Development of BELDA, Building Energy structure and Lifestyle Database of Asia

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Abstract

Carbon dioxide emissions of the world are still increasing, and it is said that 40% of them are come from the building sector. Also this sector is expected to significantly grow in the future. In order to reduce carbon dioxide emissions in the building sector, it is necessary to propose specific measures after understanding the actual energy supply and demand in accordance with each development stage. In Japan, the Architectural Institute of Japan (AIJ) developed a nation-wide database on energy consumption in housing in 2003[1]. For commercial buildings, a DECC[2] database has been developed since 2007 by the Institute of Building Environment and Energy Conservation (IBEC) with the support of the Japanese government. Both databases have been published and are available on its website. These databases have helped in the formulation of an environmental policy at national and local levels, and also been used in the design of buildings and related products.
However, information on energy demand in most Asian countries is poor. In this paper, we have outlined the components of a database of energy consumption for the building sector in Asia, which can create scenarios for reducing carbon dioxide emissions and help build platforms that can evaluate step-by-step measures that can be used, depending on the development stage of the country. We have called this database "BELDA", Building Energy structure and Lifestyle Database of Asia. We also report the results of an interview based survey, aimed at clarifying the position regarding monthly energy use in housing in both urban and rural areas that was conducted for the purpose of establishing a seed database in Hanoi, Ho Chi Minh, Phnom Penh and Bangkok.

Introduction We set three goals for this study. First, to develop a database of energy consumption of the building sector in Southeast Asia, second, to establish a Web-based platform that can evaluate policy and measures in accordance with the development stage and third, to build an international academic and research network to take advantage of it.

We cater to 5 types of users of BELDA; Non-registered user, General user, Research user, Cooperate user, Co-worker. Table 1 shows conditions for each user and availabilities

Development of Database

BELDA database is composed of 3sections; Data Registration, Building and Analyzing database, and Using Database (Fig.1). BELDA will finally include the data collected by cooperating researcher in addition to data collected in BELDA research. Basic information in BELDA is divided into 5 categories as shows in Table 2. Also we made work process of data registration, input format, and definition of related term. We have also determined the rules for confidentiality and privacy protection of content. The database is generally available on the website.

Types of user	Availability	Condition
Non-registration users	Browsing default data on the website	-
Registered users	Browsing processed data on the website	To enter minimum user information
Research users	Downloading anonymous individual data	To enter researcher information (Affiliation, Research subject etc.)
Collaborative user	Downloading anonymous individual data with some incentives	To offer research result
Collaborator	Accessing all individual data through research company	Co-working agreement with Jyukankyo Research Institute, Waseda University.

Table 1 User types

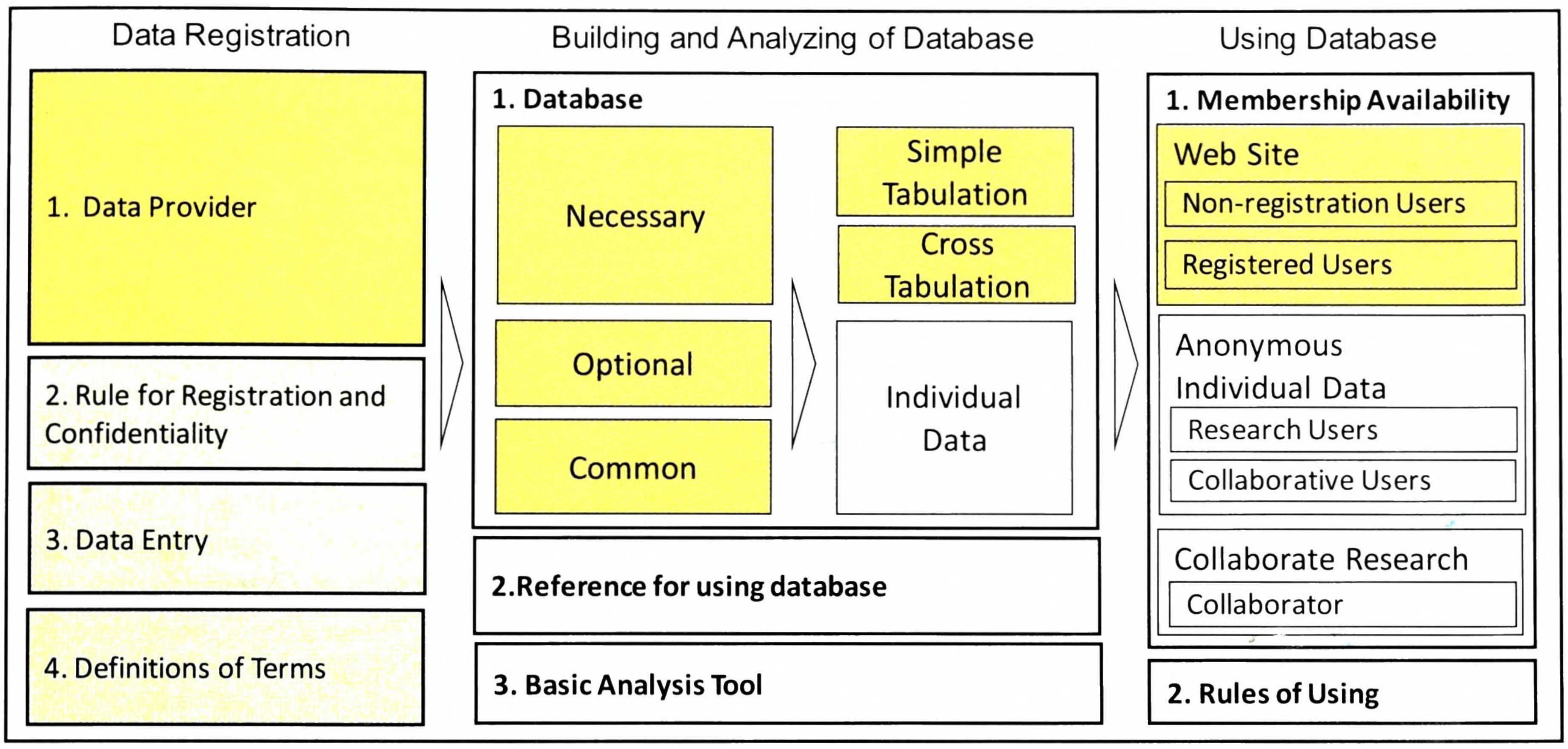


Fig. 1 Composition of BELDA

Category	Contents
Survey data	Result of BELDA survey, (2015 survey, 2016 survey at this time)
Previous data	Previous research data done in each country, Search results-internet, etc.
Macro data	Macro statistic data, such as population, GDP, etc.
User data	Registration information (name, affiliation, bio, e-mail address, specialty etc.)
Master	All master data

Table 2. Information in BELDA

This paper presents a survey we conducted in 2015 on energy consumption data and other significant information of residents in Southeast Asia which constitute the Database.

Household Energy Consumption Survey

This survey aimed to collect detailed information on energy use as well as carbon dioxide emissions per household in urban and rural areas of Vietnam, Thailand and Cambodia based on personal interviews. We collected 300 data for each country.

Vietnam (urban area): Hanoi (100 samples)
Ho Chi Minh (100 s)
Vietnam (rural area): Hoa Binh (100 s)

Thailand (urban area): Bangkok (200 s)

Thailand (rural area): Samutsakorn (100 s)

Cambodia (urban area): Phnom Penh (200s)
Cambodia (rural area): Kandal (100s)

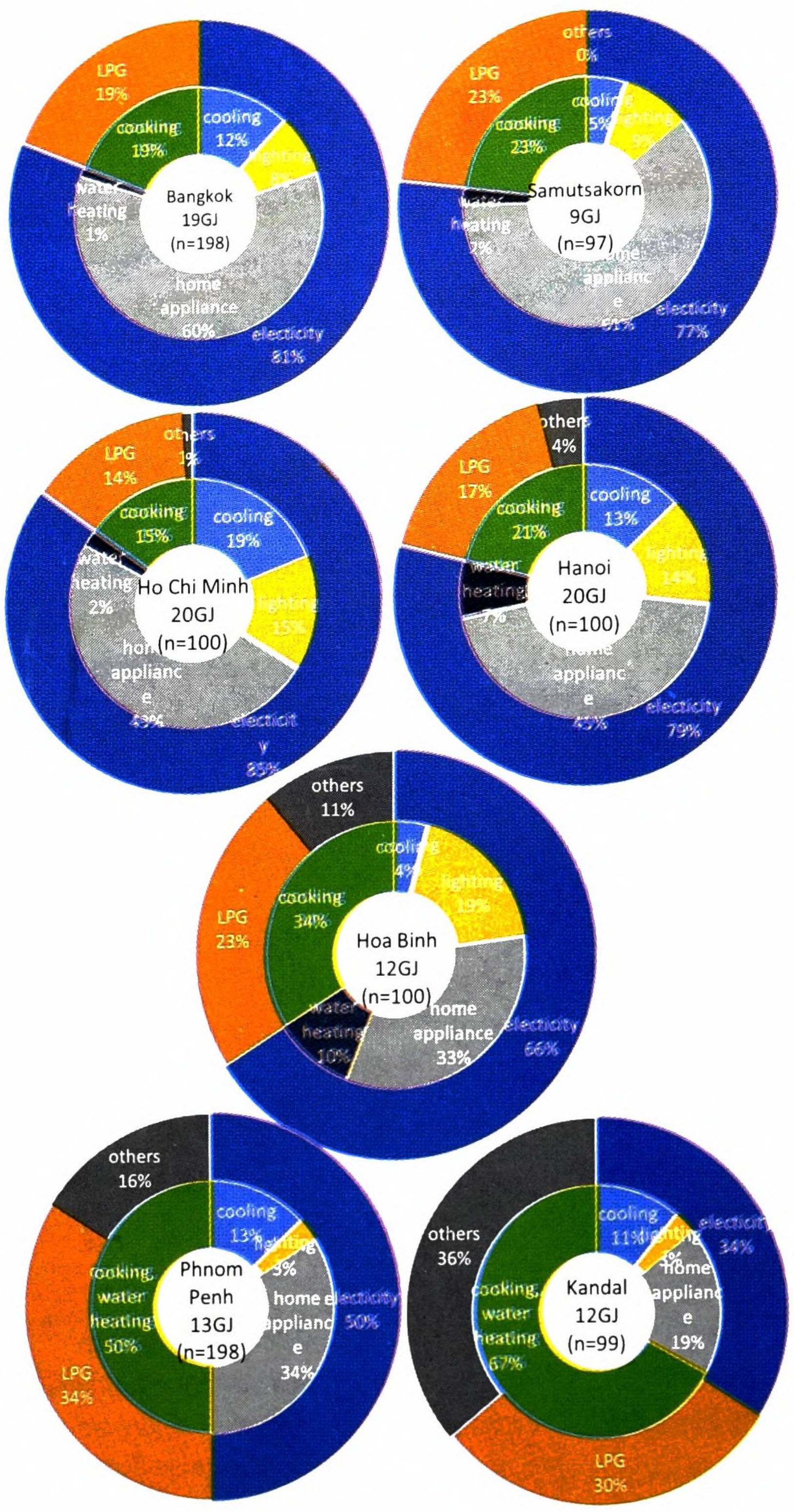
Category	Contents
Household Information	Constitution of household, Occupation, Number of workers, Household income,
Residential Information	Building type, Structure, Number of stories, Number of rooms, Total floor area, Construction year, Ownership
Facility	Cooling, Heating, Water heating, Kitchen, Home appliances
Facility use	AC/Home appliance/Shower use
Vehicle	Number of vehicles, How used
Lifestyle	Way of control room temperature Satisfaction for thermal/humid environment Energy saving action, Important points when buying home appliance
Energy Consumptio n	Yearly /monthly Energy consumption (Electricity, LPG, Kerosene, Coal, Charcoal, Firewood, Firewood)
Expense for Energy	Yearly and monthly utility bills by energy type

• **Table 3** Survey items

We conducted a questionnaire survey as shown in , and estimated energy consumption by use, based on energy consumption by type and other information. Heat conversion factors used were

Electricity: 3.6MJ/kWh	Charcoal: 30.5MJ/kg
LPG: 47.3MJ/kg	Firewood14.4MJ/kg
Kerosene: 40.4MJ/kg	Gasoline:32.78MJ/l
Coal: 26.9MJ/kg	

Fig. 2.. Energy Consumption by use



: Energy consumption by energy type and use

Fig. 2 shows yearly energy consumption per household. The outer circle is divided by type of energy source, and the inner circle by energy use. In Bangkok, Ho Chi Minh, Hanoi, Yearly total energy consumption per household is around 20 GJ for each area. Electricity occupies 80 to 90 % of total energy consumption. In Phnom Penh, energy consumption is less than in other urban areas, 13.3 GJ and electricity occupies half of that. Bangkok consumes electricity as much as Ho Chi Minh, and it is 7% bigger than Hanoi. Hanoi uses the largest amount of LPG and other fuels of the 4 urban areas. It is 2.2 times higher than Bangkok, and 1.4 times higher than Ho Chi Minh. In all areas electricity is the largest part of energy consumption, but the percentage differs area to area. In rural areas of Thailand and Vietnam, total energy consumption is about half of urban area, especially, electricity use is less than half of urban area. In rural Vietnam, they uses more LPG and other fuels than other areas. In rural areas of Vietnam, and Cambodia, "other" energy consumption e.g. charcoal and firewood is greater than in other countries.

Focusing on use, cooling occupies 12% to 19% in the urban area, 4% to 11% in the rural area. Ho Chi Minh consumes most. According to an interview survey in Hanoi, cooling period is less than half of other areas (Hanoi: 5 months, Bangkok and Ho Chi Minh: 12 months), but prevalence of air conditioning is 90%, and average number of holdings is 1.5. This is much higher than Bangkok, Ho Chi Minh, Phnom Penh.

Energy consumption by family group

Income

The more income increases, the more energy consumption increases. Especially, high income household uses more electricity for cooling and appliances. It shows strong relationship between income and energy consumption.

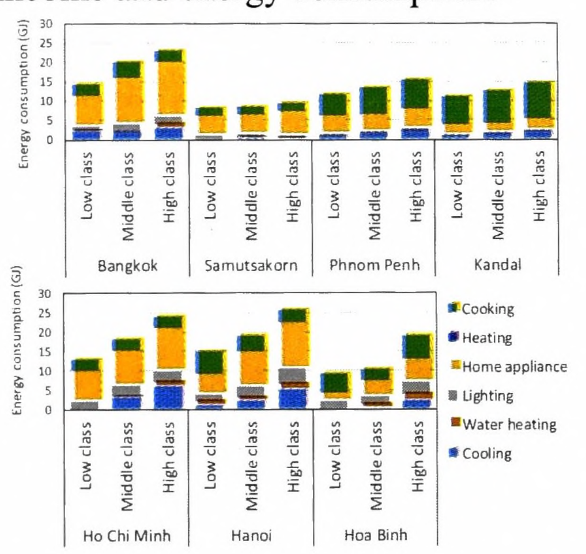


Fig. 3. Energy consumption and income

Ownership of Air Conditioners

Air conditioned households consume 60% to 90% more than non-air conditioned households. It shows that using air conditioner strongly influence electricity consumption.

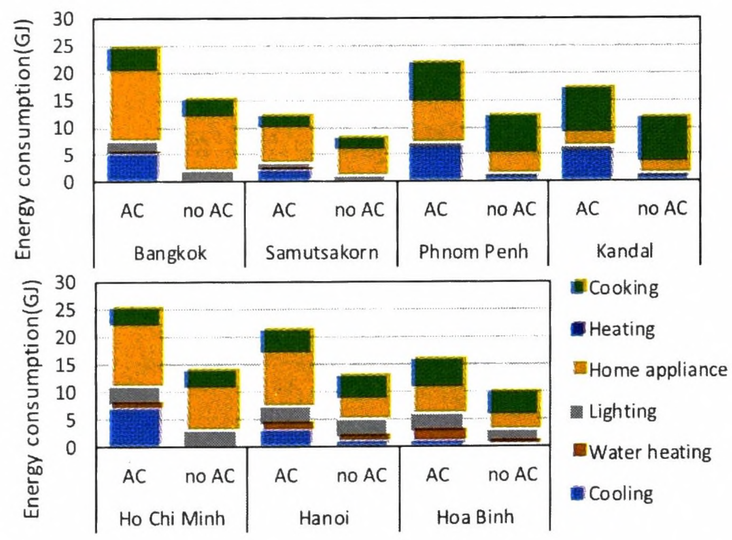


Fig4 Energy consumption and ownership of AC

Adopted Energy saving action

We defined 15 energy saving action as follows. The rate of energy saving action shows the percentage of households which answered "We do this" for each action.

a. Reduce the brightness of the television
b. Switch off power on television set when not in use
c, Do not leave the refrigerator door open
d. Try not to put too many things in the refrigerator
e. Refrain from using the air conditioner
f. Keep the temperature setting of the air conditioner higher than the comfortable level
g. Try to turn lights off when leaving a location, even for a short time
h. Use a water saving shower head
i. Shorten the time of using showers
j. Try to take cold instead of hot showers
k. Reduce number of times washing machine is run.
l. Try not to use the keep-warm function of the electric rice cooker
m. Turn off power of PC or switch to low-power mode when not in use
n. Fill pots and kettles with the optimal amount of water when boiling
o. Try to drive in a fuel efficient manner such as accelerating automobiles and motorcycles slowly

The relationship between energy-saving action rate and energy consumption is shown in **Error! Reference source not found.**. Except for Bangkok, there is no relationship between energy-saving action rate and energy consumption.

Utility costs

Error! Reference source not found. shows the monthly utility costs. The average of monthly utility costs in rural area is about half of urban area in each country. Table 4 shows the percentage of utility costs in family income. As can be seen here, in Cambodia, the percentage is 9.8 % in urban area, and 7.6% in rural area. This is the highest compared with the other two countries. Possible reasons for this are: firstly, high electric bill in Cambodia because of import of electricity. Secondly, when they use LPG, they often use more cassette bomb because of convenience although unit price is higher than that of gas cylinder.

Monthly energy consumption

Fig.7. shows the monthly energy consumption and temperature. In Vietnam, monthly fluctuation of energy consumption is the largest in the three countries. The reason is the big change in climate is hot all throughout the year, and it has three seasons: Rainy season (June to October), Dry season (November to February) and Hot season temperature, especially in Hanoi. In Thailand, the

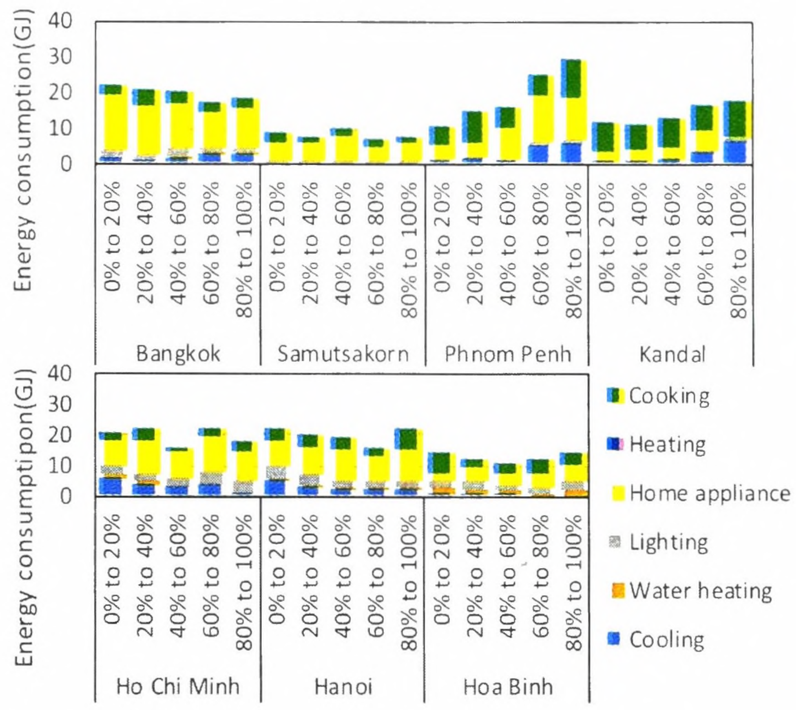


Fig. 5. Energy consumption and energy saving action

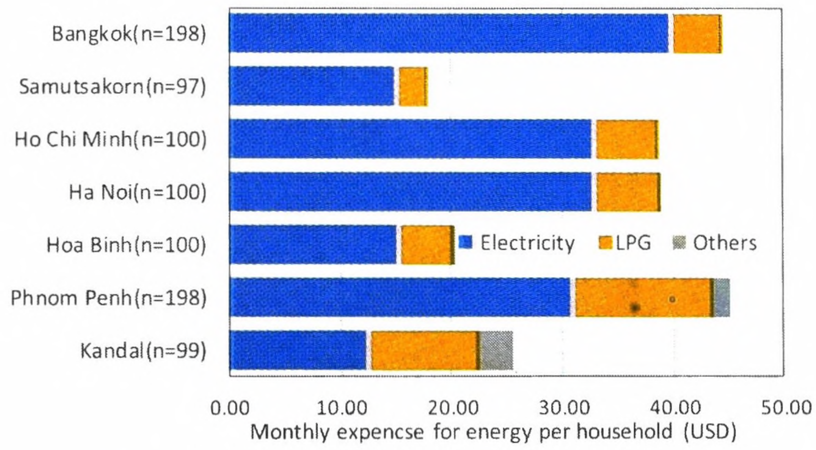


Fig. 6 Monthly utility costs

Region	Monthly Income(USD)	Monthly Utility(USD)	%
Thailand (urban)	1,258	44	3.5
Thailand (rural)	733	18	2.4
Vietnam (urban)	546	39	7.1
Vietnam (rural)	367	20	5.5
Cambodia (urban)	458	45	9.8
Cambodia (rural)	400	25	7.6

Table 4. Percentage of utility costs in income

(March to May). In Bangkok, electricity consumption is less in January and February when temperature and humidity are relatively low. The same tendency is seen in Phnom Penh. In Ho Chi Minh, electricity consumption increases from the hottest month, April, and is highest in May. During the dry season (November to March), energy consumption gradually decreases and February is the lowest. The reason why energy consumption in February is the smallest is that many people go to their home villages for Tet, the lunar New Year. Also in Hanoi, February has the smallest energy consumption excluding heating. In general, the energy consumption is least in the dry season, and highest in the rainy season.

Satisfaction for the thermal environment

Except in the rural area of Thailand (Samutsakorn), 60% to 90% of people are satisfied with their room temperature (Fig. 8). In generally, households with AC have a tendency to be satisfied with their room environment. In Samutsakorn, many people are not satisfied even if they have air conditioners. In Cambodia, having AC strongly influences satisfaction for thermal environment.

Conclusion

This paper reports an overview of the environmental database, BELDA. Energy consumption data and other significant information were collected from 900 households of three Southeast Asian countries, Thailand, Vietnam, and Cambodia and the number of valid data is 892. The report is a first brief analysis of using BELDA. We shall make more effort to find evidence that it works as a good measure for determining policy in each country.

In 2016, we are making two more surveys in these countries, one, a detailed measuring survey on electric home appliances and the other, an interview survey focused on lifestyle and future prediction.

These results will be available in BELDA soon. We are hoping that many researchers and policy makers will access our database, and provide their own data and information to share for a sustainable future

This research was supported by the Research and Technology Development Fund (1-1502) of the Ministry of the Environment, Japan. We would like to thank people who offered us their information.

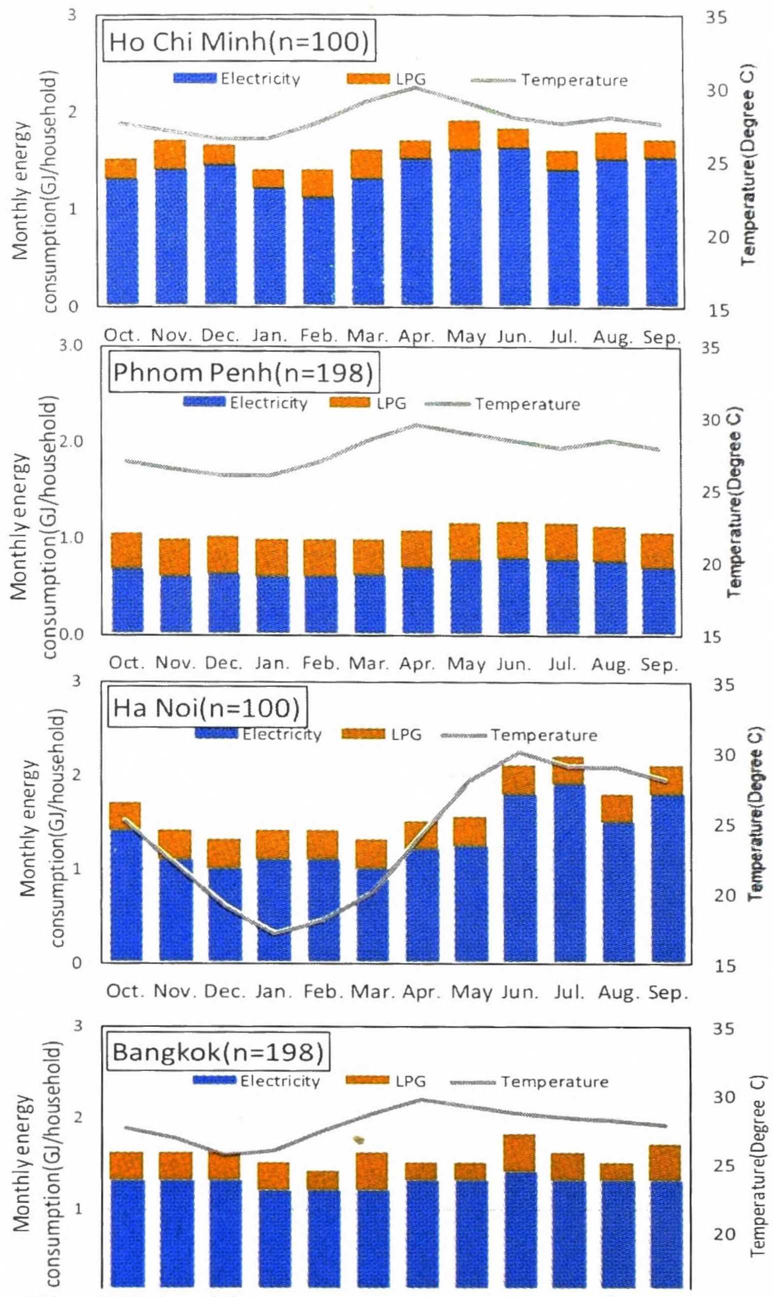


Fig. 7. Monthly energy consumption and temperature

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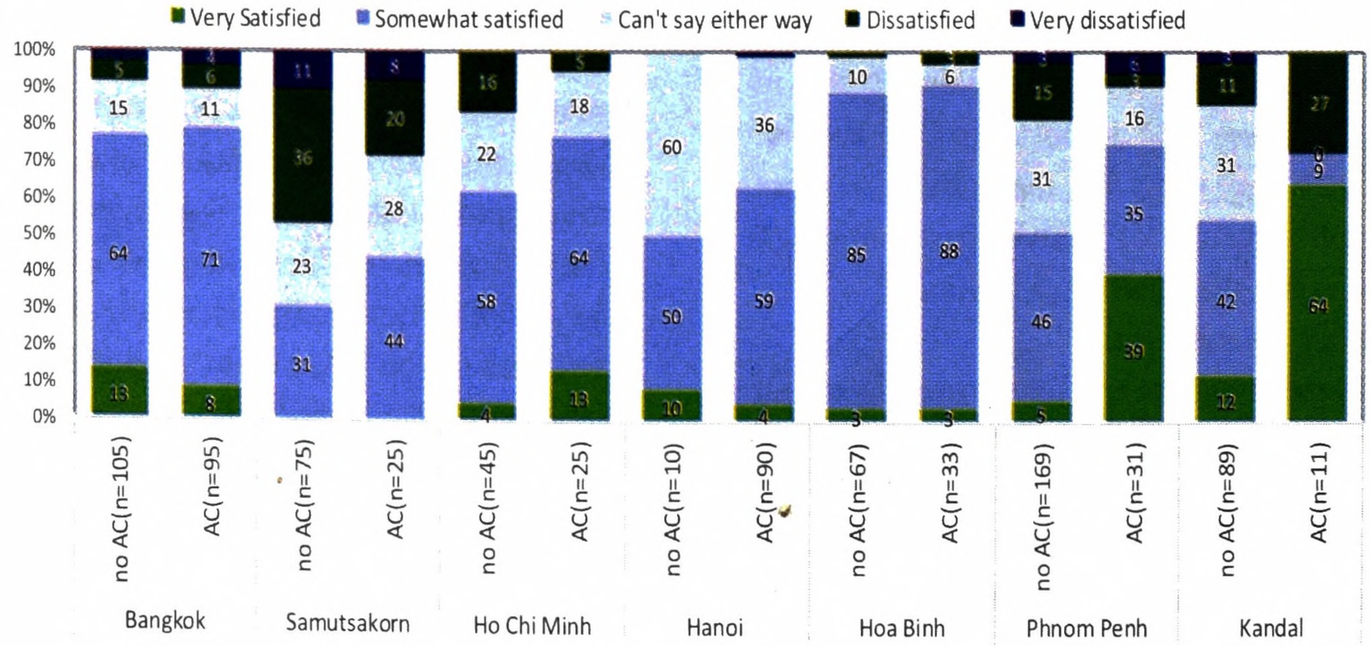
Fig. 8 Satisfaction for thermal environment



Production of algal based semi solid fuel as a renewable energy source

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Abstract

The focus of this study was to develop and examine the best methods of converting algae into different types of bio fuel. The algae were cultivated in a pond system. For rapid growing of different type of algae, nutrients were supplied by applying leachate, which was collected from Gohagoda dampsite. Five experiments were conducted. Of the algae fermented, *Aspergillus niger* gave a better yield than *Saccharomyces cerevisiae.* The slurry was distilled and a bioethanol stream was produced. To increase the ethanol content, it was double distilled. The CO_2 produced in the fermentation was sent through the pond to maximize algal production. For the esterification process, lipid was extracted from slurry using a Soxlet apparatus. Extracted lipid was heated to around 100°C in ethanol/methanol media with sulfuric acid as a catalyst. After cooling, the solution separated into biodiesel and glycerin. Due to the low density of glycerin, biodiesel could be separated. It was tested with the blowlamp and plate test and the flame length measured. A mass balance was done to provide recommendations.

Blowlamp gave flame lengths and widths of 18-19cm and 1.6-1.8cm for bioethanol and 24-25cm and 2.8-3cm for biodiesel, respectively. Mass balance showed that the 0.4982 ml of bioethanol and 0.6071ml of biodiesel were obtained from one gram of algae. Hence, at least 18-20 l of biodiesel per day can be produced while treating the leachate in the Gohagoda dumpsite.

Introduction

The need of energy is increasing continuously, because of increases in industrialization and population. Fossil fuel is a mostly important source used in the present world. The sources of fossil fuel are infinite and development of environmental friendly renewable energy sources is vital. To overcome these issues, much research is being undertaken to generate energy from renewable energy sources. Bioenergy is one of the most important components for mitigation of greenhouse gas emissions and substitution of fossil fuels. Biomass has been focused on as an alternative energy source, since it is a renewable resource and it fixes CO_2 in the atmosphere through photosynthesis. A variety of biomass from different sources have been investigated as the feedstock for the production of different biofuels including biodiesel, bioethanol, biogas and hydrogen. It has been reported that biodiesel from canola and soybean, palm, sunflower oil, algal oil are good diesel fuel substitute. Global production of biofuel has been growing rapidly in recent years, more than trebling from about 18 billion l in 2000 to about 60 billion l in 2008. According to the OPEC World Oil Outlook, liquid biofuels account for about 0.28% of total energy demand and about 1.5% of transport sector fuel production but is concentrated in a small number of countries.

Of the biomass, algae (macro and microalgae) usually have a higher photosynthetic efficiency than other biomass. The production of biofuel from microalgae has gained considerable attention as they can be converted into several different types of renewable biofuels such as green diesel, jet fuel, methane biogas, ethanol, and butanol. Therefore production of biofuel from algae is not new. Also it contributes around 40 to 50 percent of the oxygen in the atmosphere and simultaneously consumes carbon dioxide to grow without additional carbon sources. Microalgae grow quickly and contain high oil content compared with other terrestrial crops, which take a season to grow and only contain a maximum of about 5 percent dry weight of oil. Oil content of microalgae is usually between 20 and 50 percent but some strains can reach as high as 80 percent. Therefore microalgae have become the focus in the algae-to-biofuel arena. Many engineering firms and research institutes of different countries in the world have already conducted research to generate different types of algae based liquid fuel from fresh and marine algae. There are few basic methodologies to extract oil from fresh water and marine algae, which are used by several countries and scientists.

In Sri Lanka, biomass (47%), hydropower (8%) and petroleum (45%) are the main energy resources. Thus indigenous, renewable sources of energy provide 55% of the national primary energy needs. All petroleum products are imported, and used for transport, electricity generation, household, commercial and industrial requirements. The main indigenous primary energy sources of Sri Lanka are biomass and hydro electricity. The next promising primary energy source would be modern biofuel and wind energy. But very little literature is available on current research on materials such as biodiesel derived from different macroalgae. This study was focused on developing a sustainable algal based semi solid fuel as a renewable and alternate source of energy so as to combat the national energy crisis while protecting the environment. Leachate collected from Gohagoda landfill site was utilized to make culture media to ensure the supply of nutrients for rapid growth of algae. This would also help to provide an environmental friendly solution to the problem of the polluting effects of leachate.

Materials and Methods

The algae were grown in a simulated activated sludge process (ASP) and pond system. Transparent plastic bins of 50 l volume were used as the reactors as open algae growing ponds. 10 l of leachate used to fill these reactors and another 10 l of fresh water mixed into each bin. 10 l of algae sample was added into open pond, which was collected, from an abundant lake and a pond at University of Peradeniya. The aeration supply was through an aerator intermittently. Algae growing reactors were maintained for 15 days and the algae were harvested thereafter by centrifuging at 7,000 rpm for 3 minutes to get the maximum harvest.

Production of Algae based Bioethanol

200mL of harvested algae slurry was put into a 5 l plastic container and 2g of *Aspergillus niger* was added. The container was closed and allowed to ferment for 36-48 hours. The CO_2 and other gases produced during fermentation were directed into the algae growing reactor. Five replicates were made. The same procedure was used for *Saccharomyces cerevisiae.* The fermented algae slurry mixture was distilled and the ethanol vapours produced were condensed.. In order to increase the ethanol percentage in the biofuel, it was distilled again.

Production of Algae Based Biodiesel

Lipid was extracted from the centrifuged wet algae biomass was used to lipid with hexane using a Soxlet apparatus.. The extracted lipid was mixed with 450 ml methanol and 10 ml 5% NaOH and heated in a water bath at 60-80C for 10 minutes. Then 1 ml conc.. H_2SO_4 was added to the solution as catalyst and the mixture heated to 80-100C and kept thereat for 15-18 min. The mixture was allowed to cool to room temperature. After esterification, the solution separated in to two layers of biodiesel/ methylester and glycerin. After removing glycerin, pure biodiesel was obtained.

Determination of Combustion Characteristics of Produced Fuel

Direct combustion of algae as a semi-solid fuel was tried using fabricated nozzles for injecting fluidized slurry of mixed fuel. The slurry consisted of bio ethanol and biodiesel were tested for blowlamp and plate test to measure flame length. A density meter (Thermo Scientific, model Orion 44) was used to measure the density of the fuel samples. An adiabatic calorie meter was used to measure the calorific value of dry algae, bioethanol and biodiesel.

Chemical Analysis of leachate

The leachate that was used for growing microalgae as well as micro algae medium before harvesting and after harvesting were analyzed for pH, Conductivity, Salinity, Total Dissolved Solid (TDS), Total Solid (TS), Total Suspended Solid (TSS), Volatile Solid (VS) and Volatile Suspended Solid (VSS) using standard methods.

Results and Discussions

Leachate is rich in nutrients and different cation and anions and a very good substrate for both phytoplankton and zooplanktons. Therefore, leachate is one of the best media that can be used to grow micro algae artificially[11]. Hence, in this study, initially leachate without any additives was used as the growing media for the algae. The quality of used leachate is given in Tables 1A. and 1B. The TDS concentration of the leachate/algae growing media was significantly reduced (Table 1B).

Bioethanol Production

The Table 2 shows the variation of bioethanol yield with *Saccharomyces cerevisiae* and *Aspergillus Niger* as fermentation substrates. The volume of bioethanol yield was increased with *A. niger* media than *Saccharomyces* substrate. The ethanol produced was distilled twice to enhance bioethanol concentration and density was foun to be 0.890 gcm^{-3}. Conversion percentage of algae biomass to ethanol with *S cerevisiae* and *A. niger* was 43.92% ± 5 and 47.1% ± 6 on a wet basis.

Highest ethanol production of ***A. niger*** was 54.3 % ethanol (w/w) with lignocelluloses biomass in 48 hours. The highest ethanol production of ***S. cerevisiae*** was 47.8 % ethanol (w/w)[12].

Biodiesel production

Biodiesel production is based on transesterification reaction. Biodiesel is a mixture of fatty acid alkyl esters obtained by transesterification of fatty acids. These algae lipid feedstock's are composed by 90-98% (weight) of triglycerides and small amounts of mono and diglycerides. Average biodiesel yield was 59.65% ±1 on weight basis (Table 3). Wet algae biomass recovered to 54.03% ±6 on weight basis. Density of the biodiesel produced was 0.880 gcm^{-3}. Since the moisture content of the harvested algae is 80%, about 3,624g of lipid can be recovered from 1Kg of dry algae while 2,428mL of biodiesel can be produced from 1 Kg of dry algae.

Combustion Characteristics of produced fuel

Some combustion characteristics such as flame color, flame length and calorific value were studied and applied to develop semi-solid fuel, bioethanol and biodiesel. Flame color and temperature of a flame are dependent on the type of fuel involved in the combustion. Fluid mixture, having 1:1 ratio of Algae slurry: bioethanol and biodiesel was combusted separately using plate test. Table 4 shows the characteristics of the mixed semi solid fuels. Extracted biodiesel and bioethanol were combusted separately by using different types of pressurized burner nozzles. Pressurized air line was connected to a compressor under controlled conditions. Bioethanol and biodiesel were combusted by using a blowlamp. Both gave a horizontal clear flame. The length and width of the resulting horizontal flame were measured. Blowlamp gave flame lengths and widths of 18-19cm and 1.6-1.8cm for bioethanol and 24-25cm and 2.8-3.0cm for biodiesel.

Conclusions

In the absence of any measure to characterize the combustion of the slurry, plate test was used and gave positive results. It was compared with mixed slurries with algae based bioethanol and algae based biodiesel and with the known fuel petro diesel. The mixed fuel was given flames when composted in a blowlamp. The performances were acceptable with well defined flame characteristics of lengths and widths. Blowlamp gave flame lengths and widths of 18cm-19cm and 1.6cm-1.8cm for bio ethanol and 24cm-25cm and 2.8cm-3cm for bio diesel, respectively. Mass balance showed 0.4982 mL of bioethanol/g of algae and biodiesel, 0.6071mL/g of algae. Hence, at least 18-20 L of biodiesel /day can be produced while treating the leachate in Gohagoda dump. Converting algae to bioethanol and biodiesel gave comparative yields. Applying leachate as a nutrient source for algal growth it could reduce the cost of treating landfill leachate. Future studies should be focused in most effective, efficient and low cost in order to simulate micro algae harvesting methods for large scale plant.

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Table 1A: pH, Salinity and Conductivity, **Table 1B:** Total Dissolved Solid (TDS), Total Solid (TS), Total Suspended Solid (TSS) of A. leachate, B. algae growing medium and C. effluent after harvesting algae

Trial	pH			Salinity (%0)			Conductivity (ms)		
	A	B	C	A	B	C	A	B	C
1	7.76	7.56	7.43	9.8	7.2	6.2	16.99	15.36	15.2
2	7.76	7.9	7.36	10.6	6.7	5.9	18.19	16.89	15.12
3	7.61	7.64	7.95	9.2	6.5	6.2	15.76	14.67	12.98
4	7.59	7.53	7.98	9.8	6.3	5.3	16.73	14.98	11.97
5	7.8	7.21	7.15	10.3	5.95	3.93	17.62	12.9	10.25

Trial	TDS (mg/l)			TS (mg/l)			TSS (mg/l)		
	A	B	C	A	B	C	A	B	C
1	10,700	3,300	2,560	7.366	7.126	5.895	1	0.75	0.6
2	10,100	2,850	2,340	9.445	8.943	7.367	0.82	0.74	0.67
3	10,800	2,660	2,190	9.564	8.544	6.947	0.652	0.592	0.51
4	11,200	1,920	1,450	8.332	-	-	-	-	-
5	10,500	1,740	1,270	8.967	-	-	-	-	-

Table 2 Comparison of bioethanol production

Replicate	Ethanol yield/ kg of algae (wet basis)				Ethanol yield/ kg of algae (dry basis)			
	S. cerevisiae		*A. niger*		*S. cerevisiae*		*A. niger*	
	(ml)	(g)	(ml)	(g)	(ml)	(g)	(ml)	(g)
1	492	433	520	461	2,460	2,165	2,600	2,306
2	500	442	530	467	2,500	2,210	2,650	2,334
3	492	433	540	476	2,458	2,163	2,700	2,379
4	505	446	535	471	2,525	2,230	2,675	2,355
5	503	443	545	481	2,513	2,213	2,725	2,404
Average	498	439	534	471	2,491	2,196	2,670	2,356
Standard deviation	±5	±5	±8	±6	±25	±25	±39	±31

Table 3 Biodiesel productions/Kg of algae(wet basis)

Replicate	lipid amount (g)	Biodiesel (ml)	Biodiesel (g)	Lipid to biodiesel %	Biomass to biodiesel %	Lipid to diesel %
1	907	598	532	58.62	59.75	65.87
2	901	606	540	59.89	60.63	67.29
3	892	604	538	60.24	60.4	67.68
4	917	612	545	59.38	61.2	66.72
5	911	616	548	60.14	61.57	67.57
Average	906	607	540	60	61	67
Std. dev..	±9	±6	±6	±1	±1	±1

Table 4,. Flame characteristics of produced fuel by using blowlamp test

Parameter	Algae slurry + bioethanol	Algae slurry + biodiesel	Bioethanol	biodiesel	Petro-diesel
Testing method	Plate test	Plate test	Blowlamp	Blowlamp	Blowlamp
Volume (mL)	15mL+15mL	15mL+15ml	30 mL	30 mL	30 mL
Nature of flame	Vertical irregular flame	Vertical irregular flame	Horizontal flame	Horizontal flame	Horizontal flame
Colour of flame	Yellow	blue -yellow	blue + colourless	shade blue +colourless	shade blue + colourless
Length of flame	5.5-7.0cm	7.5-9.0cm	18-19cm	24-25cm	29-30cm
Width of flame	1.2 -1.5cm	1.1-1.3cm	1.6-1.8cm	2.8-3cm	3.4-3.6cm
Flame tempera. (Cumber et al., 1992)	Yellow at 1,000° C	Blue flame at 1500°C	Colourless flame at 2500 °C	Colour less flame at 2500°C	Colour less flame at 2500°C
Time duration of flame(s)	70-80	80-90	170	190	205