ENERGY, ENVIRONMENT AND CLIMATE CHANGE ISSUES: PHILIPPINES

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Contents

Energy in the Philippines

The Philippines: Demography and economy

Area (million sq. km)	***0.3***
Population (million persons)	***65***
GDP (10^9US$)	***64.9***
Energy data	
Electricity generation * (10^9kWh/year)	***26***
Coal (10^6t)	***4.5***
Oil (10^6t)	***14.84***
Gas(10^6t)	***0***
Hydropower (TWh)	***17.2***
Commercial energy consumption (10^{18}J)	***0.84***
Total primary energy consumption (10^{18}J)	***0.93***

Source: Department of Economics & Statistics-Statistical Outline (1995-96) Tata Services Ltd; Data to 1994 unless otherwise specified. * Data for 1993

This book looks at the Philippines, and how the energy used by various sectors affects its environment, especially through the production of greenhouse gases.

The sectors chosen are:

- Energy-efficient and environmentally-sound industrial technologies:
  - Iron & steel industry
  - Pulp & paper industry
  - Cement industry
- Biomass as an energy source and technical options for greenhouse gas emission reduction

These sectors were chosen because of the large contribution they make to the overall burden of environmental pollution.

Part 1: Development of energy efficient and environmentally sound industrial technologies

The industrial processes

Three specific industrial sectors were analysed to see what could be done to make them more energy efficient and environmentally sound.

Iron and steel industry

The iron and steel industry in the Philippines is one of the most significant growth industries in the country and is one of the biggest users of energy, although a significant amount of steel is imported to meet demand. Energy efficiency could be raised by several technical interventions such as pre-heating scrap, combustion control, optimizing motor drives, cogeneration, improved electrical supply, energy-efficient lighting.

Environmentally, strict government policies on industrial pollution have led to the widespread adoption anti-pollution devices. However, the dust collected (containing hazardous metals) is commonly dumped untreated as pellets. Although companies have policy guidelines related to the environment, many are only communicated verbally to the employees.

Pulp and paper industry

The pulp and paper industry in the Philippines is reliant on old and energy-hungry machines, for which spare parts are difficult to find. The industry is one of the high fuel-oil consuming industries in the country. It is heavily dependent on imported raw materials, particularly virgin pulp, waste paper and paper-making chemicals. Most machines operate at low-speeds, with no integrated process-control devices and little instrumentation. Though there are sufficient technical skills to run the mills, there is a lack of engineering skills for process design.

Cement industry

There are three types of processes employed by the industry; wet, semi-dry and dry. The technologies employed in the Philippines are outdated, resulting in high fuel and electricity consumption. The principal fuels used are; coal, coke, and fuel oil. There is tremendous scope for improving the efficiency of energy use in the cement industry, relieving the increasing burden of energy cost and contributing significantly to lower production costs and competitiveness.

There is a need for high-efficiency dust collectors to be installed to remove the large amounts of fine particles discharged into the atmosphere.

Overview of the industrial sector

The economy of the Philippines, after a few years of stagnation, is now approaching a growth rate of 6% per year, with industrial growth at around 5%. Tariff structures, investment incentives, financial assistance, and environmental protection are the major factors that have affected the extent to which industry has adopted energy-efficient and environmentally-sound technologies.

Industry in the Philippines suffers from a number of constraints:

- Though there is no longer a shortage of electricity, unstable electricity supply causes severe hardships for industry. Voltage-sensitive equipment, such as precipitators for the cement industry, have difficulty operating with grid power. The government is currently addressing this problem.
- Inconsistent and inferior quality fossil fuel, containing a high percentage of sulphur, has led to corrosion problems in boilers, kilns and furnaces.

In the Philippines, which has a fully liberalized economy, all enterprises are privately owned. Nevertheless, government policies and institutional support play a crucial role in promoting energy-efficient and environmentally-sound technologies. Key decisions are made by the chief executive in small firms and by the board in larger ones. Technically competent plant managers come from the ranks, assisted by groups with specialized knowledge and skills. Safety is a priority, and there are active member associations and company social gatherings.

Foreign equipment suppliers have an important role in promoting clean technologies. The suppliers conduct regular seminars to introduce these technologies, processes and equipment. They have therefore become the major sources of information in this field. All suppliers provide before-sales services, such as plant evaluations and cost-benefit analyses on adoption of the equipment they supply, and some will agree to equity participation.

Energy conservation

The factors that impact on energy provision are shown in the following tables:

Positive factors in energy management in the Philippines
• Management commitment to energy conservation in most industries has been expressed
• There are some individual consultants with formal training in industrial energy efficiency
Negative factors in energy management in the Philippines
• The cost of energy is high, which discourages growth in the economy, though fuel oil prices are relatively low, so oil is used in power plants for power generation
• There are no energy efficiency standards or formal energy policies in industry
• There is weak implementation of energy conservation measures because of lack of in-house capability to conduct energy audits
• Monitoring is normally limited to total plant energy consumption
• There are no indigenous suppliers of energy-efficient and environmentally sustainable technologies
• There are no consulting firms in the Philippines specializing in industrial energy efficiency

Environmental pollution; causes and consequences

The tables below shows some of factors affecting environmental management.

Positive factors in environmental management in the Philippines
Management commitment to environmental protection
Some companies have environmental protection measures well above legal requirements
Increasing environmental awareness by plant employees
Awards to cleanest plants, both in terms of money and recognition
Adoption of '5S+1' - a Japanese concept for productivity improvement
Negative factors in environmental management in the Philippines
Low level of fines for violating or failing to comply with regulations does not reflect the internal or external costs of pollution prevention and management.
Environmental manager is usually an 'add-on' role to another staff member

Key areas to improve energy efficiency and reduce pollution

The Filipino NGO, Pollution Control Association of the Philippines (PCAPI) works with the government to protect the environment and has been offered a position representing industry on the Technical Committee on Formulation of Environmental Standards.

The basis for the environmental framework in the Philippines is enshrined in a decree, known as the Philippine Environmental Policy, shown in the following table:

Philippine Environmental Policy
To create conditions under which man and nature an thrive in productive and enjoyable harmony with each other
To fulfil the social, economic and other requirements of present and future generations of Filipinos
To ensure the attainment o an environmental quality that is conducive to a life of dignity and well being

Key internal factors affecting selected industries

Iron and steel industry

The iron and steel industry in the Philippines has evolved into one of the most significant growth industries in the country. The factories involved all have continuing programmes on improving their use of raw materials, improving the operation of their production processes, improving their products, controlling waste emissions and general housekeeping. Some companies conduct formal waste minimization audits, others adopt waste reduction research.

Pulp and paper industry

The pulp and paper industry in the Philippines has bleak long-term prospects. It is generally inefficient and non-competitive. Operating fewer but bigger units would take advantage of economies of scale and benefit from modern process technologies. Plants will need to be moved away from densely populated areas because of environmental requirements. Similarly, facilities for dealing with hazards will put major demands on small mills. Reducing waste generation should be high on the industry's agenda, improving profitability as well as benefiting the environment. Waste reduction has never received the priority it deserves.

Cement industry
There is tremendous opportunity for improving the efficiency of energy utilization in the cement industry, not only because of its big share in the country's energy consumption, but also because the sector consists of a relatively manageable number of energy-consuming equipment facilities of appropriate size compared to other sectors. Technologies to improve the efficiencies at end-user level have been identified, and to some extent are already being appreciated by the industry. Relieving the increasing burden of energy cost by achieving greater energy efficiency will undoubtedly contribute significantly to lower production costs and enhanced competitiveness.

Role of internal actors

Organisational structures
All industries in the Philippines are privately owned. However, due to the business climate, some privately-owned companies operating in similar fields have limited interaction and sharing of experiences because of fear of divulging confidential data and competitive pressure.

Industrial restructuring programmes have been developed since 1991 in some sub-sectors, to prepare industries in the Philippines to compete with the country's ASEAN neighbours. Currently, small industries survive because they are shielded from international competition by high import tariffs

Human resources and development
The productivity (described in tonnes per capita) is high. Training of personnel is given both locally and abroad, and the capabilities of industries are built through their own initiative.

Energy and environment management system
Though there are no formal energy policies, some plants report energy consumption. Work related to this is an additional assignment, and monitoring of energy use is usually limited to total plant consumption. Some companies adopt strict environmental protection measures, and there is increased environmental awareness by plant employees. They tend to adopt Japanese concepts for improving productivity.

Role of external actors

Government

- Though investment priority plans have been designed to provide incentives, such as tax concessions to industries, they do not encompass environmentally-friendly and energy-efficient technologies.
- Most R&D is currently conducted on product development or improvement rather than process and equipment development. Equipment that is developed is mainly for small-scale applications.

Equipment suppliers

- Equipment suppliers could play a vital role in promoting efficient technologies by educating enterprises on new technologies' processes and equipment, supplying equipment on loan and entering into collaboration with local manufacturers to bring down costs.

Finance

- Industries suffer from high rates of interest. Financial support plays a decisive role in the adoption of energy-efficient and environmentally sound technologies. At present, high capital costs are a major barrier for adoption.

Non-government organisations

- Where NGOs are active in environmental protection activities, they are more socio-economically beneficial when they take a participatory approach to finding solutions to environmental problems

Regulation bodies

- Currently, there are no regulations for energy-efficiency improvements. Fines levied for non-compliance for polluting industries do not reflect the cost of pollution prevention and management.
- Industries in the Philippines prefer to upgrade than to build new plant. This is to minimize cost and to avoid difficulty in getting government approvals and acquiring environmental and land use permits.

Part II : Study of biomass as an energy source and technical options for greenhouse gas emission reduction

Biomass is a vital energy source

The total energy consumption in the Philippines in 1995 was estimated to be about 32 million tonnes oil equivalent (Mtoe) of which biomass amounted to about 11.5 Mtoe, or 35% of the total. Most of the biomass consumption (about 69%) occurs in the residential sector, with stoves as the major end user.

Historically, the Philippines has been heavily dependent on imported oil for its energy needs. In recent years, the Philippine government started to take measures to decrease the country's dependence on oil by developing indigenous energy resources. With the country's recently introduced programme towards diversification, the total energy requirement is projected to increase at an average rate of 6.6% per annum, over the period 1996-2025.

A study by the Regional Wood Energy Development Programme (RWEDP) of the FAO estimated that the consumption of woodfuels in the Philippines is only about 25.84% of their sustainable supply from traditional sources. Also, large amounts of agricultural residues generated annually remain unutilized. Thus, the present supply of biomass fuels can potentially provide a much larger share of the total national energy requirements.

Biomass can provide further energy service in the Philippines through:

- end-use efficiency improvement
- use of agricultural residues, currently disposed of by dumping or burning
- plantation in degraded land.

Pattern of biomass energy use

It can be observed in Table 1 that a large quantity of biomass was consumed in the residential sector in 1995. Cooking stoves consumed over 18 Mt of biomass fuels. Fuelwood, agricultural residues and animal wastes in the total biomass used for energy amounted to 12.05%, 87.82% and 0.13%, respectively.

In the commercial and industrial sectors, about 1 Mt of fuelwood, 7.4 Mt crop residues and 11 kilotonnes (kt) of animal waste were consumed. Furnaces consumed 0.24 Mt fuelwood and 0.47 Mt crop residues, while boilers utilized

0.71 Mt wood and fuelwood and 6.9 Mt of crop residues (mostly bagasse). In addition, 0.58 Mt of biomass fuels were used in dryers.

Table 1: Consumption of biomass fuels by end-use in the Philippines in 1995

Resource	Industrial and commercial sectors		Residential sector	
	End-uses	Tonne/Year	End-uses	Tonne/ Year
Wood Fuelwood Wood-waste	Boilers	712 292	Cooking stoves	14 557 024
	Cooking stoves	13 916		
	Drying	42 722		
	Other Technologies	3 413		
	Furnaces/Kilns	239 642		
TOTAL		**1 011 985**		**14 557 024**
Coconut husk with shell	Cooking stove	108	Cooking stoves	220 096
	Driers	10 114		
	Furnaces	700		
	Other	426		
TOTAL		**11 348**		**220 096**
Coconut Fronds	Cooking stove	1 579	Cooking stoves	1 100 482
	Drying	2 780		
	Furnace	410		
	Other	412		
TOTAL		**5 181**		**1 100 482**
Coconut Shell	Boilers	200 604	Cooking stoves	770 337
	Cookstove	181		
	Driers	605		
	Furnaces	38 208		
	Gasifiers	847		
	Other	78		
TOTAL		**240 523**		**770 337**
Coconut Husk	Driers	509 113	Cooking stoves	110 048
	Furnaces	7 467		
	Other	63		
TOTAL		**516 643**		**110 048**
Bagasse	Boilers	**5 969 434**		
	Cooking stoves	629		
	Furnaces	17 582		
	Other	2		
TOTAL		**5 987 647**		

Table 1 contd				
Charcoal	Boiler	24	Cooking	300 317
	Cooking (Restaurants)	4 323	Water Heating	200 211
	Driers	53	Others	192 511
	Furnace	9 072	Flat Iron	77 004
	Gasifiers	586		
	Other	165 546		
TOTAL		**179 604**		**770 043**
Rice Hull	Boilers	6 824	Cooking stoves	1 100 482
	Cooking stove	1 473		
	Driers	16 085		
	Furnaces	399 985		
	Other	7 774		
TOTAL		**432 141**		**1 100 482**
Animal Manure	Biogas	10962	Cooking stove	69548
			Flat iron	7
			Lighting	1
TOTAL		**10 962**		**69 556**

Present biomass energy use is very inefficient and polluting

Conservation potential

Energy from biomass normally commands the biggest share in the supply of energy in rural areas of developing countries, fuelwood often accounting for a major fraction of it. Most traditional technologies existing in the rural sectors, have been identified as 'inefficient' and there is room for numerous minor and often major improvements in efficiency. The amount of biomass that can be saved through efficiency improvement can serve as a source of additional energy and can potentially substitute fossil fuels to reduce net GHG emission.

Table 2 shows the estimated biomass saving potential in the Philippines. The study reveals a saving potential for fuelwood of about eight million tonnes. In addition, about 2.2 million tonnes of agricultural residues and 0.25 million tonnes of charcoal can also be saved.

Table 2: Biomass saving potential in the Philippines (Million tonnes/year)			
Sector	**Type of biomass**		
	Fuelwood	**Agri-residues**	**Charcoal**
Domestic cooking	7.41	1.18	0.25
Industrial Oven	0.03	-	-
Boilers	0.07	0.72	-
Furnaces	0.10	0.36	-
Total	**7.61**	**2.26**	**0.25**

Emissions from biomass fuels

Table 3 shows the total emission of the selected gases/pollutants associated with biomass use for energy in the Philippines in 1995. About 29 million tonnes (Mt) of carbon dioxide, 1.4 Mt of carbon monoxide, 132 kilotonnes (kt) of methane, 350 kt of total suspended particles, 44 kt of sulphur oxides, and 36 kt of nitrogen oxides are released annually from biomass combustion in the Philippines.

Table 3: Emission Generated from Biomass Use (1995)						
Type of Fuel	Total Emission (kt)					
	CO_2	CO	CH_4	TSP	SO_x	NO_x
Fuelwood	17713.11	1018.31	99.85	120.61	6.91	22.17
Agri-residues	9669.53	214.60	25.94	216.33	37.06	11.30
Animal waste	60.24	0	0	0	0	0
Charcoal	2118.64	173.12	6.43	13.30	0.45	2.76
Total	**29561.52**	**1406.02**	**132.21**	**350.24**	**44.41**	**36.23**

Emerging biomass energy technologies and their potential role in mitigating GHGs.

Biomass Combustion

Combustion of biomass, which currently accounts for about 14% of the global total energy consumption, is likely to assume a much greater importance in the future as the world tries to mitigate the threat of climate change. Currently, practically all developing countries have some form of improved cooking stove programme.

Practically all biomass-based electricity generation plants employ steam turbine systems. Such electricity generation is established in developed countries, where relatively cheap, waste biomass is available. Most systems are based on low-pressure boilers (about 20-25 bar) with efficiencies slightly below 20%. Modern biomass powered high pressure (about 60-100 bar) boiler-turbine systems produce electricity with efficiencies approaching 32%.

Thermal energy, produced by burning biomass and other low grade fuels, can be used for small-scale power generation using an external combustion engine, such as the Stirling engine. This may be of great interest for rural applications, since there is potential for higher efficiencies than those using gasifier-engine or steam-based power plants of similar capacity.

Although historically disappointing, the technology now appears to be improving. Based on studies in Denmark, the overall electricity generation efficiency of biomass powered Stirling engines of capacity 36-150 kW is expected to be 21-26%. Some field units are currently being tested in New Zealand and this new generation of Stirling engines may be considered for applications in the developing countries in the near future.

Cogeneration is the process of producing two useful forms of energy, normally electricity and heat, using the same fuel source. The process is well established in industries such as pulp and paper, sugar mills etc. Cogeneration is practised in sugar mills worldwide to meet in-house demand for steam and electricity, typically by using low-pressure boiler-steam turbine systems. Through the use of high-pressure systems, mills can produce substantial surplus electricity for selling locally or to the grid.

In the Philippines, steam and power generation are the major uses for biomass in the industrial sector. They mainly comprise industries producing biomass wastes that can be used as fuel such as sugar processing, logging/wood products, and paper processing.

Biomass gasification

Gasification technology is more than a century old. After World War II, interest in gasification technology practically disappeared, as oil became a cheap and convenient energy source. The energy crisis of 1973 triggered renewed interest, and a number of institutes and organizations built and tested/operated gasifier systems, mostly based on earlier designs.

Over the last 8-10 years, interest in large-scale biomass gasification for power generation has been growing. Efficiencies of over 40% are predicted for such plants. For capacities lower than 5-10 MWe, catalytic gas cleaning and low-tar gasifier designs may make a new generation of such gasifiers feasible.

Small-scale gasification has been shown to be viable in the Philippines. Small-scale gasifiers, designed by the Department of Science and Technology are being used for small-scale pottery and brick-making projects and drying of paddy, fish and paper maché. The technology is not widely adopted due to:

- Lack of reliability in the absence of trained technicians
- Low cost of crude oil which makes it economically attractive
- Lack of sustained promotion campaigns outlining the benefits

Biomass carbonization

Charcoal is used for domestic cooking and other applications. Because of diminishing fuelwood supplies, charcoal-making, from residues which often cause environmental problems if left unutilized, is becoming more attractive. A wide range of devices, developed for carbonizing agricultural and other residues, have found limited acceptance so far.

Recent developments in biomass carbonization include generating energy from the waste gases produced during batch carbonization. The process improves both the overall process energy efficiency and the environment. Another development is torrefaction, a low temperature carbonization process that produces a substitute product for conventional charcoal in some applications. A new technique developed in Hawaii, USA is reported to yield charcoal at 42% to 62% of the original weight, compared to about 15-30% for conventional carbonization.

The University of the Philippines College of Engineering (UPCE) studied a pyrolytic converter in the late 1980s with the primary objective of demonstrating the viability of a small-scale pyrolytic converter using rice hull. The result of the test runs showed that pyrolysis of rice hull is difficult but feasible.

Biomass densification

Depending on the type of equipment used, densification can be categorized into four main types: piston press densification; screw press densification; roll press densification; and pelletizing. Products from the first three types of densification are large compared to pellets, and are normally called briquettes.

Densification involves compressing the raw material, which causes two problems; high electrical energy consumption by the driving motor; and wear of machine parts. Two recent developments for reducing wear and energy consumption of densification machines comprise:

- preheating to soften the raw material just before its compaction in briquetting machines.
- the use of a small amount of a thermoplastic material both to lubricate the die of pelleting presses and to improve calorific value of the densified product.

Efforts are also under way to apply advanced surface coating to the screw of briquetting machines that can dramatically increase their life by reducing wear.

Biogas production

Biogas technologies are already considered a commercial venture in the Philippines. However, even though a number of installations are operating successfully, use of biogas is not widespread. This is due to lack of information and technical know-how and high initial investment costs.

Table 4 shows an assessment of the level of development of various biomass energy conversion technologies in the Philippines.

GHG emission mitigation potential of Biomass Energy Technologies (BETS)

Efficiency improvement of existing biomass energy systems and deployment of modern BETs can significantly reduce GHG emission, often at a negative cost. The emission mitigation potential is estimated by comparing a typical current situation with an assumed improved situation.

The current situation is characterized by inefficient use of residues, with a certain amount disposed of wastefully. Fossil fuels, which could be substituted by residues, are burned, causing GHG emission. In the assumed improved situation, residues are used efficiently, and previously wasted residues are substituted for fossil fuels in a selected type of modern biomass energy system.

Table 4: Biomass energy conversion technologies in the Philippines -stages of development							
Direct combustion systems	**Resource**	**Applications**	**Stage of development** (*key below*)				
			L	**P**	**D**	**V**	**C**
Improved stoves	Fuelwood	Households; commercial establishments					*
	Rice hull					*	
Furnaces; ovens; boilers	Fuelwood	Heat, steam, power					*
	Charcoal	Process heat					*
	Bagasse	Heat, steam, power					*
	Coconut shell/husk	Heat, power					*
	Coconut shell / charcoal	Waste heat recovery		*		*	
	Rice hull	Heat				*	*
	Rice hull	Heat, power			*	*	
Gasification Systems	Charcoal	Process heat				*	
	Rice hull	Heat			*		
	Wood/ wood wastes	Heat, power		*	*		
Biogas System	Animal manure	Households (heat)			*		
	Animal manure, stillage	Industrial (heat)				*	*
		Industrial (power)				*	*
Pyrolysis, Liquefaction	Wood wastes	Heat, power	*				
	Other biomass	Heat, power	*				
Densification (Briquetting)	Rice hull	Heat					*
Liquid Fuels	Alcohol, coconut oil	Transport, power				*	

Stages of development
L: technical concept/laboratory studies under way
P: technical feasibility proven by pilot studies
D: Technical feasibility proven by demonstration projects
V: Proven competitive with conventional systems; ready for commercialization
C Technology already commercially available

Table 5 gives the estimated energy generation potential and total GHG emission mitigation potential for rice husk in different modern energy systems in the Philippines. Most of these technology options offer a lower cost of energy generation than comparable fossil fuel based options.

Table 5. Emission mitigation potential of different technological options for using rice husk efficiently		
Technology option	**Energy generation potential**	**Mitigation potential (kg x 10^6 CO_2 equiv/year)**
1: direct combustion to produce steam	16064 TJ	1930
2: direct combustion for electricity generation (1 MW)	725 GWh	750
3: direct combustion for electricity generation (2.5 MW)	837 GWh	866
4: direct combustion for electricity generation (12 MW)	1394 GWh	1444
5: direct combustion for electricity generation (29 MW)	1746 GWh	1808
6: gasification for electricity generation	498 GWh	359

Conclusions

Energy from biomass constitutes an important part of the total energy supply in the Philippines. The manner in which biomass is currently utilized for energy is, however, far from ideal and is characterised by gross inefficiency and pollution of the environment. Biomass fuels could provide a much more extensive energy service than at present if these were used efficiently. This could serve to reduce emission of greenhouse gases through substitution of fossil fuels.

The Philippines has an abundant supply of biomass resources, which could be a potentially significant source of energy. Some resources are already being exploited for energy, but considerable amounts are still treated as waste, and remain untapped.

Biomass consumption for energy in the Philippines was about 27 million tonnes in 1995. Of this, nearly 70% was consumed by the residential sector.

Cooking stoves and boilers are the major end-use applications of biomass fuels in the household and industrial sectors respectively.

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