7 Economic and Socio-economic aspects of waste management

Background

Understanding the socio-economic impact of waste management systems and renewable energy solutions becomes necessary for setting up the necessary framework conditions and for having the impacts integrated into the political, social and economic system of a country.

Educational objective of the chapter

To throw some light on the significance of environmental economics towards understanding the impact potentials of promoting an appropriate economic instrument to reap the right benefit.

7.1 Factors to be considered in waste management system

7.1.1 Justifications for initiatives to augmenting renewable energy solutions:

The government polices of recent years face a strong critique from social activists stating that bio fuel are to blame for the shortage of grains and the inflation forthwith. To counter this argument and to find an efficient alternative to corn ethanol, a few firms (GeneSyst International, Netherlands and Blue Fire Ethanol USA) have begun to build and develop ethanol plants that use household wastes to produce the fuel. This brings a double dividend cutting down on wastes volume going to landfills thereby, reducing the negative impact on environment; bringing economic benefits to individuals and the economy. Household waste is inherently putrescible and it can be decomposed with the help of methane bacteria. It may ferment naturally in a landfill, which even when lined is at comparatively low cost. But, the landfills cause considerable safety and environmental hazards. The technologies that help to produce energy out of wastes prevent the release of green house gases in the form of carbon dioxide, methane, nitrogen oxides along the volatile organic compounds from entering the atmosphere. They avoid the release of methane that otherwise would be emitted when the waste decomposes, and the release of CO2 that would be emitted from generating electricity from fossil fuels. Hill et al (2006) evaluate whether the bio fuel from corn grain or bio diesel from soybeans can replace much petroleum without impacting food supplies. They find dedicating all US corn and soybean production to bio fuel can meet only 12% of the gasoline demand and 6% of the diesel demand. Biomass from wastes, whereas, can provide much greater supplies thereby reaping two goals of containing the problem of managing wastes and meeting the growing energy demands.

If the demand for food grew with the growing middle class population of Asian countries along the rising depletion of world stocks, the resultant effect would be rising food prices. Therefore, the best solution under the present circumstances is to switch to renewable energy solutions. The project, INVENT, therefore, offers a breakthrough in its contribution suggesting proper use of the by product of consumption and production activities to use as input fully knowing the ‘economic value’ of the commodity. Secondly, it does not suggest for anything like food withdrawal from the stock thereby leaving it for the purpose it is meant for.

7.1.2 Cost-effectiveness and sustainability issues

The government polices in Europe seem to pace faster in the renewable energy sector. Europe’s renewable energy sector represents around 50% of the world market for renewable energy. And the sector of industry employs more than 300,000 people. European Union’s Energy Efficiency Action Plan has set a goal of 20% energy consumption reduction of non-renewable energy sources by 2020. The target will reduce emission equivalent to 780 Mt of GHG each year and this will also reduce energy cost of 100 billion Euros every year. This action plan of European Union will be complemented by 21% of switch- over to renewable sources. According to the Directive 2003, in 2010 5.75% of all transport fuels in Europe has to originate from biomass. Biomass trade will involve sustainability aspect whether the biomass has been produced from renewable and sustainable sources identified
by the EU. According to the EU Directive on power from renewable sources (2001/77) bio degradable fraction of industrial and municipal waste has been identified as the sustainable and renewable source of energy production. Europe will also be the first region to grasp the environmental contribution from Green Heat technologies and also likely to benefit from early mover advantage, the most in economic terms.

Renewable energy accounted for 13.3% of the world’s total primary energy supply in 2003. And, almost 80% of the renewable energy supply was from biomass. An increase in the use of renewable energy should significantly reduce the burden on conventional sources of energy. The economic feasibility of renewable sources can be reaped when their production is extended to a large scale and cost effective sources of renewable energy should be supported irrespective of their size of operation.

Out of the total world electricity production renewable energy sources account only for 17.6% share with hydroelectric power providing almost 90% of it. But, as the renewable energy technologies become even more cost competitive in the future they will be able to replace a major fraction of fossil fuels for electricity generation. In the near future, home generated electricity from micro generation may also become the norm, with the surplus sold to the grid.

7.1.3 Economic evaluation and viability of waste management systems

7.1.3.1 Economic viability of integrated waste management:

The question of implementing a concept of Integrated Waste Management should therefore assign priority to appropriate reduction and reuse strategies, complemented by recycling activities. Of course, all these strategies and activities have to be technically and economically viable or "reasonable", given the framework conditions of a particular country.

What do we understand by economic viability of certain strategies and actions in the context of waste management? The Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal (Germany, September 1994) addresses this issue in Article 5: Basic Obligations of Closed Substance Cycle Waste Management. Paragraph 4 states: "The obligation to recover waste is to be met, to the extent this is technically possible and economically reasonable, especially when a market exists, or can be created, for an extracted substance or for extracted energy…. Waste recovery is economically reasonable if the costs it entails are not disproportionate in comparison with the costs waste disposal would entail."

This last statement is difficult to verify in practical situations. This can be judged from the experiences with the Renewable Energy Sources Act in Germany. Nevertheless, it is a consequence of the optimality criterion introduced and explained earlier. For the practical implementation one would have to conduct a Benefit-Cost-Analysis on the basis of the available information to single out the best strategy or the best alternative.

7.1.3.2 Economic viability of an investment on waste treatment facility:

The financial analysis of a project revolves around the monetary aspects of the project and the return on the investment to the investors. It includes the payment transfer of taxes, duties and subsidies in this regard. The economic analysis, on the other hand, evaluates whether the project brings benefits to the whole economy apart from the region it serves. It takes into account the socio economic aspects of the benefit that emanates from the project. It takes, also, into account the prices of the traded goods as well as the shadow prices of the non traded goods and services.

The economic viability of a project can be calculated on the basis of the net benefit the project produce. The payback period is the length of time between the initial investment and recovery of the investment from the annual cash flow into the project. The shorter the payback period the more attractive it is for investors to choose the option. The financial analysts usually begin with estimating the capital cost of the project along projected power output, annual revenues, expenses, and deductions to arrive at the net benefit. A simple payback period is calculated without regard to the time value of money.

The pay back period of an investment on a project can be calculated as follows:

\[
\text{Pay back period} = \frac{\text{Total investment cost} - \text{subsidy amount}}{\text{annual revenue} - \text{annual expenditure}}
\]

Net Present Value:
Net Present Value (NPV) is the most common method of calculating the net benefit of a project. It is the sum of all years’ discounted after-tax cash flows. The net present value method is a valuable indicator to identify the economic viability of a project because it recognizes the time value of money. Projects whose returns show positive net present value are considered to be attractive.

Net Present Value can be calculated as follows:

\[
NPV = \sum_{t=1}^{n} \left( \frac{B_t - C_t}{(1 + k)^t} \right)
\]

This is one of the dynamic approaches to calculating the present value of the money invested in the past or expected to be invested in the future. This method compares the benefit and cost of the project. This can be done by compounding the amount invested in the past or discounting from the expected investment of the future with the help of a factor which depends on the interest rate and the length of time between the payment period and the present period.

Depending on the results if the Net Present Value is positive, then the project can be counted as an economically viable option. Investing in such project can fetch a higher return to the investor than an investment on capital market. This method however is ideal for evaluating the relative economic viability between a few projects.

7.1.4 Optimality of waste treatment strategy

An optimal strategy of waste treatment is the one that will either maximise the fossil primary energy savings or minimise the costs per unit of fossil primary energy savings achieved by the utilisation of available biomass residues and wastes (Dornburg and Faaji, 2006). According to general understanding, the concept of integrated waste management is based on the strategy of the three “R”: Reduce, Reuse, and Recycle. Material production, cost and energy could be saved by using less and reusing or recycling more. The problem is then to identify the “optimal” level of the three R with optimality respecting the individual situation of each group of relevant stakeholders.

The stakeholders are

- Individual households, who as consumers benefit from a clean environment and “green” energy, but also from a sufficient supply of packaging material;
- Individuals, who profit directly from collecting discarded materials for reuse or recycling purposes;
- Companies, which profit from recycling activities, but also from the production or usage of packaging material

The optimality concept should – in agreement with the Pareto-Principle – ideally be based on the well-being of individuals; companies are as usual considered to be “owned” by either individuals (in the case of private companies) or the general public (in the case of public companies), and profits of the companies are valuable for their owners. According to the Pareto Principle, optimal levels of the three R are then given, if there is no other allocation with different levels of the three R, which increases the well-being of some individuals without hurting any other.

Given this definition it is clear that the optimality concept itself depends on the concrete situation in a country, in particular on the current state of the environment, the economic growth process, the innovative potential of the industry, and the relations to international partners. It therefore leaves some room for the implementation.

7.1.5 Practicability considerations

The practical implementation of the concept of Integrated Waste Management is not an easy thing to do. It is the missing information on preferences of households, on markets for recycled material, on possible technological innovations, which matters the most.

Therefore, the question of a practical concept for Integrated Waste Management is essential and should be handled with great care. As environmental commodities with characteristics of public commodities play a substantial role in this context the market mechanism alone cannot be expected to provide an optimal solution. Modifications to the framework conditions are necessary; in addition to that we could use some plausibility considerations to approximate an optimal solution.

Not only in Germany, the three R “Reduce”, “Reuse”, “Recycle” are interpreted to give priority to the reduction of waste. Waste which cannot be avoided should – if feasible – be reused and the rest should be recycled, which includes combustion to generate energy from renewable sources. In
addition to that, the depositing of untreated biodegradable material and of municipal solid waste containing organics ceased in Germany in June 2005.

If one agrees that source reduction strategies have many favourable environmental impacts, including reducing greenhouse gas production, saving energy, and conserving resources, in addition to reducing the volume of the waste stream, and that biodegradable material should be – if technically and economically feasible – used to generate energy from renewable sources, this approach is probably in agreement with the optimality principle.

7.1.6 Free market – a prerequisite

Renewable energy options may have to be supplemented by reserve capacity, storage or increased trade with the neighbouring areas. The electricity markets of the future need to provide consumers with a highly reliable, accessible and flexible power supply. Most of the Asian countries have electricity markets dominated by large state owned or private monopoly enterprises. With their political clout these enterprises almost prevent the new ventures from entering the market and this discourages investment in this area of economic sector. To make the system work, there needs to be fully liberalised market available for access to budding enterprises. The networks may have to be separated from the supply of power giving new traders impartial access to the market and facilitate cross border energy trade within the Asian countries. Transparency, accountability and accessibility should be the three important features of liberalising energy sector.

Like the European Union, the Asian countries may have to give priority to generating installations using renewable energy sources or waste or producing combined heat and power, provided the safety and reliability regulations of the grids are not compromised.

7.1.7 Benefit considerations

7.1.7.1 Energy empowerment – a sure way to poverty eradication

The quality of life is represented as being proportionally related to the per capita energy use of a particular country (Suganthi & Samuel, 2000). The awareness, literacy level, information dissemination and a change in the life style contributing to the shift from non-commercial to commercial energy source option in many Asian countries rural and semi-urban areas can, if well propagated, be used for the shift from non-renewable to renewable sources of energy, as well. Therefore, the South East Asian countries like Cambodia may have to plan for grid infrastructures which can accommodate diverse generators ranging from micro power systems to massive grid connected renewable complex. In some other Asian countries like India the grids require substantial investment in updating, with the replacement and interconnection of networks. Whereas in countries like Cambodia and Sri Lanka where only a very small fraction of the population have access to grid electricity (for example in Sri Lanka it is only 10%) the infrastructure can be designed so as to accommodate a mix of power which may solve the issue of the cities of Asia plunging into darkness part or most of the day. A low carbon renewable energy future can also be made possible.

7.1.7.2 Employment benefits

Biogas and the renewable energy production are labour intensive and they can provide employment to people. The additional employment will, however, vary with trends in the labour markets of the countries. The jobs created thereby, may be low value jobs but in periods of high unemployment the positive job creation will be viewed with less scepticism. These options suit the developing countries as most of them have younger population and a large work force. On the other hand, if the community is involved in the production then the workers can be drawn from the community where the project serves. This can improve the income distribution among the rural population and different income brackets. A significant population shifting to urban centres one of the typical issues the developing countries have to tackle in the past few years, can be reduced. This removes the additional burden on the resources at the urban centres. In the case of biogas, the conventional fuels not utilised are conserved and this improves their value.

The employment effects of renewable energy projects can be such as the direct employment in construction, operation and maintenance; indirect employment of job creation in the supply chain supporting the projects; induced employment created because of the wages earned through direct and indirect employment spent in goods and services thus creating jobs. But, the renewable energy projects may create job losses too in the non renewable energy sector. Job losses may also be due to support-mechanisms which result in lower spending elsewhere in the economy.
7.1.7.3 Macro level effects
The regional and the national economy where an economic activity of producing energy from renewable sources operates may have to take into account the cost and benefit of the operation of that project.

Any project whether it produces biogas or energy from renewable resources is expected to produce some economic effects. Such projects create external economies where the outcome influences the utility function of the consumers and the social welfare function in the economy thereby creating better living conditions and improved quality of life along less spending on health aspects. On the whole, only the energy needs of the regions or nations can not justify the cause of the move from non-renewable to renewable sources of energy. Such projects should ensure for an improved living conditions of the community apart from their environmentally benign move.

The economy benefits from balance of payments as the project output substitutes imports of fossil fuel options of the country. If the country exports renewable energy to the neighbouring nations it benefits the country additionally. If the plant is fully invested by the sources from inland with the least import content of not only the investment but the materials for the plant, the nation may have to face less external diseconomies arising due to fluctuations in the exchange rates.

If the transmission network are installed afresh in the case of renewable sources of energy or biogas or if there is any incremental cost of investment in providing additional networks, they should be calculated taking into account the costs of losses occurring due to distance of the production unit and the customers. In many developing countries, under monopolistic practices, the energy suppliers sell the energy at a higher rate than under a competitive structure. If the renewable energy supply operates under competitive market conditions, it can function without creating any market distortions.

7.1.8 Impact considerations

7.1.8.1 Economic impact
The downside of generating energy from biomass has been the reason behind the shift to fermenting waste to create biogas option. It was argued that if the land is used to producing maize and grain for generating heat and energy will it not have negative impact on food production; will not more fertilisers and pesticides be needed to grow more renewable raw materials; if the raw materials are imported will it not amount to contributing to further deterioration of endangered tropical eco-systems. However, these queries will not be raised if the bio gas which is climate-neutral and energy-rich is processed by fermenting waste especially bio wastes from households.

7.1.8.2 Improved health conditions and enhanced economic growth
The huge pile of wastes not segregated with hazardous components is a common sight in many developing countries of Asia. The result is a low level of sanitary and health conditions in these countries. Almost all of these countries have a large section of their population suffering from infectious and contagious diseases. The rural and urban poor of the subtropical areas of the Asian countries suffer from epidemics and gastrointestinal diseases due to the polluted water bodies and landfills. The sanitary and health conditions can be fairly improved if the issue of waste management issues are not ignored by these countries. Setting priorities in waste management through recycling the waste either via any energy recovery method or through getting treated biologically could reduce the negative impact of the wastes to a large extent. The biogas treatment for example, may improve the hygiene conditions of the community. This will have an overall positive impact on the health conditions of the community the biological treatment plant serves. A reduction of impact on such intestinal diseases can be taken as a benefit of the organised waste treatment facilities. Schistosomiasis a disease in rural China was reduced by 99% through the introduction of biogas technology. Tapeworm infections, in China, have been reduced to 13% of the pre-biogas level (GTZ). Biogas treatment of wastes can reduce the expenditure the individuals, a region and the country as a whole, spend on health care.

In countries like Thailand and Cambodia there is a huge scope for biological waste treatment through biogas. Biogas supply as a form of energy to the households can improve the nutrition and the health conditions of the community. Biogas supply can ensure the population of secured form of energy to the rural and urban poor who can boil water and use them to escape from the water borne diseases prevalent in these developing countries.

7.1.8.3 Use of by-product of biogas
The by product i.e. the fertiliser, of biogas generation can replace the commercial fertilisers. The biogas plants produce a rich organic waste which can be dried and used as a fertiliser. In the Asian countries both fertilisers and fuel wood are increasingly expensive and therefore, biogas has a
potentially bright future in these countries. In most of the Asian countries, the governments support the inorganic fertiliser industry through subsidies. And, inorganic fertilisers sometimes do not replace trace mineral elements in the soil which become gradually depleted by crops grown there. The governments can help the organic fertiliser production providing subsidies and can stop the subsidies given to the inorganic fertilisers. This can also work as one of the important aspects in incentive mechanism for setting bio gas plants.

In Germany around 8.4 million tonnes of organic wastes (2006) are being composted but with the debate on climate change, increasing energy prices, governmental support (Renewable Energy Sources Act – EEG) and technological improvement in biogas technology has paved the way for fermenting the organic waste.

In the process of composting the end product i.e., the finished product is utilised but in the process of fermentation of wastes both the end product and the energy generated as by product are utilised. However, fermentation process is more expensive than the composting and an investment is advised only when the demand conditions for the power and heat generated, are certain. The subtropical climatic conditions of Asian countries also suit for setting up biogas plants.

7.1.8.4 Linkage between energy security and literacy:

Many regions of the Asian countries suffer from the problem of illiteracy when the population who otherwise, should have been in the course of learning are found to be the bread winners of their families. Energy insecurity forces them to put in double the volume of work thereby depriving them of time for equipping themselves with learning. Energy security can reduce the magnitude of their hardships.

The Asian urban centres suffer from scarcity of resources due to populations migrating from their villages. As the villages can not offer the potential work force with jobs, the younger population shift to the cities thereby, leaving less polluted and cleaner villages for the more polluted urban centres. Setting biogas facilities or energy recovery facilities at less urban centres can balance the population pressure on the natural resources. This will solve another issue of the unorganised sector operating on waste collection. Under circumstances of a lenient environmental policy implementation, workers – adults, children – from the unorganised sector work under poor working conditions and unhealthy sanitary conditions and this causes a negative health impact. For example, in countries like India where the many of the waste collectors are from the unorganised sector selling some contents of the wastes, like needles and syringes to small units of manufacturers who produce medical products like syringes. This recycles the hazardous waste into the economic stream and this has been the main cause behind the rural and urban poor suffering from infectious and contagious diseases.

With the help of anaerobic digestion a renewable energy can be captured from the segregated wastes. This will not only reduce the CO2 emissions (Table 7.1-1) through a reduction in the demand for the fossil fuels but it can also capture methane which is the second most significant green house gas. The methane so captured can be used as fuel for cooking purposes in the Asian countries and this will have a strong impact in the reduction of rate of deforestation as in countries like Cambodia firewood is still, the most prevalent fuel for cooking purposes. Income level in some groups of communities of Sri Lanka has risen as the women are freed from up to two and half hours of a day of their domestic labour in fuel collection, cleaning smoke-blackened utensils and disposing of animal wastes of their cattle.

<table>
<thead>
<tr>
<th>Type</th>
<th>Saving</th>
<th>CO2 reduction Mt/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH₄</td>
<td>13,24 Mt/year</td>
<td>330,9</td>
</tr>
<tr>
<td>Biogas</td>
<td>33,321 m³/year</td>
<td>-</td>
</tr>
<tr>
<td>Fossil fuels substituted</td>
<td>-</td>
<td>44,7 – 52,7</td>
</tr>
<tr>
<td>Fire wood saving</td>
<td>-</td>
<td>4,17 – 73,8</td>
</tr>
<tr>
<td>Total</td>
<td>-</td>
<td>418,5 (average)</td>
</tr>
</tbody>
</table>

Table 7.1-1: Emissions reduction potentials [Reference: GTZ, 2007]
7.1.9 Financing considerations

7.1.9.1 Requirements
For the biogas production or renewable energy generation project to be funded from lending institutions, they should fulfil certain requirements.

From the perspective of lender:
A feasibility study giving a brief description of the project; summarising history of the group, cooperative or company that is proposing the project; mentioning the findings of the feasibility study on technical, management, marketing and financial characteristics of the project proposed and the most important aspect of socio-economic implications of the proposed project, is necessary at the first instance. The feasibility study should describe the location of the project, climatic conditions of the region, the infrastructure facilities like the communication network, roads, ports, airports, banks, schools, electricity and so on. The technical aspects of the project like the size, capacity, efficiency; purpose of the project; raw material requirements; equipment and other fixed asset requirement; life expectancy of the machinery newly acquired and existing machinery, land, buildings and other movable and immovable assets should also be detailed (Arnot, 1985). The feasibility study has to give some details of marketing like supply and demand conditions for the output and the raw materials to produce the product; production costs, price policies, marketing policies and strategies for methods of the product distribution. It should elaborate the contribution of the project towards the regional, provincial and national economy. The annual volume and value of the sales expected and the net savings should also be mentioned. On the financial front, the study should project details of its expected loans, grants and investments and the sources the investor opted for. The amount and terms of selected or proposed financing including security offered schedules of repayment and interest rates. Any lending institution will find the project feasible and viable if the feasibility study offers some valid information on logistics information like the transport and storage and access to the raw material and market are taken into consideration. The lender may also be interested in knowing whether the project can be a low cost producer; whether the project will be supportive and stable under the existing regulatory framework of the region and the nation; whether it will survive technology risk factors; how the by-products have been valued and included; how it is going to make impacts, positive as well as negative, on environment; other considerations specific to the operation of the plant.

7.1.9.2 The role of the government
The human impact through energy consumption directly influences the global climate and producing and using renewable energy sources can reduce the impact to a great extent. A combination of governmental polices can improve the incentive mechanism towards an efficient use of existing non renewable resources and switching to renewable sources of energy. Renewable energy from one or two sources can also be clubbed to make a hybrid system and this can serve regions that are off-grid or those regions having limited power. The government polices can favour increased use of renewable sources by fostering collaboration, removing market barriers for renewable energy sources and developing markets for the products of renewable sources.

The political structure of many developing countries does not extend a vivid support to projects who can contribute substantially to meet their energy needs. The industrial lobby of these countries contribute a major share in meeting the election campaigns expenses and party funds and therefore, they have a major say in the political decisions of these Asian countries. There is not adequate transparency in the political decisions of these countries. The decision makers also, are apprehensive that the shift from non renewable to renewable sources of energy may hurt their countries’ competitiveness in the global arena. Nevertheless, they extend their willingness, verbally, under some circumstances, for the move. The initiatives of the government allocating a certain quota of funds in their respective, national budgets can only affirm their real interest in such move. Sometimes, when the profitability of biogas plants are viewed with scepticism by the private investors the government will have to invest in such plants so as to alter the investment decisions of the private entrepreneurs. The government can also grant subsidies to the private and community owned biogas plants through grants and soft loans. If the investors fear an uncertain demand conditions for the energy produced at their plants, the government can assure them through demanding certain share of energy for use in the government offices and biogas can be used in the canteens of the government offices and in the public utilities of the municipalities.

The government can give some tax exemptions to those households who shift from the use of non renewable sources of energy and fuel use to renewable sources. The hurdles for the move are overcome, if the investors could get grants and credits from the financial institutes, from the national banks thereby assuring the project initiator of sufficient funds.
On the whole it requires both the private and public sector involvement. Technical details like the transmission grids and infrastructural improvement should also, be taken into account. Economic viability and the micro and macro level feasibility should be assessed. The financial issues like the cost, fixed and variable cost, should be estimated. Material requirements should be evaluated. The available know-how of technology at the regional and national level should also, be analysed before hand. The community should be given sufficient information so as to create public awareness. Last but not the least, the issue of sustainability should not be over looked.

7.1.10 Biomass and renewable energy – points to ponder

7.1.10.1 Renewable energy sources and EU member states

The share of renewable energy sources in total energy consumption increased slowly in the EU-25 between 1990 and 2004 from 4.4% in 1990 to 6.3% in 2004. Significant further growth will be needed to meet the indicative target of a 12% share by 2010. All renewable sources increased in 2004. In relative terms, the strongest increase came from wind and solar energy. In absolute terms, 60% of the increase was accounted for by biomass, and about 39% split equally between hydropower and wind energy. Solar energy continues to increase very rapidly but still accounts for less than 1% of total renewable energy (EEA 2007).

7.1.10.2 Some observations on benefits of renewable energy:

Abu- Qudais and Abu- Qdais (2000) find the energy content of municipal solid waste generated in Jordan accounting for 6% of the annual imported oil consumption of the country resulting in an annual saving of USD 24 million. And converting the municipal solid waste energy content to electric supply there may be a yield of 1.77 MW/day, which may be used for desalination of 300,000 m3/day of sea water with the help of reverse osmosis process which may account for 12% of the water consumption of Jordan/day in the year 1995.

The following table lists energy density in BTU/lb, as well as the number of homes of 100 tons (200,000 lb) fuel that can power for one year

<table>
<thead>
<tr>
<th>Fuel</th>
<th>Heat Content (BTU/lb)</th>
<th>Number of homes powered by 100 of fuel *</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel oil</td>
<td>19,178</td>
<td>18.7</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>24,582</td>
<td>24.0</td>
</tr>
<tr>
<td>Coal (Bituminous)</td>
<td>12,250</td>
<td>12.0</td>
</tr>
<tr>
<td>Wood (Dry)</td>
<td>8,600</td>
<td>8.4</td>
</tr>
<tr>
<td>Refuse Derived Fuel</td>
<td>5,900</td>
<td>5.8</td>
</tr>
<tr>
<td>Ethanol</td>
<td>12,741</td>
<td>12.4</td>
</tr>
<tr>
<td>Landfill Gas</td>
<td>6,517</td>
<td>6.4</td>
</tr>
</tbody>
</table>

* This assumes firstly a 30% thermodynamic efficiency and secondly a typical home using 18,000 kW-hr per year

There are 89 waste-to-energy plants operating in 27 states managing about 13 percent of America’s trash, or about 95,000 tons each day. Waste-to-energy facilities generate about 2,500 megawatts of electricity to meet the power needs of nearly 2.3 million homes, and the facilities serve the trash disposal needs of more than 36 million people. The $10 billion waste-to-energy industry employs more than 6,000 American workers with annual wages in excess of $400 million (IWSA).

If the transportation bio fuels such as the cellulose ethanol are produced from low-input biomass either grown on agriculturally marginal land or from biomass from household wastes, the environmental benefits and its supply will be much greater than if it is produced from food-based biofuels (Hill et al 2006).

7.1.10.3 Potentials of biomass

Biomass ranks the fourth as an energy resource. It fulfils, approximately 14% of the world’s energy needs and 35% of the energy needs of the developing countries (Demirbas, 2004). Biomass can be divided into more specific terminology, with different terms for different end uses: heating/cooling, power (electricity) generation or transportation. The term ‘bio energy’ is commonly used for biomass
energy systems that produce heating or cooling and/or electricity and 'bio fuels' for liquid fuels for transportation. The biomass sector could make a major contribution to the security of supplies, as biomass has become a major factor in energy, environmental and agricultural policies. Although progress has been made, this has not been enough given the potential of biomass and the available technologies.

Only a part of biomass that grows can be supplied for energy use, due to technical, ecological and economic reasons. Only a less than two thirds of the lumber grown in Germany, is used for biomass every year. The total bio energy potential in Germany is the equivalent of 56 million tonnes of crude oil units. This would be enough to meet 50% of the total automotive fuel consumption needs of Germany, including air traffic (Scheffer 2000). There is enough biomass in the EU-25 to produce up to 115 million tonnes of synthetic automotive fuels every year (Kaltschmitt and Vogel, 2004). Expansion of bio fuels production and their use also raises some concerns, most importantly due to their diverting land away from use for food, biodiversity-preservation. Added pressure on water resources for growing bio fuel feedstock is also of concern in many areas of the world.

7.2 Environmental Economics

Environmental economics is, one of the many fields of Economics, concerning environmental issues. The objectives of the environmental economics are to provide an economic approach to the environmental problems thereby evaluating the reasons and consequences of the economic approach; to investigate the behaviour of the economic agents namely the consumers and the producers and the mechanisms leading to the environmental problems; finally, prescribing appropriate economic instruments to handle the environmental problems.

It is well known that the quality of environment affects the well being or the utility of the consumers either positively or negatively. As environment is treated in economics as a commodity the actions of economic agents bring some negative effects, say, pollution and similar problems when individuals do not bear all the costs of their actions. The costs, if, are not met at the current period will be costlier in the future while the ‘quality’ of environment is considered as a scarce resource in Economics. The social cost of producing any good is its cost to every individual in the society and this also, includes who do not produce or consume it. The social cost therefore, is the private cost what the producer incurs plus the cost the others incur. When the social cost of producing any good exceeds the private cost there is negative externality. Similarly, there occurs positive externality when the social benefit exceeds the private benefit. A market failure occurs when any economic activity produces an externality.

It is because of the public character of the environmental commodities like clean air and clean water for example, which makes the accountability of these commodities a difficult issue to deal with. And this public characteristic of the environmental commodities creates market failure. On a smaller scale the problem does not appear to be difficult to tackle but on a larger scale with a huge population the accountability can not be easily shared and with the inherent human nature of shifting the burden to others we, directly or indirectly, intentionally or unintentionally shift the burden on the economically challenged section of the society.

Pollution bears a financial implication when an economic activity of one person causes a negative effect, called negative externality, on others and also the extent of damage it has on others. By disposing of the effluents into the river a factory working around a water body, say a river can cause negative health impact on the community living along the river. And in the absence of governmental interference the factory may not share the accountability of its production activity. The financial implication the community bears in cleaning the river system and paying for the medical bills, owing to the economic activity of the factory owner, is the external cost outside of the purview of the calculations of the factory owner while calculating his private costs. He calculates only the cost of machinery and salary to his employees for example, into account. Whereas the local municipalities take into consideration the cost of mitigating the pollution the factory creates. Therefore, the private and external costs are clubbed together to arrive at the social cost and if it exceeds the social benefit what the community reaps out of the economic activity of the factory, it becomes an unsustainable economic activity and the factory owner therefore, should be made liable for sharing the social cost with the other members of the society. This can be done by the governmental interference of imposing some taxes on the unsustainable and polluting manufacturing activity of the factory owner (Baumol and Oates, 1998). Each society has to decide upon a solution to tackle the fundamental economic problems or the allocation problems. And the solution needs to be feasible. The solution will depend on the traditions, religion, concepts of fairness the society adopts. And this introduces the concept of optimality and a feasible or efficient allocation should fulfil some normative criteria and only then can the solution be called Pareto-Optimal or Pareto-Efficient.
This assessment explains our consumption behaviour. With each of our economic activity every one of us knowingly or unknowingly, directly or indirectly create an ecological footprint and when the consumption behaviour is made responsible we reach closer to sustainable development. Sustainable development is the ideal way of exploiting the resources say, natural resources economically in such a way to satisfy the needs of the present generation without compromising the wealth and health of the future generation (UNEP). As it avoids any irreversible damage, it inevitably assumes an economic growth function in harmony with the environment and the surrounding ecosystem. Hence, under this principle the available resources will remain the same for each generation. Any unsustainable production or consumption will inflict a cost on the future generation and any unsustainable production may restrict their available quantity to the future generation. Modifying our consumption behaviour from the consumption of energy from non renewable sources to renewable sources is an example. Future generations will have access to the renewable sources as much as the present generation as they are renewable and less polluting.

As we already know that there is external cost owing to negative externalities from unsustainable production or consumption behaviour and the external effects are not taken care of by market mechanism. This is due to missing market and therefore, we need to invest in correcting the damage. And any further delay may have a greater incidence on the future generations and on the economically less advantaged sections of the society. Higher standards of regulation might be economically advantageous. A strict environmental policy may induce innovation, reduce inefficiency and trigger industrial competitiveness (For more details: Porter hypothesis, Porter, 1998) Changing polluting machinery and improving transport mechanics are some of the ideal solutions in reducing green house gas emissions.

The optimal level of ecosystem stability and costs of pollution mitigation is reached where the social costs of economic activity are equal to the social benefits. But, it is not the case under the present conditions where the external effects are greater than the investment we make to reduce the environmental problems for example, global warming.

If the energy from non renewable sources signal entering a threshold level not sustainable for the planet and the future generations investment in that sector should be reduced and the investment on renewable sources should be augmented. This will reduce the harmful environmental effects. But, how to bring this into effect? The shift in investment from one sector to another will not take place if the patterns of consumption and production and our life styles are not changed.

In the above figure, let us assume that it costs 10 dollars to manufacture one unit of a product. And to have a 2 dollars profit, the manufacturer should sell the product for 12 dollars. But, when we assume that a 2 dollar worth of external costs of cleaning up the environment (polluted due to the production of one unit of this particular product) is added to the private cost of 10 dollars and if the producer still wants to reap the same amount of 2 dollars profit the price rises to 14 dollars. The demand decreases due to the price increase. And this shifts the supply curve to the left. At this point of intersection the price reflects the damage the production causes to the environment. And without this, there would have been a surplus supply of the particular good.
Hence, from the angle of the society, any economic activity will be considered benign if the social benefits exceed the social costs. And, the private manufacturer may be interested in a particular economic activity only if it fetches him more benefits than the private costs. We can consider this with the help of generation of energy from non-renewable sources and renewable sources. Social cost of energy from conventional sources is higher than energy from renewable sources as it consists of external costs of production as well as usage. Whereas the private costs of producing energy from renewable sources is higher as the initial investment costs are high. While in the former case there is an indirect subsidy making the private costs lesser, in the latter the subsidies are absent making the private costs appear higher. And this warrants the interference of the public sector to set the framework conditions for the private entrepreneurs to switch to generating energy from renewable sources. This the governments can do by subsidising the production of energy from non-conventional sources like biomass for example by introducing micro credit facilities. If we take the example of German Renewable Energy Sources Act 2004 (BMU) the objective behind the introduction of the act was to facilitate a sustainable development of energy supply. This the German government could do by regulating the grid system operators and they were obliged to guarantee priority purchase and transmission of all electricity from renewable sources (Wiesmeth, 2008). Similarly, any economic activity generating more social costs than the social benefits can be curtailed through stringent taxes on the activity whether a tax on the input or a tax on the output depending on the circumstances (Pigou, 1928). Internalisation of the environmental effects will complete the market system. Some practical economic instruments like Pigou-Tax or the Emission certificates issued by the government can reduce the problems.

The globalisation and liberalisation and trade of the South East Asian economies have also brought certain environmental problems like deforestation, soil degradation, water pollution growing waste problems to quote a few. Growing economies with change in life styles and consumption behaviour in the absence of environmental care will widen the gap thereby, making the magnitude of the problem huge. In the energy sector for example, the governmental interference providing proper framework conditions for the investors so as to reduce the reliance on non-renewable sources of energy would be a proper move at the present circumstances.

- **Conventional Energy**

- **Renewable Energy**

![Figure 7.2-2: Private Costs](image_url)
7.3 Socio-cultural aspects of waste management

7.3.1 Factors influencing waste management

There are clear differences in the attitudes towards waste recycling and managing among diverse cultural groups. These attitudes vary depending on the religious, cultural beliefs, gender and generational differences. In many developing countries the people who work in waste management have a different socio-cultural background than the rest of the population. The socio-economic status of the workers of waste management system is usually, very low. People who belong to the economically rich group believe that their littering practice is the right thing, in that it offers employment for some one (Mongkolinchiralunyia, 2005). Low education levels and unhealthy working conditions of the poor in combination with their status lead to a negative self-perception and lack of self-confidence (UNESCO, 2001). Their occupation is usually, considered to be of the lowest status in the society. Historically, outcasts and marginal groups such as slaves, gypsies and migrants have performed waste collection and recycling activities in developing countries ((Nas and Jaffe, 2004). While ascertaining the support and participation of the community for a shift in the waste management system the socio-cultural attitudes of the population towards wastes and their attitudes to gender roles relating to waste management in and outside their homes; their openness to integrated approaches involving recycling and composting; their ability and willingness to pay for an improved waste management system should be considered.

7.3.2 Factors affecting the waste composition

The physical and chemical characteristics contribute toward the composition of household waste. They are directly influenced by the food habits, cultural and socio-economic, seasonal and climatic conditions of the community generating the waste (Bhoyar et al 1996). The components of municipal solid waste may vary from urban and rural community and also from one country to another (Abu-Qudais and Abu-Qdais, 2000) and may vary within a country of vast expanse with diverse cultures, like India. In fact, the composition of wastes differs in two localities that differ considerably due to the socio-economic status of the residents in these areas (Basu, 1995). Wastes from food constitute a major component of solid waste stream generated in developing countries (Diaz and Golueke, 1987).

7.4 Waste management and South-East Asian countries

7.4.1 Objectives

Until some few decades ago, the disposal of wastes had not been a great problem, for, the population had been not much. The land available to dump wastes was sufficient too. With the rapid industrialisation and urbanisation there has been a tremendous upward swing of rural population migrating to urban centres. This has led to a significant change in the socio-economic status and a
subsequent change in their consumption pattern as well. Waste management infrastructure and the institutional capability must go hand in hand with the growth of any nation. The governmental policies aiming at development issues therefore, should address the strategic natural resource management simultaneously. The objectives of the South East Asian countries is to maximise the use of local natural resources to achieve least cost options in the power sector. This can be achieved by expanding access to electricity by the rural population through promoting renewable energy; facilitating opportunities to private entrepreneurs and help them come out with their efficient and cost-effective services; designing appropriate policy measures in setting effective tariffs; promoting technologies of renewable energy for on-grid and off-grid mode; and, increasing the standards of living of the rural poor with the help of right economic opportunities. The net societal benefits of the alternative energy can be measured only with the help of data on farm yields, commodity and fuel prices, farm energy and agro chemical inputs, plants efficiency, production of co product, green house gas emissions and other environmental effects (Hill et al 2006). The incentive regime for a decentralised renewable energy solution for south East Asian countries will be to include subsidies to reduce the start-up cost thereby promoting affordability. Further incentives can be created through providing assistance in capacity building for supporting market infrastructure.

7.4.2 Cambodia

The Royal Government of Cambodia is keen addressing issues related to adequate supply of energy throughout Cambodia at affordable prices. It explores policy avenues which encourage exploration and development of alternative energy sources to promote energy efficiency. The main sources of energy of Cambodia are biomass and conventional sources of energy. Biomass based fuels make an indirect contribution to promoting cogeneration. Cambodia is quite rich in biomass and therefore, there is a large scope for market for biomass energy. The per capita energy consumption of Cambodia from conventional energy is about 48kwh per annum and Cambodia ranks among the lowest in energy consumption in the Asian region. Only 12% of the households have access to electricity. The total installed capacity of electricity is 150 MW and out of this 100 MW are in Phnom Penh. Cambodia has no fossil fuel resources and it is a net importer of fuels. The oil import levels for Cambodia in 2002 were approximately 7,200 bbl/day.

Table 7.4-1: Economic statistics of South-East Asian countries [ADB Report]

<table>
<thead>
<tr>
<th>Country</th>
<th>Purchasing Power Parity (PPP) $</th>
<th>Real GDP Growth per cent 2003</th>
<th>GDP 2004</th>
<th>Per Capita PPP $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cambodia</td>
<td>18 billion</td>
<td>5.0</td>
<td>5.5</td>
<td>1500</td>
</tr>
<tr>
<td>Thailand</td>
<td>429 billion</td>
<td>5.2</td>
<td>5.5</td>
<td>6900</td>
</tr>
<tr>
<td>Vietnam</td>
<td>168 billion</td>
<td>6.9</td>
<td>7.1</td>
<td>2100</td>
</tr>
</tbody>
</table>

Around 80% of the national energy consumption is met by biomass fuels and the rest is covered by imported fossil fuels (MIME, 2001). There is no national grid for electricity transmission except a 115 kv single circuit transmission line of 120 km to Phnom Penh from Kirromin min-hydropower station. Power supply is available through small isolated systems using diesel generators. Due to lack of adequate infrastructure and regulation, rural population of Cambodia pays very high prices for electricity that is supplied by private diesel set operators. The price of power is therefore, very high. According to the data in the year 2000, the average tariff is about 14.6 US cents/kWh in Phnom Penh and 25 to 50 US cents/kWh in rural areas. The total installed capacity of Cambodia is 200 MW and out of this 65% capacity is in the Capital city Phnom Penh. The per capita consumption of power is only 48 kWh per annum which is quite low in the whole region. The annual growth rate of demand for power is 12%.

Cambodia is served by 24 small isolated power systems. There is an estimated 600 Rural Electric Enterprises (REE) in Cambodia, serving 60,000 customers (SME, 2001). The average generating capacity of the 600 REEs is about 100 kW each and about 60 MW in total. There is virtually no transmission link between load centres. Peak demand in 2003 was 120 MW in Phnom Penh and 40 MW for all other provincial centres. Power is imported across the borders of Cambodia from Vietnam, Laos, and Thailand. The Royal Government, Cambodia encourages conditions which attract private sector investment in the power industry.
Table 7.4-2: National Energy Demand of Cambodia [Adapted from COGEN3]

<table>
<thead>
<tr>
<th>Type of Fuel</th>
<th>1994</th>
<th>2000</th>
<th>2005</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wood</td>
<td>77,721</td>
<td>89,616</td>
<td>103,552</td>
<td>106,344</td>
</tr>
<tr>
<td>Other biomass</td>
<td>1,754</td>
<td>1,600</td>
<td>1,559</td>
<td>1,351</td>
</tr>
<tr>
<td>Gasoline</td>
<td>6,006</td>
<td>10,765</td>
<td>15,288</td>
<td>20,284</td>
</tr>
</tbody>
</table>

The Ministry of Industry, Mines and Energy (MIME) Cambodia is responsible for Concession Licensing for implementing biomass, coal and natural gas-based cogeneration plants in Cambodia. However, small projects below 125 kVA the municipal or the provincial authorities may grant the concession license.

7.4.2.1 Supply constraints of energy in Cambodia

Cambodia suffers from the following constraints:
- inefficiencies of old generating equipment
- uncompetitive market structure
- inadequate legal framework
- inadequate investment framework
- inadequate administrative capacity
- lack of access to electricity

7.4.2.2 Demand for electricity and its transmission

The forecasts are based on expected average annual consumption growth rates of 9 – 12%. The conservative estimates for growth rates are between 5 and 6% nationwide. The Royal Government of Cambodia has long term plans to establish a national electricity grid by 2016. The grid, however, may cover only the southern region and some parts of western region of Cambodia. There is a large scope to promote decentralised, cost-effective and reliable clean energy services of renewable energy technologies in Cambodia. The Royal Government of Cambodia has taken efforts towards decentralised, demand-driven, private sector initiatives in the power sector. The renewable energy device connection in the regional and national grids is expected to be facilitated.

7.4.2.3 Financial and other constraints

Cambodian banks offer short-term loans at high interest rates. The micro-finance institutions provide credit at interest rates of 40-60% per annum. The initial cost of setting renewable energy systems is high and this works as a deterrent.

There are other technical issues which deserve attention. Cambodia, like any other developing region in the world, is not devoid of problems like lack of institutional and infrastructure capacity in most of its rural areas. As the volume of operations of renewable energy systems are low there is less access to have spare parts. There is also lack of basic socio-economic and technical data on the primary resources for renewable energy technologies like biomass resources.

The low literacy level hinders dissemination of information on renewable energy technologies and also, their marketing aspects are non-existent.

7.4.3 Thailand

7.4.3.1 Rudimentary information

In 2007 Thailand’s total commercial energy consumption was 80,019 thousand tons of crude oil equivalent (ktoe) while peak generation of electric power system was 22,586 ktoe. During the 1990s approximately 90% Thailand’s commercial primary energy consumption was imported. Despite the rapidly growing energy demand Thailand’s per capita commercial energy consumption is still very low compared to other industrialised countries. As a result, the per capita emission of greenhouse gases is estimated to be about 5.5 tons of carbon dioxide.
7.4.3.2 Supply and demand conditions of power

The Electricity Generating Authority of Thailand (EGAT) is the single buyer of electricity owning half of the power generating capacity. It sells power to two distributing facilities. The economic crisis of 1998 slowed down the demand for power in Thailand. This resulted in excess generation capacity and the reserve margin rose to 35.1% in 2003 (Piyasvasti Amranand, 2006). To cope with the problem, the purchase of power from cogeneration facilities under long term contracts was temporarily suspended. However, the renewable energy projects continued in Thailand.

Constraints:
- Unattractive purchase price
- Expensive interconnection requirements
- Technological risk

7.4.3.3 Renewable energy potentials

Apart from bagasse, rice husks and wood chips other sources like household wastes, biogas from pig farms and other types of agro industry and wastes from palm oil factories assure the potential to generate 1,700 MW of power additionally. The support of the government giving financial incentives with soft loans and investment subsidies for selected types of renewable energy projects is very much a need at the present circumstances. Private investments are being encouraged through Energy Service Companies (ESCO) and ESCO venture capital fund has also been established. It appears that there is right policy mix to encourage renewable energy options in Thailand.

7.4.3.4 Community’s responsiveness

The incentive behind the developed countries efforts to finding a solution to fall back has been because of the increased pressure on energy supply. And they also understood that depending on corn could be an economic blunder. But, they were not the only reasons behind their success. The countries could promote the renewable energy projects through making the public aware. And as with awareness increase, the compatibility with existing land use was considered by the provinces and local municipalities to bring the Acts into force. Therefore, the challenge of the local municipalities and the scientific communities of the developing countries will be to provide information and opportunities for renewable energy facilities, including large scale operations, while ensuring that adverse effects are eliminated or minimised. Some studies (eg. Mongkolnchaiarunya, 2005) cite how a few projects could motivate the residents of a rural area, with emphasis on poorer communities, of Thailand to bring recyclables for exchange of eggs to keep their surroundings cleaner. This signifies the community empowerment through self-reliance establishing new relationships of more equality and less dependence between poor communities and local municipal administration in Asian countries. Although, most of the communities of Asia react sharply to environmental issues in the recent years, Thailand paces a faster than its South East Asian counterparts.

Most of the financial resources Asian countries use is for waste collection and transportation and only a small fraction of the resources are being spent for waste disposal methods like composting and land filling and incinerating. The least resources are spent towards source reduction or for material recovery. Sometimes, there is lack of sense of acclimatising by those who move to urban centres and this leads to less social motivation in matters of waste disposal.

7.4.4 Vietnam

7.4.4.1 Vietnam – a snapshot

The purchasing power parity of Vietnam is 227USD billion with a GDP growth rate of 7.7 in 2004 (EIA, 2005). Vietnam is therefore, making a steady progress in tackling issues of rural poverty so as to include provision of reliable electricity supply. More than 87% of the households have access to electricity. Large fraction of population relies on non-commercial energy in the form of biomass resources such as wood, animal dung and rice husks. The Vietnam industry is responsible for 40% of the economy. 30% of the population of Vietnam is considered to be below the poverty line.

The rural population of Vietnam receives a low quality service from the grid like a low voltage and poor reliable supply. The per capita electricity consumption of Vietnam is among the lowest in Asia. And electricity demand of Vietnam is expected to grow between 15-16% per year until 2010. Electricity of Vietnam (EVN), the power company run by the State, plans to commission 16 hydro power plants by 2010 and increase capacity while Financial, a private company, will construct 8 additional coal-fired power plants (Vietnam Report). Despite its being a significant oil producer, Vietnam relies on imports of petroleum products as the country lacks refining capacity.

Vietnam does not import or export electricity across its borders. The Vietnamese government with its commitment to reducing rural poverty focuses on improving electricity access to a target of 90% of its population. The national grids connect the densely populated areas and the rural areas are
connected by local hydroelectric power. The Electricity of Vietnam (EVN), however, plans to develop a national electricity grid connecting several regional grids. It plans to upgrade the transmission line around Hanoi (EIA, 2005). The government of Vietnam estimates that around 9,300 miles of new high voltage transmission lines and 173,600 miles of new medium and low voltage transmission lines may be necessary to accommodate the energy demands by the year 2010. The high cost grid extension and the country’s geographical complexity will preclude the inclusion of around 1,100 remote mountainous communities. These communities consist of 750,000 households and around 3 million people. Some of the communities have access to commercial energy through local small grids and local power production from sources like hydro power plants of low capacity. Around 30% of the people of Vietnam live without electric power. There exists a considerable potential role for biomass and other renewable sources of electricity generation. This will include grid connection of the larger renewable energy systems and a considerable market for renewable systems for the communities and households that are likely to remain off-grid.

In Vietnam, several companies are operating in the fuel market, but as they all stem from the same mother company they are heavily influenced by the biggest market player—Petrolimex which alone accounts for a 60% market share. When the crude oil price rose to the peak of USD 147 a barrel in July, 2008 the price of A92 gasoline in Vietnam raised to VND19,000 from VND14,500 per litre, a surge of more than 31%. But, after the world oil price drop to almost 50% falling below USD77 (Saigon Times, October, 2008) in the beginning of October, 2008 the price of A92 remained almost, in the same level. The companies gave a rationale that as they had to make up for the losses incurred during the last period the prices did not fall in the succeeding period. By bringing transparency into the business process through including representatives of social associations, consumers and the media, the society can benefit from reasonable fuel prices.

### 7.4.4.2 Renewable energy sources and Vietnam

Biomass including wood fuel and agricultural residues like rice husk, rice straw, coffee husk, and bagasse are widely used for energy production in Vietnam. Biomass fuel sources like forest wood, rubber wood, log residues, saw mill residues, sugar cane residues and coconut residues need a mention. Biogas is another not much utilised resource in Vietnam. Over 50 million tonnes of biomass is produced each year with only 30-40% is used towards energy production. The energy captured is used for cooking and only a small capacity, around 150 MW, is used for electricity generation in sugar mills. Biomass is currently, being treated as a non-commercial source of energy and it is collected and utilised locally. The use of biomass for producing energy in a commercial way has still, not received much attention of energy planners.

### 7.4.4.3 Barriers to implementing renewable energy projects in Vietnam

**Legislative:**
The current policy and regulatory framework in Vietnam is inadequate to providing necessary drivers to accelerate the development of renewable energy sector.

**Technical:**
- There is lack of reliable data on biomass energy sources in Vietnam
- There is shortage of high quality technology at affordable prices
- The biomass conversion technologies are imported and therefore they are expensive and thereby, making them not affordable for the many individual entrepreneurs.

**Financial:**
- There is lack of commercial business and infrastructure to provide renewable electricity equipment and services
- There is continuing high cost of biomass conversion technologies affecting the price of energy generated from biomass
- Access to finance is limited for consumers, business and project developers

### 7.4.4.4 Community reaction

The community reaction to environmental violations of Vedan, a private company discharging volumes of untreated industrial water into the river (Saigon Times, Oct. 2008) clearly affirms the awakening of Asian countries to prioritising environmental improvement. Matzuwaza an
VII Economics and Socio-economic aspects

An environmentalist working with the Japan International Cooperation Agency in Vietnam believes that Vietnam’s economic development over the past decades has resulted in an unprecedented rate of pollution. Vo Quy, a Vietnamese Zoologist, who has been honoured among ‘Heroes of the Environment’ by Times News magazine, fears the toll of torrid economic growth affecting the flora and fauna of Vietnam. He wants the younger generation to take an active lead in environmental issues protecting environment.

7.4.5 Laos

7.4.5.1 Basic data

Out of the least developed countries in terms of low income, human resource weakness and economic vulnerability, 8 Asian countries have a number of priority issues pertaining to the country’s development. And, management of municipal solid waste is one of the priority urban issues. Lao PDR is one of the Asian countries least developed suffering from poor waste management. Vientiane is the capital city of Lao PDR with a land area of 3,920 square km. The population of Vientiane was 639,326 in the year and it has been estimated to be growing at a rate of 4.7% (NORAD). Vientiane consists of nine districts but the waste management infrastructure serves the wards in four districts namely Chantabouly, Sikhottabong, Sisattanak and Xayseththa districts. Waste generation is about 200-250 t per day. There is on an average 0.75 kg of solid waste generation per capita. And more than 40% of the waste generated is biodegradable (INVENT Final Meeting). Collected waste is being dumped at the dump site 18 km from Vientiane and the site is called km18. 30% of the wastes generated are sold and recycled and this makes the composition of wastes collected by the waste pickers and which is found in the dump site different.

The agricultural residue is substantial to improve the use of biomass technologies like biogas technology and improved stove for cooking. The biogas technology will reduce the greenhouse gas emissions from the waste of animal dung. In rural areas most of the households have animals. This makes the biogas technology ideal technology for rural and livestock farm. In Lao PDR, it is estimated that there are about 4 million metric tons of animal dung per year. There can be biogas generation around 280 million cubic metres. In Laos the use of biomass as energy is about 90% of the total energy consumption. In the past few years, the government organisation and a few private organisations have developed biomass technologies and transferred to the use of the people.

There are technology and financing constraints on biomass and there is also insufficient information. At present, the Technology Research Institute (TRI), and the Science, Technology and Environment Agency (STEA) are conducting a demonstration project at the Training Centre on different sources of biomass-based energy, for example generating electricity from rice husk. There is a huge potential for various biomass technologies in Laos, but there is a shortage of data on local resources and feasibility in different areas of the country.

As Lao PDR is an oil and gas importing country, petroleum security is essentially the basis of import policy, at present there is no restriction on imports of petroleum products. Adequate imports are allowed to meet the country’s demand. In addition the importer/supplier are required to maintain a minimum 10% reserve at all times as a supply security measure

7.4.5.2 Key issues of waste management in Vientiane

- Lack of awareness among the residents
- Problems arising due to poor management of waste like bad odour
- Poor waste pickers working under unhygienic conditions affecting their health conditions
- Poor aesthetic and fear of losing tourists
- Institutional deficiencies
- Inadequate legislation
- Resource constraints

7.4.5.3 Barriers to implementing renewable energy solutions

Lao PDR like Vietnam suffers from legislative, technical and financing problems. But, above all, in the case of Lao PDR the data availability is quite limited. This could impair any analysis.

7.4.5.4 Micro credit facilities and environmental awareness

Most of the Asian countries have experienced success relating to micro credit facilities and the following economic benefits. Laos will not be an exception to the rule. The small loans provided to
the poor borrowers bring positive effects in household production and consumption, the focus on wom en, the social capital created from community network improvement. An enhanced human and social capital can improve environmental outcome. Some studies (eg. Anderson and Locker, 2002) provide information on how micro credit facilities bring increased environmental awareness in the society. With the micro finance there is an incentive creation and this helps the message being spread across various sections of the society.

7.4.6 Barriers found common in South East Asian countries

7.4.6.1 technical and technological
The level of understanding of technology related to renewable energy solutions and biogas production among the South East Asian countries were only slightly different from one another. It is therefore, necessary to adopt any technology suitable to the existing level of knowledge in the region. In the remote areas of countries like Cambodia and Laos it may be an impediment if any technological solution is implemented without informing the community. This makes it necessary to spread knowledge and information through students who receive information at the universities or at the institutions they study. This brings more pressure on the teaching community to perceive the right information so as to pass it on to the younger generation.

7.4.6.2 institutional
The South East Asian countries suffer from institutional barriers. Renewable energy solutions and biogas generation are not well known or well understood. The authorities from the institutions do not understand the practicability of the renewable energy solutions and their benefits they may not be willing to support a project on biogas generation or renewable energy production. An organised political framework may reduce institutional barriers to a large extent.

7.4.6.3 informational
If the physical, chemical, technical, economic, social aspects are not known it may be a bottleneck towards creating willingness for such initiatives. And therefore, information barriers may cause acceptance problem and a following lack of support.

Learning outcome:

After reading the chapter the reader should have learnt the impact considerations of waste management systems, the benefits associated with an efficient renewable energy solution and biogas generation, the importance of economics in understanding environmental problems and the framework conditions of South East Asian countries.

Self-assessment

1. How and to what extent are the environmental problems related to and dependent on economic growth?
2. Describe the concept of external effects. In which sense, do external effects lead to missing markets?
7.5 References

- BMU (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, Germany)
- EEG (2004): Erneuerbare Energien Gesetz, English Translation
- GTZ Biogas Digest Vol. III
- Nas, P.J.M and Jaffe, R (2004): Informal waste management: shifting the focus from problem to potential Environment, Development and Sustainability Vol. 6 pp 337-353
- Pigou, A C (1928): The Economics of Welfare London: Macmillan and Co
- Piyasvasti Amranand (2006): Thailand Energy Minister on alternative energy, cogeneration and distributed generation: Crucial strategy for sustainability of Thailand’s energy sector
Internet sources:

http://www5.gtz.de/gate/publications/BiogasDigestVol1.pdf
http://www.eia.doe.gov/emeu/cabs/vietnam.html
http://www.unep.org/
http://www.recambodia.org
http://www.recambodia.org
www.re-focus.net
http://www.gtz.de/en/
http://www.bmu.de/english/renewable_energy/doc/6465.php
http://www.gtz.de/en
http://practicalaction.org/