern Europe and very hot in summer like Bangkok or Jakarta. So the energy sector of Japan has enormous demands for both heat and cool. The turnover of district-heating companies comes from rather cold water sales than hot water. Even from 1984, Tanuma, a northern municipality in Japan, near Nikko, had inaugurated heating/cooling facility for local authorities' sub-office. It might be the first case of pellet fired cooling in the world.

There is a huge demand for air conditioning in ASEAN region. For example, in greater Bangkok region, at peak time, the share of air conditioning rises 70 % of total electricity consumption. Along with the increase of income level, the installation of air condition equipment will increase rapidly.

Absorption Chiller can cool items with relatively temperature heat. By scattering water on the ground, it becomes cool around. When water evaporates from liquid to vapor form, it removes heat. The absorption chiller uses the same principle. Water evaporates in the chiller, and it supplies Chilled water. LiBr lithium bromide solution has a character to absorb water vapor strongly. Absorption Chiller uses this principle. Evaporated vapor is absorbed and collected by the solution. LiBr solution absorbs water vapor in absorber, and it has become weaker. The concentration should be increased by heating. Oil, gas, steam or hot water heat up this diluted solution. Cooling water makes vapor from regenerator to liquid form again. Vapor will become liquid and then it will be used to cool chilled water in evaporate again.

Usually, electricity generation from biomass uses the Rankin cycle through the expansion of steam. Except for small reciprocal way, steam turbine is widely used. There are two schemes; one is back pressure and the other is condensing. Back pressure equipment intends to use both heat and electricity. Theoretically and also practically, Heat and Power, i.e. co-generation is more efficient than sole electricity generation.

As for electricity supply in India and Indonesia, due to frequently occurring blackouts, many companies and even wealthy household have "Diesel generator" meet with their electricity contract. Summing up this capacity, the capacity of electricity generation in national level has been duplicated,

Stable supply of electricity is indispensable for high-tech factory in quantity and quality. For Micro Processor and inverter, in case of weak signal or power, cannot work without stable electricity supply. So it is compulsory to avoid using electricity generated from biomass for robust purposes, such as space heating and hot water supply and also air conditioning.

EU had once made their target to attain 10% of their liquid fuel from renewables, i.e., biomass. However, they had reduced their target because, it means the more import of various biomass from Brazil and other countries. Never correspond to European farmer's income.

For the transportation sector, there is another way to reduce fossil fuel consumption, i.e. ‘Social Fix‘ or some limited expression ‘Modal Shift’. Energy consumption of rubber tyre and road is seven to eight times higher than that of steel wheel and steel rail in nature. Thai people had experienced that, in the metropolitan area, rail transit is far more efficient and economical than transit by automobiles. Jakarta, HCMC and many other cities had better follow this direction.

For Cargo transportation, with the heritage of the colonial era, Vietnam and Indonesia have not enough but reliable rail network. Thai also has radial network from Bangkok. For this system, official renovation is planned but not yet put into practice.

**Supply potential in ASEAN**

Arable land has been dedicated to food production. Maize, cassava and rice are for starch production, and sugarcane is for sugar production. These carbohydrates are rather precious foods, and prices are fluctuating with international commodity market.

Irrigation capacity limits land for rice production. Maize and cassava production depends on the market condition. The price of first-generation biofuel depends on the unit price of sugar and starch. So the most prominent supplier of biofuel is Brazil and the US, the most competitive producer of sugar and starch, respectively.

Too much area has been deforested mainly for cash crop production. Salinity and erosion made it impossible to recover vegetation. Additionally, by erosion and nutrition loss, yields of these crops decrease. It means less productivity or high cost of raw materials for biofuel.

Permanent cultivation in steep terrain has the risk of soil erosion except for rice terrace. Forest administration in south East Asia tends to prohibit the swidden agriculture of ethnic minorities. In the case of Japan, for forest reserve in the watershed area it is allowed to cut trees with an insignificant restriction. Applying coppice degeneration, 20 to 40 percent of Japanese forest had continued to produce charcoal for several hundred years. Component of this forest was evergreen or deciduous broadleaf species, mainly Quercus spp.

The problem of land use in Indochina peninsula is the conversion of forest to permanent cultivation in steep terrain. Along with the extension of the road network, deciduous and evergreen mountain forest has changed to maize, cassava and sugarcane field. There is no supply of organic matter from former forest vegetation. Nonetheless, sparsely planted crops cannot protect soil from erosion by rainfall. (Fig. 10,11,12,13)

For example in Northeast Thai, edges of "Nong" are not so steep, but too large area had been cut, and then converted to cash crops. So to protect local climate, soil and nutrients are necessary to establish tree stands as the Royal Project now trying to establish the combination of ponds and woodlots.

From European experience, forests are held by peasants; small-scale ones are more productive than that by large-scale owners. Historically over populated, common in the humid part of Eurasia, the old continent, land productivity stays higher than that in sparsely inhabited area.

In the mountain region, these years, reevaluation of swiddenning system has been catching on with researchers focusing on intensive current inputs, fertilizers and chemicals, for permanent cultivation. They show the possibility of sustainable use by traditional and inherent skills.

One of them, Schmidt-Vogt evaluates that “The Thai government pursues a policy of either replacing swidden farming by permanent farming or reforesting former swidden areas. Both their drawbacks. Permanent farming on the poor highland soils is possible only with a high input of fertilizer and also of herbicides and pesticides because of

the tendency to cultivate only a few cash crops in monocultures. Widely spaced cash crops, such as maize or cabbage, are also more conducive to soil erosion than rice."

Stress on economic incentive is represented as permanent farming or reforesting former swidden areas endorse alternative valuations of forest based on different economic or cultural criteria. One practical option is to maintain systems of swidden which guarantee a high-quality forest cover, but also to modify these to allow more scope for generating cash income.

Sabhasri had pointed out even in 1986 that trees are the soil builders, not the grasses. So, as for the income of these farmers, additional benefits of weeding and thinning would be the economic return from cutting logs of high calorie species for fuel. Moreover, rice production is very poor. If woody species in the study area are suitable for charcoal and saw logs, the economic return might be better if land use in these hills were restricted to forestry.

After all, in the temperate region, a major part of organic matters are stored in the soil, in the boreal zone, more in soil. In the tropical region, however, trees store almost all organic matters and very little in the soil. To secure continuous production, there must be significant standing stock of trees. Not the soil but trees produce biomass in the long run.

In Vietnam, by long-lasting wars, mountain area had been degraded. By applying silvicultural skills and change in land policy, there are relatively prosperous standing volumes of *Acacia Mangium* and other tree species.. Mountain region usually has more precipitations, so it has larger annual growth of vegetation. Only if it is possible to protect land with sufficient vegetation cover from hard rainfalls. .

In continental ASEAN, how to utilize or not to utilize their land is a critical issue. As for primary energy, some member countries had been exporters and centres, but, now are changing to partial importers. Well maintained rice field, i.e. having stable irrigation and drainage can be sustainable. Hills and Mountain continue to lose soil and nutrient bearing poor biomass stocks. Clear idea for different natural and anthropological conditions, respectively, is essential and urgent.

**NEXT STAGE**

After the Big Bang, the establishment of the ASEAN Economic Community (AEC), there must be enormous business opportunity in the biomass market to emerge. Topographically North of Indochina peninsula is mountainous and cool. Until today, these areas are isolated by inconvenient traffic condition. From now on, manufacturing of heating equipment will be established. None the less, including island ASEAN, there is enormous demand for cooling equipments. Moreover, for Indonesia and India, suffering from electricity shortage, these equipments have to use energy source other than electricity.

Thermochemical or biochemical way, by the nature of biomass and/or through processing, many kinds of by-product and many types of energy have been brought. To maintain the total efficiency of the process these byproducts have to be used internationally. In general, materials, heat and electricity would be produced simultaneous. (Fig. 14,15,16)

Thermochemical process mainly based on pyrolysis of biomass. Biomass is paralysed by heat into the gas composed of mainly $CO_2$ and $H_2O$. Although the composition of gas is slightly different from mineral coal, industrial process designed for coal can be easily applied to the gas. During the WWII, Germany had produced a plenty of gasoline for aircraft with this process. By the process, using *Fischer-Tropsch process,* it is possible to produce gasoline, diesel oil and many kinds of materials for synthetic plastics as from oil refinery. Moreover, of course, heat and electricity are produced as a by-product.

Biochemical process means the decomposition of crystallized cellulose, a polymerized form of glucose. This process is partly similar to Pulp industry. In 1950's, Japanese pulp companies produced ethanol. Once the production had been stopped but now two major paper companies are trying to expand ethanol production.

Bio-refinery or bio combinate will be very fundamental scheme for the future. Transition from exhaustible resources to renewable resources needs corresponding processing falsities until the transition will take place. ASEAN countries have potentially high yield of biomass raw materials. Concrete research and decisive investment alone can realize this possibility.

## CONCLUSION

From the ecological point of view, mountain region has enough potential to supply biomass regionally. Moreover, biomass for energy will become an important sector in rural areas.

To develop biomass utilization rapidly, the most cost effective way is starting from heat (and cool) market along

with the experience and the knowledge of precedent countries. Electricity and then biofuel will follows almost automatically, for supply chain and technology will be improved steadily. The production cost of first generation biofuel is dependent on sugar or starch price and so remain expensive. Second-generation biofuel will come from bio-refinery. However, feasibility of this facility is dependent on the scale and intensity of biomass supply change and capacity to sell heat and other by-products.

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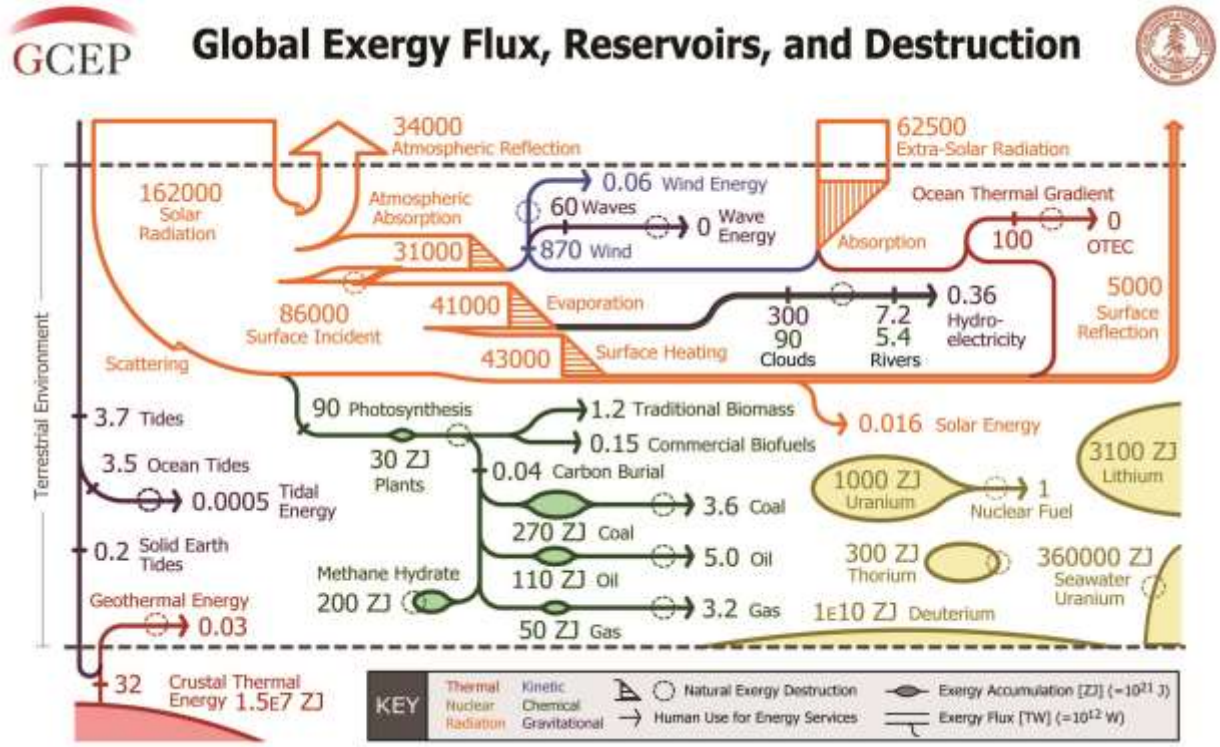


Fig. 1 Global Exergy Flow https://gcep.stanford.edu/pdfs/GCEP_Exergy_Poster_web.pdf

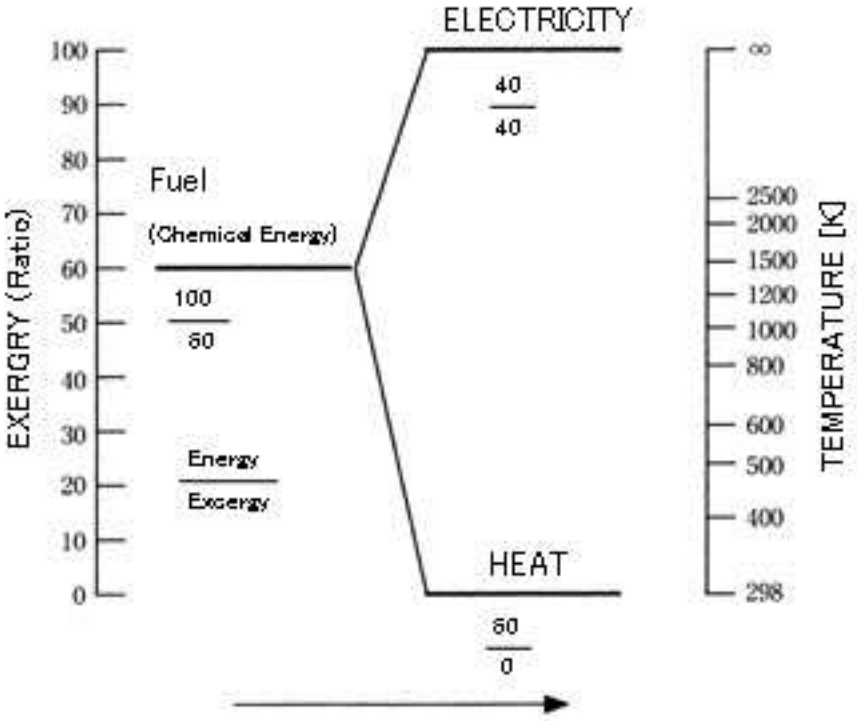


Fig. 2 Exergy/Energy Flow Electricity Generation (from Tsutsumi, Yoshida,1999)

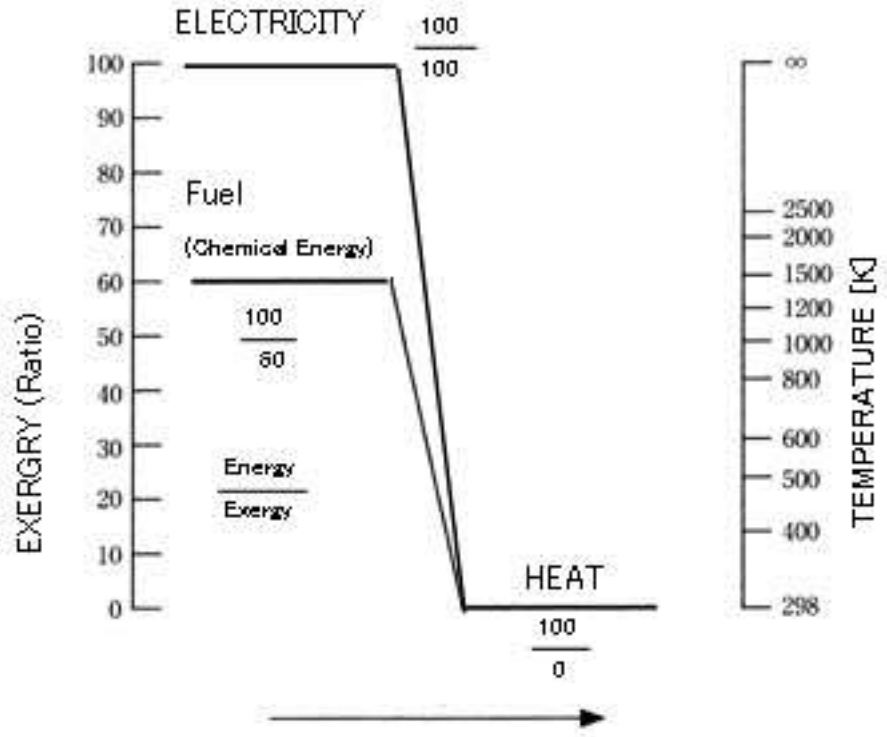


Fig. 3 Energy/Exergy Flow Direct Combustion

Fig. 4 An Electric Boiler (A Hotel in Bangkok)

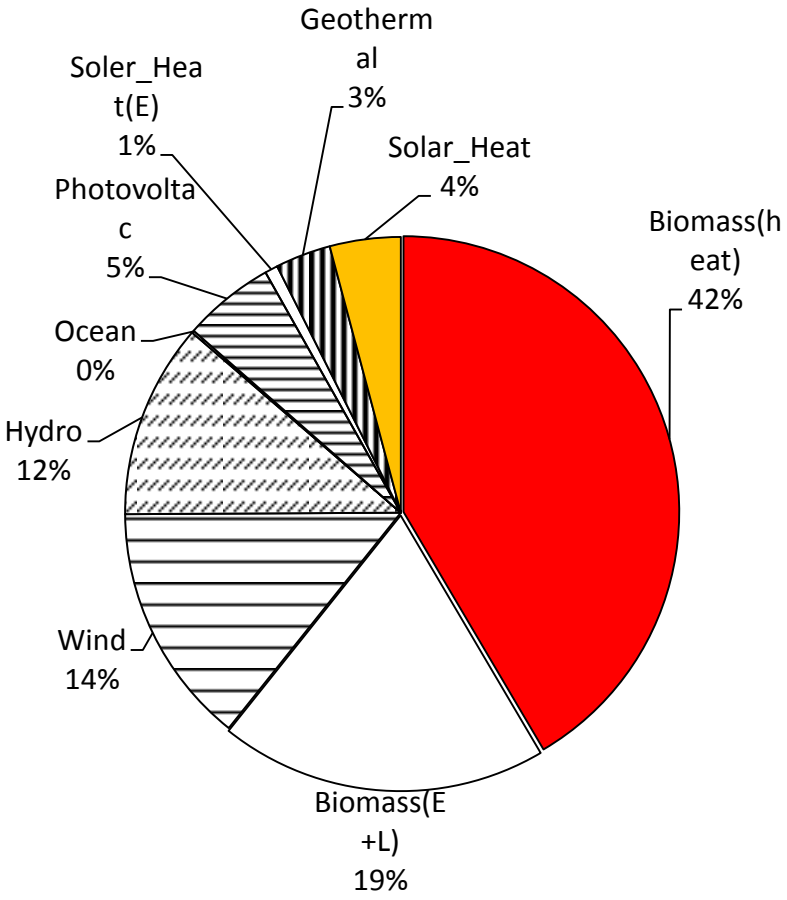


Fig.5 Renewable Energy Technology Road Map, EREC, 2008

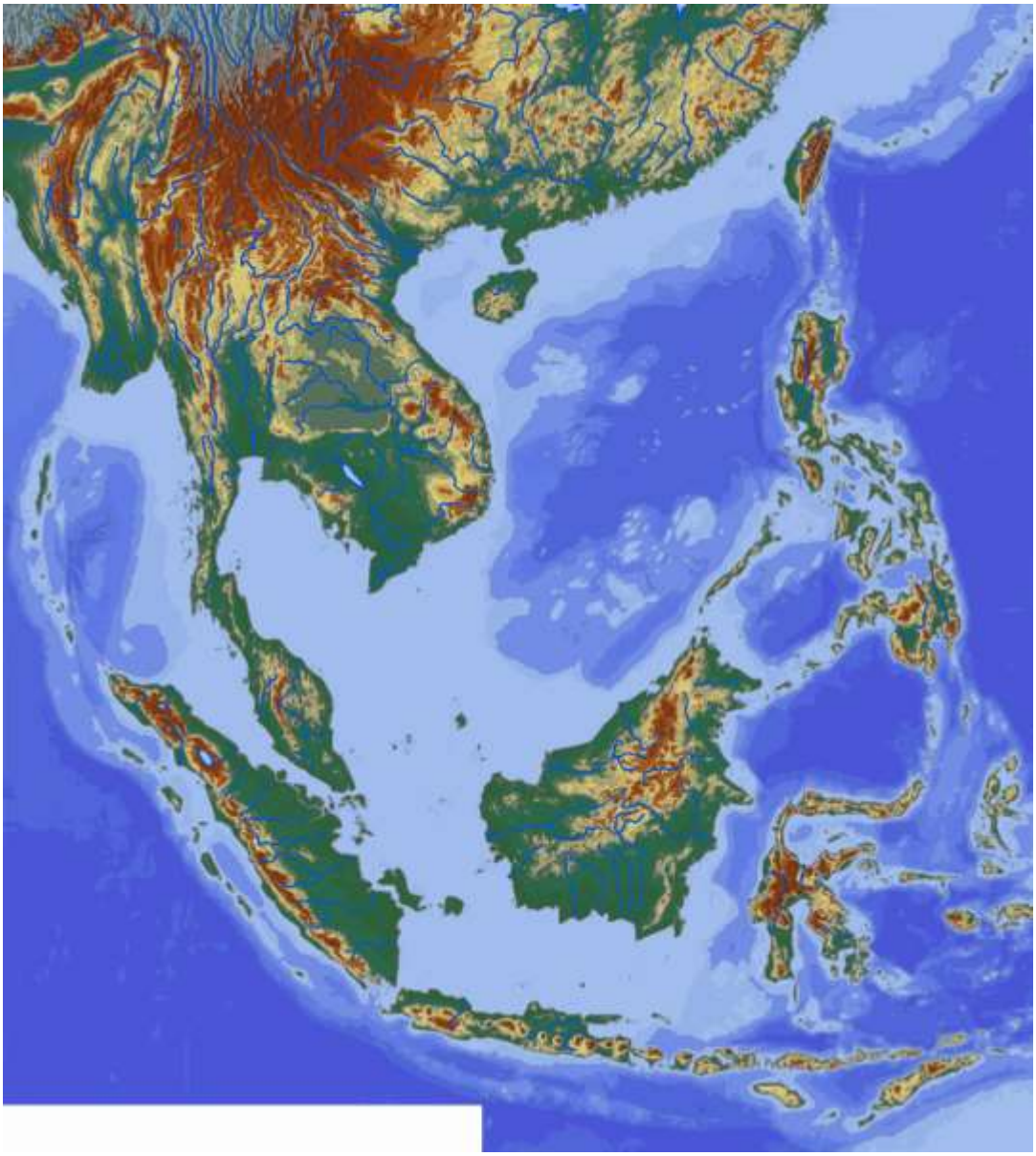

Fig 6 The Topography of South East Asia

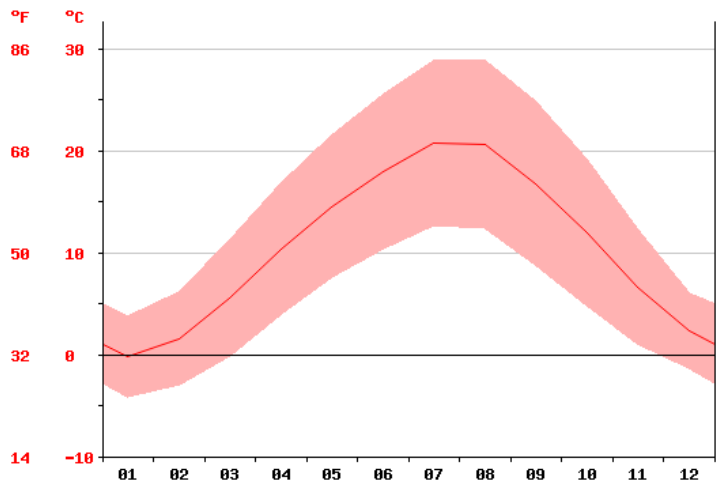


Fig. 7 The Temperature of Sapa (Vietnam)
http://en.climate-data.org/location/518916/

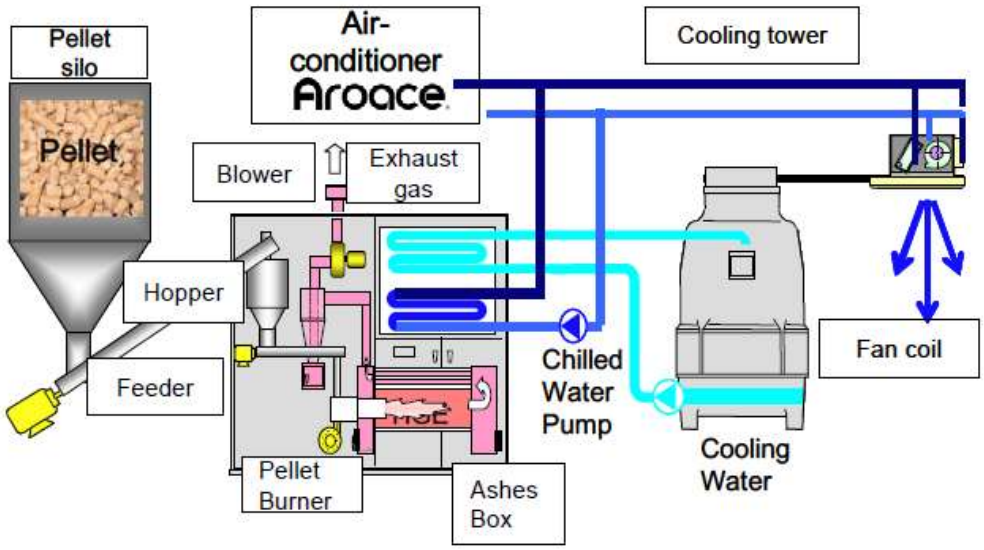


*Figure 8. System of Pellet Fired Absorption Chiller-Heater*

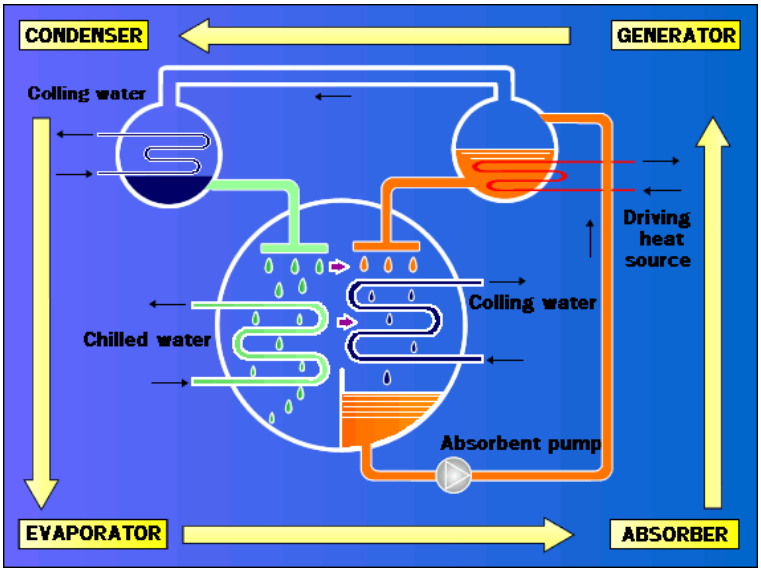

Fig. 9 Absorption Chiller PPTPLC


Fig. 10 Maize Field in Loei Province

Fig. 11  Maize field in Loei Province

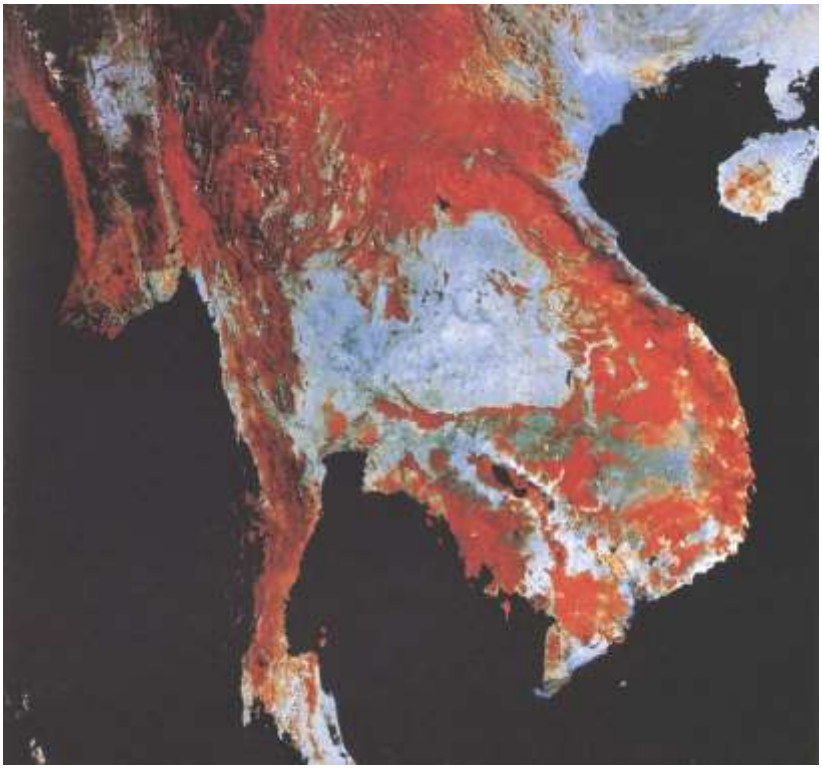

Fig.12 Satellite Image (NOAA), NRCT 1994
White: Arable land, Red: Forest

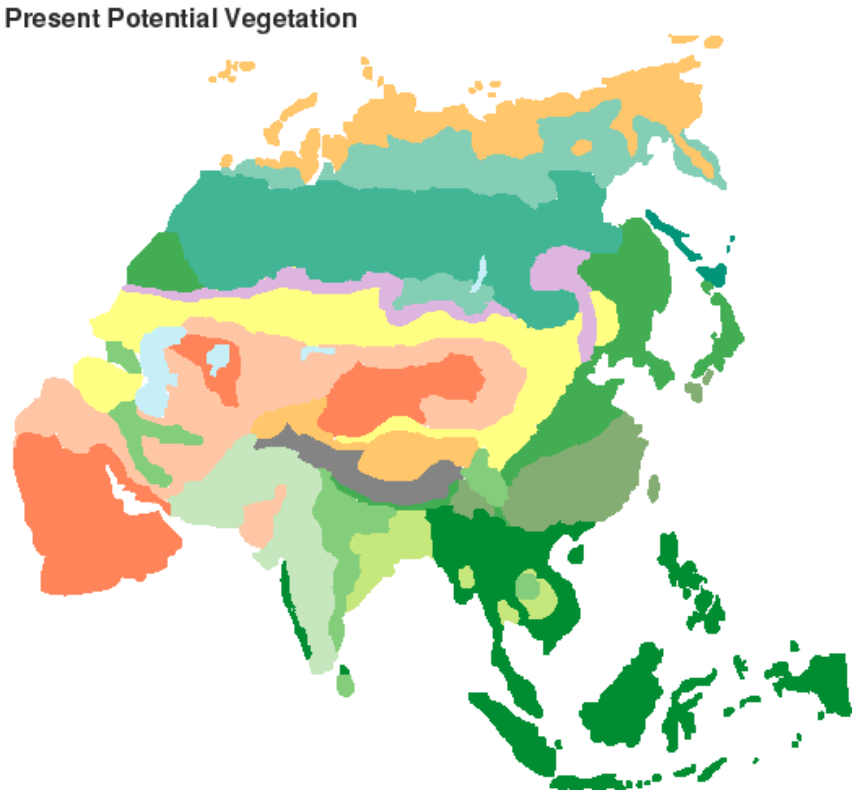


Fig. 13 Potential Vegetation
http://www.esd.ornl.gov/projects/qen/euras%28p.gif

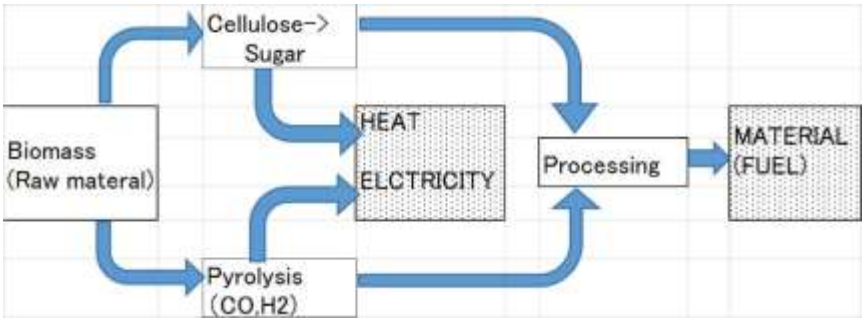


Fig.14 The Scheme of Bio-Refinery

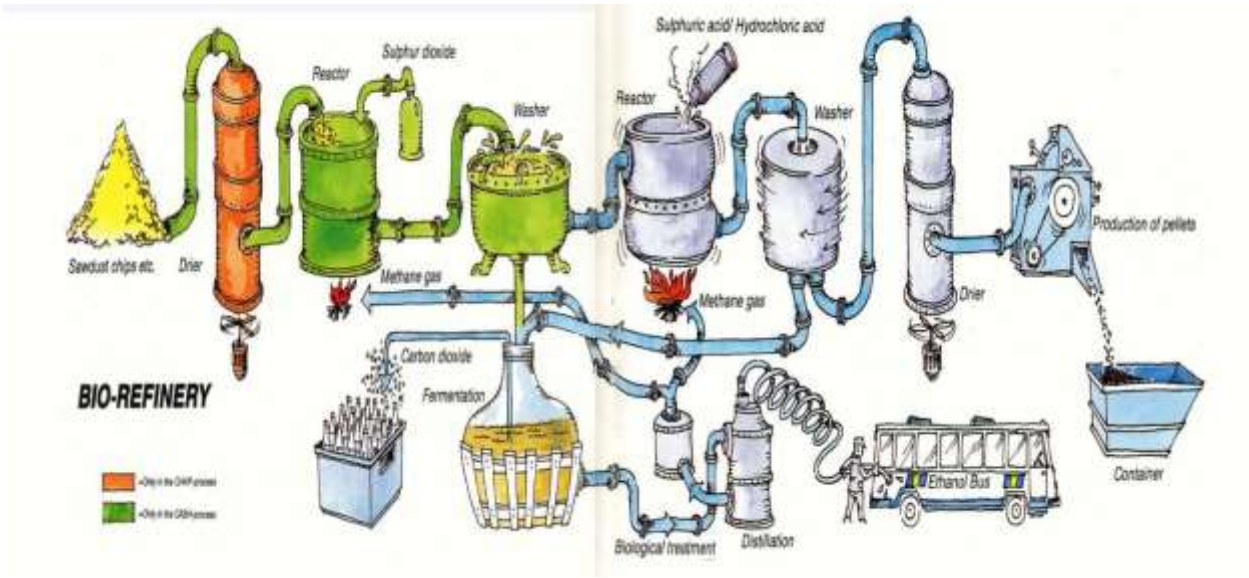


Fig.15 Bio-Refinery from a brochure of SEKEB (Sweden)

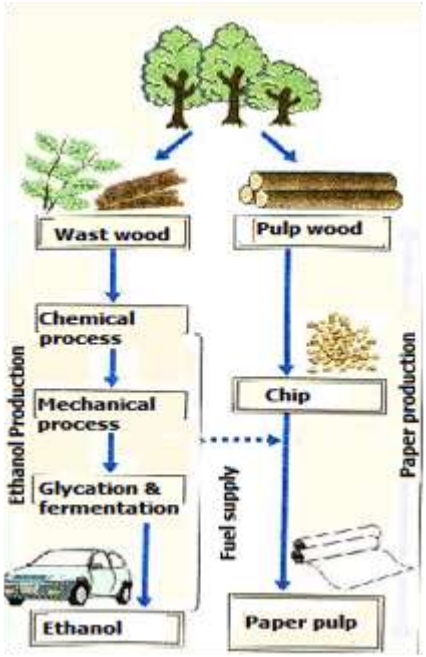


Fig. 16 Bioethanol from timber
*www.**oji**holdings.co.jp/content/.../f_infor_2012_01.pd...*