A Study of Biomass as a Source of Energy in Vietnam

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ABSTRACT

Biomass is a major source of energy in Vietnam. However, as in the case of most other developing countries, reliable estimates of biomass energy use in different economic sectors of Vietnam are not available. This paper presents the status of biomass energy in Vietnam including sectoral and end-use utilization of different biomass fuels by end-use technology. It is estimated that the total biomass consumption for energy was about 34.69 billion kg (13.34 MTOE) in the year 1991; this amounted to about 72.5% of the total primary energy consumption of the country. The share of fuelwood in the traditional energy supply is about 84%. The household sector is the major end-user and consumes 91.5% of the total biomass energy.

1. INTRODUCTION

Actual population and conventional energy consumption in Vietnam during 1990 and 1995 as well as their projected values for the years 2000, 2005, and 2010 are given in Table 1. The table shows that conventional energy consumption in Vietnam is expected to grow steeply, the projected consumption in the year 2010 being well above six times the consumption in 1990.

Table 1. Actual and projected population and conventional energy consumption in Vietnam [1].

Year	Population (Millions)	Energy consumption (MTOE)
1990	68.31	4.62
1995	74.63	6.87
2000	82.10	11.35
2005	88.53	18.79
2010	97.38	29.63

Besides conventional energy, a substantial amount of biomass energy is also consumed annually. The main sources of biomass energy in the country are fuelwood, crop residues, and animal dung. Reliable estimates of consumption of these fuels are normally not available. Considering the importance of assessing biomass energy use for energy planning purposes [2], a regional study was carried out on a number of Asian countries within the framework of a project funded by the Swedish International Development Cooperation Agency (Sida). This paper presents the results of the study of biomass as a source of energy in Vietnam.

2. BIOMASS ENERGY RESOURCES

2.1 Fuelwood

Vietnam has substantial forestry resources, the total area under forest being about 96.4 billion m^2, which is 29% of the total land area of the country. The country also has a vast area of wasteland amounting to 142 billion m^2. The total amount of fuelwood consumed in Vietnam in 1991 was 28.11 billion kg or 11.24 MTOE [3].

Estimated production of fuelwood, including wood wastes in Vietnam for the years 1994 and 2010 are shown in Table 2 [4]. Fuelwood production in the country in 1994 was 49 billion kg and has been projected to decrease to about 43 billion kg by the year 2010. About 60% of the total fuelwood directly or indirectly come from natural forest.

The fuelwood requirement has been reported to be about 29.37 billion kg (10.35 MTOE) in the year 1994 and projected to rise to 39.42 billion kg (13.85 MTOE) by the year 2010 [4]. Considering that the current as well as projected fuelwood production is higher than the requirement, Vietnam appears to be one of the few countries that do not face any overall fuelwood shortage.

2.2 Agricultural Residues

In Vietnam, agriculture is the main source of income for the majority of people. Agricultural residues available locally in large amounts represent a substantial source of energy. The total theoretical energy potential of any crop residue can be estimated from the total annual generation of the product of crop production and a suitable value of residue/crop ration.

With assumed values of residue/product (i.e., ratio) for each type of crop as well as heating value of the residue, the total theoretical energy potential of agricultural residues in Vietnam has

Table 2. Fuelwood production in Vietnam in 1994-2010 [4].

Fuelwood sources	1994			2010		
	million kg	(%)	thousand TOE	million kg	(%)	thousand TOE
Natural forests	10814	22.09	3802	8282	19.38	2910
Natural forests (wood wastes)	18498	37.78	6501	13697	32.05	4811
Plantation	5128	10.47	1807	5190	12.15	1831
Other wooded lands	7124	14.55	2511	6790	15.89	2394
Agriculture areas	7396	15.11	2605	8772	20.53	3098
Total	48960	100.00	17,26	42730	100.00	15044

been estimated to be 18.51 MTOE and 29.14 MTOE for the years 1994 and 2010, respectively, as shown in Table 3 [4]. The most important agricultural crop in Vietnam is rice which accounts for 84% of total agricultural residues generated annually.

2.3 Animal Waste

The major domestic animals in Vietnam are buffalo, cow, pig, chicken and duck. Animal manure is mainly used as fertilizer in the plain areas of the North. In the South, chemical fertilizer is preferred and animal manure is disposed of as waste.

Based on the total number of animals in 1993, assumed volatile solids production for various types of animal and biogas production per kg of volatile solids, the biogas potential of waste is estimated as shown in Table 4. The theoretical potential of biogas that can be produced if the entire quantities of wastes are used for biogas production has been estimated to be 11.28 million m^3 of biogas. Assuming a calorific value of biogas as 21 000 kJ/m^3, the theoretical potential of biogas energy in Vietnam has been estimated to be 2.03 MTOE. Assuming the recoverable fractions of wastes of cattle/buffaloes, pig, sheep, and human to be 50%, 23%, 33%, and 100% respectively [5], the recoverable biogas potential of animal wastes in Vietnam has been estimated to be 0.924 MTOE.

3. BIOMASS ENERGY TECHNOLOGIES

3.1 Biomass Gasification

The utilization of producer gas generated by gasification of charcoal or uncarbonized biomass to operate internal combustion engines of vehicles dates back to World War II in Vietnam. The interest in this technology declined after World War II with the availability of cheap petroleum fuels.

In the early 1980's, rice husk gasification for electricity generation was developed in the South. It was concentrated in Ho Chi Minh City and Hua Giang and Minh Hai provinces. It has been reported that there are about 15 installations with capacity of 75 kW in Hua Giang and Minh Hai provinces [8].

Recently, gasification of rice husk for drying paddy has attracted attention. Several rice mills have been reported to have installed imported rice husk gasifiers.

3.2 Biogas Production

Although several biogas plants are reported to be in operation, the total contribution of biogas towards national energy supplies remains insignificant in Vietnam. The feedstock for the plants include human and animal wastes, domestic wastes, green crop residues, etc. The gas is used mainly for cooking and lighting. The utilization of biogas has been successfully tested in diesel and petrol engines [8].

3.3 Improved Cookstoves

Various designs of improved cookstoves, of both portable and fixed types, have been distributed in Vietnam. The efficiency of the stoves has been reported to be in the range of 32% to

Table 3. Energy potential of crop residues in Vietnam in 1994-2010 [4, 6].

		1			1994[2]			2010[2]		
Crop	Residue type	RPR	Mois-ture	LHV kJ/kg	Production million kg	Residue production million kg	thousand TOE	Production million kg	Residue production million kg	thousand TOE
Rice	Straw	1.757	2.71	13,800	23,528	41,339	13,391.50	36,187	63,581	20,596.66
	Husk	0.267	12.37	13,480		6,282	1,987.82		9,662	3,057.36
Maize	Stalks	2.000	11.50	17,200	1,001	2,002	808.32	2,120	4,239	1,711.52
	Cob	0.273	7.53	16,280		273	104.33		579	221.27
Cassava	Stalks	0.062	15	14,680	2,436	151	52.03	1,839	114	39.28
Cotton	Stalks	2.755	12	14,650	18	50	17.20	39	107	36.80
Soyabeen	Straw+ Pods	3.500	15	14,860	125	438	152.79	219	767	267.55
Jute	Stalks	3.000	10	16,860	28	84	33.25	0	0	0
Sugarcane	Tops	0.300	10	15,810	7,550	2,265	840.60	12,160	3,648	1,353.87
	Bagasse	0.290	49	8,570		2,190	440.57		3,526	709.34
Coconut	Shells	0.120	8.7	16,410	4,158	499	192.20	5,525	663	255.39
	Husks	0.419	10.3	16,360		143	55.00		190	73.00
Groundnut	Husks	0.477	8.2	16,860	294	140	55.41	459	219	86.67
	Straw	2.300		15,190		676	241.04		1,057	376.90
Coffee	Husks	2.100	10	16,360	166	349	134.03	444	933	358.31
Total					39,304	56,881	18,506.00	58,942	89,285	29,144.00

[1] Assumed RPR from Bhattacharya [6]

[2] Production estimates by Koopmans [4]

Table 4 Potential of biogas in Vietnam in 1993 [6, 7].

Animal	Animal population (thousand)	Volatile solid generation (kg/head/day)	Specific biogas yield (m^3/kg VS)	Theoretical biogas production potential (thousand)		Recoverable biogas production potential (thousand)	
				m^3/day	TOE/year	m^3/day	TOE/year
Buffalo	2960.8	2.01	0.475	2827	508.6	1414	254.3
Cattle	3333	2.67	0.310	2759	496.4	1380	248.2
Goats + Sheep	353	0.33	0.490	57	10.3	19	3.4
Pig	14873.9	0.59	0.490	4300	773.7	989	178.0
Human	71025.6	0.06	0.314	1338	240.8	1338	240.8
Total				11281	2029.8	5140	924.7

34% based on lower heating value [8]. Although considerable efforts are being made for promotion of improved cook stoves, actual dissemination has made very slow progress so far.

4. SECTORAL BIOMASS ENERGY CONSUMPTION BY END-USE TECHNOLOGY

Biomass fuels play a very important role in the national economy, although the share of traditional energy in total energy consumption has been reported to have decreased from 77.4% in 1985 to 66.1% in 1995 [1]. Fuelwood, agricultural residues and charcoal are the main biomass fuels in Vietnam.

As shown in Table 5, 34.69 billion kg (13.34 MTOE) biomass was consumed in Vietnam in the year 1991. Fuelwood supplied the largest share of total biomass fuels accounting for 84.22% of the total consumption, followed by rice husk/other crop residues 13.64%, charcoal 1.95%, and bagasse 0.19%.

From Table 1, conventional energy consumption in Vietnam in 1991 has been estimated by interpolation to be about 5.07 MTOE, so that the total primary energy consumption in the form of conventional and biomass energy in 1991 was 18.41 MTOE; thus biomass energy consumption was about 72.5% of the primary energy consumption in 1991.

The sectoral biomass consumption for energy by end-use during 1991 in the country is shown in Table 6. The household sector accounted for 31.87 billion kg (12.21 MTOE) or 92% of the total biomass consumption for energy. In the household sector, biomass energy is mostly used for cooking and space heating.

In the industrial and commercial sectors biomass energy is used for handicraft and traditional industries, such as brick making, roof tile making, lime burning, porcelain, refractories, pottery, etc. The commercial and industrial sector consumed about 2.82 billion kg (1.13 MTOE) or about 8% of the total biomass for energy.

The estimates of biomass consumption for energy for different end-uses during the year 1991 in the country are shown in Table 7. In Vietnam, 20.84 billion kg of fuelwood, 5.23 billion kg of crop residues, 190 million kg of charcoal were consumed in traditional cook stoves in the residential sector. In addition, 2.31 billion kg of fuelwood and 581 million kg of crop residues were used in improved cook stoves. The fuelwood consumption in the space heating fireplaces for the same year was estimated to be 2.71 billion kg.

Table 5 Biomass energy consumption in 1991 [3].

Biofuels	billion kg	MTOE	(%)
Fuelwood	28.11	11.240	84.22
Bagasse	0.12	0.025	0.19
Rice husk/other residues	6.06	1.820	13.64
Charcoal	0.40	0.260	1.95
Total	34.69	13.345	100.00

Table 6 Sectoral biomass energy consumption in Vietnam in 1991.

Sector	billion kg	MTOE	(%)
Household	31.87	12.21	91.53
Industrial and commercial	2.82	1.133	8.47
Total	34.69	13.34	100.00

Table 7. Biomass consumption in Vietnam in 1991 by end-use technology [3].

Biomass	Industrial, commercial and agricultural sectors	% of M.C on W.B	million kg per year	Residential sector	% of M.C on W.B	million kg per year
Wood	Boilers		582.00	Fireplaces		2,706.60
	Furnaces		1,350.00	Stoves		
		14-23			14-23	
				- Traditional		20,836.00
	Commercial cooking		317.00	- Improved		2,315.00
	Total		**2,249.00**	**Total**		**25,857.60**
Crop residues	Bagasse fired boilers	50	123.50			
				Stoves		
	Commercial cooking	15	18.50			
				- Traditional	15	5,234.00
	Rice husk fired brick boilers	15	228.00	- Improved		581.00
	Total		**370.00**	**Total**		**5,815.00**
Charcoal	Commercial cooking		120.00			
	Industrial heating	3.0	85.50	Charcoal stoves	3.0	190.00
	Total		**205.00**	**Total**		**190.00**

In the industrial and commercial sector, the estimated fuelwood consumption was 2.25 billion kg. The consumption in boilers, furnaces, and commercial cooking was 580 million kg, 1.35 billion kg, and 320 million kg respectively. In addition, 120 million kg of bagasse, 18.5 million kg of crop residues, and 230 million kg of rice husk were utilized in the sugar mill boilers, commercial cooking, and rice husk fired boilers, respectively. About 120 million kg charcoal was consumed in commercial cooking and 85.5 million kg in industrial heating.

5. CONCLUSIONS

Biomass energy consumption in Vietnam amounted to about 72.5% of total primary energy consumption in 1991. Current as well as projected fuelwood suppply is greater than demand in Vietnam.

The total biomass energy consumption in Vietnam in 1991 was 34.69 billion kg (13.34 MTOE) in which the share of the fuelwood, crop residues, and charcoal wa 84.22%, 13.83%, and 1.95% respectively. About 92% biomass fuels was consumed in the residential sector in 1991.

About 74% of the fuelwood and 85% of the crop residues were consumed in the traditional cookstoves in 1991, while approximately 8.23% of fuelwood and 9.4% crop residues were consumed in improved cookstove.

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