



Prospects of Waste to Energy in Institutional Buildings

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Abstract

Waste and Energy have cohabited for a very long time as electric energy come from fossil fuels which invariably is from waste. The quantum of electric energy harnessed for development most especially in the developing Nations has remained very low. There has also been a growing desire by Nations to opt for alternative energy, with this eminent treat our Colleges and Tertiary Institutions are not left out of this quagmire. It is why this study investigated the waste to energy management and generation on yelwa campus of Abubakar Tafawa Balewa University Bauchi, as a prospect of waste to energy in institutional buildings, through a questionnaire adoption and chi-square analysis; from the findings, the available facilities for the collection and disposal of the wastes were inadequate, which resulted in the personal management of wastes by individuals in the community who either dispose such wastes in unused septic tanks, old and unused reservoir(s) and in some cases indiscriminately in open space within the campus finally, about 27.82 tons of waste is generated annually from five faculties and suggested the adoption of a viable option of converting this generated waste to usable energy.

Key words: Waste, Energy, Campus, Alternative, Generation

1 Introduction

Conventional fuel needed in production had been missing or unattainable. Natural resources through fossils form the bulk of electric energy [1]. The bulk of the productive activities of people depend on electrical energy.

Developing countries find it difficult having enough electricity to cater for their demands more so, in institutions where such energies are on high demand if not profoundly desired to run consistently the Administrative and Class activities.

Numerous alternatives are on the prowl for alternative source of energy to compensate for the shortages from grid. In a study of energy alternatives in Sweden [2], an ability to run energy plant from waste generated electricity since 2007 with over 13.7Twh recovered through waste with 12.2Twh as heat and 1.5Twh as electric and supplied 250,000 houses with electricity and heated up to 810,000 this has been predicated from drift in population activity between 1975 to 2007 through an efficient waste management means while in Bangladesh, [1], posit it that waste materials can be a new source of energy. Hence campuses around developing nations can look into implementing such alternatives in terms of small energy service as the situation demands. It should be noted that since electricity is a product of waste, clean energy can be from landfills and

with a good management solution from waste on campus community, it can enjoy good electric energy service powered by waste [3] Local energy plant source may include High proportion of impurities (plastic, wood, metal), high dry matter, heterogeneous substrate composition, seasonal variation in composition.

It should be noted that these waste can come in the form of dry waste – organic solid, green matter and solid manure with up to 60% dry matter content [3]. Waste is made every day from leaves. Some are recyclable while others are not. This in general can include municipal solid waste (MSW) Construction and Demolition (C&D) debris, Agricultural waste, Livestock and Industrial waste. This study investigated wastes management in institutional building, in ATBU Yelwa Campus and found that 27.8tons of waste is annually generated from the faculties; no experts are involved in the collection transport and reuse or recycling of this waste so generated. In fact the wastes are allowed to fallow in an open field manner with a complete absence on how it can be converted to produce energy for the campus. Appendix 1 gives a pictorial representation to the manner in which the waste are dumped (open dump and reservoir). Principally it has been recognized that the most environmentally friendly approach to combat the challenges and problems associated with solid waste is by the adoption of the integrated waste management: reduction, recycling, reuse and effective treatment with an ultimate disposal in environmentally acceptable strategy. Waste to energy option is considered to be one of the most effective ways of final disposal [5].

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Waste in institutional buildings could be defined as by-products of production processes and human activities which must of necessity be generated. According to Pohjola, (1998) in [6], wastes are unwanted things, whose creation was not the initial intention but not avoidable and have no purpose to the persons that created them. He opined that wastes are things that were given a finite purpose, thus destined to become useless after fulfilling it. And could be things with well-defined purposes, but whose performance ceased being acceptable due to a flaw in their structure or state or things with well-defined purposes, and acceptable performance, but their users failed to use them for their intended purposes. [7] argued that, 'from the laws of thermodynamics, the production of wastes is concomitant of a main production process and that industries have to look beyond their factory walls, and seek for external utilization of their waste, in accordance with the principles of Industrial Ecology'. The argument here is that wastes are necessarily products of all production activities that deal with solid and liquid substances. In other word, to create an aesthetic environment for example, one has to plant flowers and cut the lawn from time to time. Even the flowers that are planted must be trimmed from time to time. Where new equipment is to be used, the wrappers and materials used for encasing it must be removed. All these activities generate wastes in an institutional environment.

Equally, Odebunmi, 2001 in [8] agreed that waste generation has become an aspect of the living and cannot be banished but only be managed. Accordingly, wastes to energy consist of any waste that can be treated and generate energy in the form of electricity, heat, or transport [9]. This goes to cover Sludge Liquid and gaseous waste with the most common of them as municipal solid waste. While the generation has many factors that could be responsible amongst this is public habit, local climate, industrial and economic development.

In Nigeria, fossil burning for electricity has been the mainstay, as such any situational change along this source will directly affect the energy supply of the Nation, more so with the dwindling faith of the fossil burning for energy and a consequent global warming, and an alternative will suit the study area [10]. In the case of Abubakar Tafawa Balewa University, (ATBU) Yelwa campus, notable wastes generation is associated with multidimensional activities. These included among others the need for creation of aesthetic environment, constructions of buildings, commercial activities and other such acts that lead to unwanted by-products.

Unlike community wastes that could be said to be extremely heterogeneous mixture of constituents that appears to vary according to seasons, Waste generation in institutional buildings could be said to be fairly constants since such wastes revolve round solid constituents mostly. Conceptually, solid waste is any solid material which is discarded by its owner, user or producer who in the case of institutional buildings, are the officials occupying the offices where such wastes are generated. A clear appreciation of the quantities and characteristics of the waste being generated is a key component in the development of robust and cost-effective solid waste

energy management strategies. It is to the advantage having of any built environment particularly developing countries having an environment that will have an effective waste management particularly through conversion to energy as it will enhance good service, cooperation in waste management will become necessary, resource waste will be minimized and a reduction in emission of hazardous substances [2].

2 Research Methodology

The research design for this study is the descriptive approach. It used the survey method to find out the perception of the population on the prevailing phenomenon. It established facts from existing conditions and proposes solutions to the observed phenomenon. It is purely based on aggregation of facts observed from expressed opinions since the possibility of experimentation would not be feasible within the study period.

The main instrument of the study is the questionnaire method as it can cover large population distributed within a wide area and compatible with most sampling techniques. The design is an efficient means of gathering large amount of information to improve on existing phenomenon [11].

The study area is the Abubakar Tafawa Balewa University (ATBU) located in Bauchi state Nigeria. The population for this study consisted of staff, students and commercial operators within the Faculty Areas and the student Hostel Environment for ease of questionnaire administration at the Yelwa Campus of the ATBU Bauchi. Random sampling procedure was used in selecting the sample size used in the study. In this approach the designed questionnaire were administered randomly on the target population (offices, classes, hostels and the commercial areas). The use of the random procedure allowed for equal chances of representation within the population [11]. Field observation was also used.

The data collected was analyzed using summary statistics such as frequencies and percentages for the demographic characteristics of the respondents. Also the mean and standard deviations were used in the analysis of the variables for the assessment of wastes management sections. The hypotheses tested the inferential statistics; this included the Chi-square procedure which established the significance of association between the investigated variables as they relate to wastes management on the campus. All hypotheses were tested at the probability level of 0.05.

3 Results and Discussion

Though Two hundred (200) respondents was the sample size proposed for the study but only 193 successfully provided the required information in the administered instrument, representing a total of 96.5% of the population sampled. This paper dealt mainly with the aspect of waste generation as gotten from the research to suggest viable means of utilizing such waste for energy generation on campus. The socio-demographic characteristics of the respondents was considered to have association with their opinion on the management of wastes on campus are place of residence, sex, type of occupation

and their duration of stay in the campus. Among the personnel data 60.1% of the total population was residing off the campus while 39.9% resides within the campus. In the analysis of the remaining demographic characteristic, this variable was used to distinguish the respondents respectively. In figure 1, the respondents are classified along their gender with the status of their residential location by staying on or off campus.

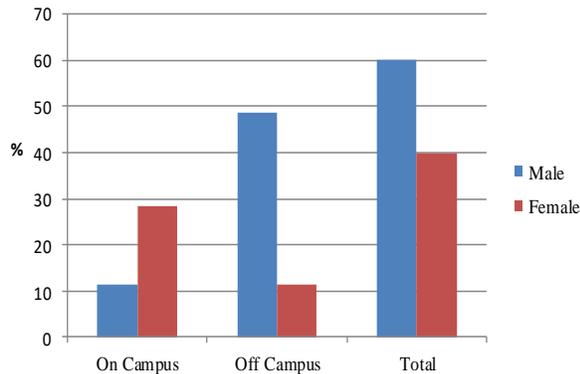


Figure 1: Classification of the respondents by location and gender. Source: Field survey 2012.

The figure revealed that of the 116 that resided outside the campus, 11.4% of the respondents were male while 28.5% were female. For the 77 that resided in the campus, 48.7% were male while 22 or 11.4% were female. In the overall classifications, 39.9% of the respondents were female while 60.1% were male. The study could therefore be said to involve all persons within the campus in terms of gender affiliation. However the total resident number on campus is 39.9% while those off campus amount to 60.1% of the sampled population.

The type of occupation practiced on the campus was considered to be associated with the wastes that could be generated by the respondents. In Table 1, the respondents were classified along their residential locations and occupation on the campus.

Table 1: Classification by location and occupation in the campus

Occupation	On campus %	Off campus %	Total %
Student	25.4	45.1	70.5
Staff	11.9	10.9	22.8
Business on campus	0.5	4.1	4.7
Residing on campus	2.1	0.0	2.1
Total	39.9	60.1	100.0

Source: Field survey 2012

The distribution in the table revealed that 70.5% of the respondents were students. Of this total 25.4% were residing within the campus while 45.1% were living outside the Yelwa campus.

The total number of the respondents who were staff of the university made up 22.8% of the total respondents from, 11.9% live within the campus while 10.9% of the total respondents were residing outside the campus. Those doing

business, represent 4.7% of the respondents doing businesses on the campus, only 0.5% is residing inside the campus. The remaining 4.1% of the total respondents usually come from outside the campus to do their businesses. 2.1% of the respondents were not engaged in any form of occupation. They were merely residents within the campus.

Duration of stay on the campus was considered to be of importance in this study because of the experience of wastes management that could be associated with it. In Table 2, the respondents are classified by their location of residence and duration of stay in the campus.

Table 2: Classification of the respondents by years of stay

Duration of stay on campus	On campus %	Off campus %	Total %
Below 1 year	6.7	3.6	10.4
1-3 years	18.7	13.5	32.1
Above 3 years	14.5	43.0	57.5
Total	39.9	60.1	100.0

Source: Field survey 2012

Table 2 revealed that 10.4% of the total respondents have not stayed beyond or up to one year on campus. However, 32.1% of the respondents have been staying on campus for between 1 and 3 years. Most of the respondents 57.5% have been on the campus for more than three years. This distribution means that the respondents could be expected to have stayed long enough on campus to know the problems of wastes system since in most cases they would be directly involved through their activities as revealed in Table on types of waste generated

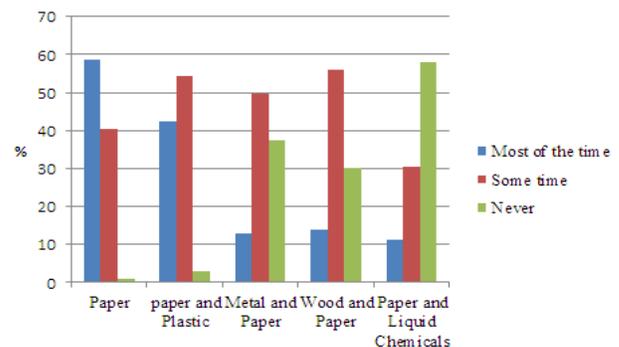


Figure 2: Respondents' opinions on the types of wastes generated on the campus based on activities. Source: Field survey 2012

Following the expressed opinions of the respondents in the table, paper wastes accounted for the highest generated material waste from the various activities on the campus. This is clearly demonstrated from the percentages in item 1 to 6 in figure 2 above. In item 1 for example, 58.5% and 40.4% of the respondents were of the opinion that most of the time and sometimes that paper wastes mostly accompany their activities on the campus. Only 1.0% of the respondents said they do not generate paper wastes from their activities. While item two (2) captures 42.5% and 54.4% of the respondents expressing same opinion but

included plastic as some of the wastes they generate, equally from item three (3), 13.0% and 49.7% of the respondents included metal and papers as the wastes they generated. In item 4, 14.0% and 56.0% added wood among the paper wastes they generated. Next to paper wastes as indicated in the table is plastic. This is seen in the distribution for item 2 of the table. Apart from paper, other wastes as indicated in the table are metals, wasted water and liquid chemicals. These wastes generally require different approaches in their management. However from the observed discarded components of wastes in the Faculty of Environmental Technology as well as the administered questionnaire for a semester and by personal observations, and estimate on Table 3, gives the values of the wastes were estimated using a weighing balance. Agricultural waste seemed to be the highest component of waste generated by the activities, hence revealing equally that waste generation within the campus goes with seasonal activities. Other types of waste measured include paper with the next highest value and plastic and metal having the lowest value.

The percentage of each component was computed on the estimated total weight of the wastes measured. This estimate was then used to extrapolate the amount of waste generated throughout the five (5) faculties within the campus including Faculty of Science, Faculty of Management Sciences, Faculty of Vocational and Technical Studies, and the Faculty of Engineering and Faculty of Environmental Studies.

Table 3: Estimated components of wastes disposed Kg/day

Type of wastes	Weight in kg/day	Percentage
Biodegradable wastes	56.36	50.1
Paper	39.16	34.9
Plastic/metal	16.88	15.0
Total	140.50	100.0

Source: Field survey 2012

It also goes to say that an estimated waste generation from the five faculties annually is put at 27.82tons. These wastes generally require different approaches in their management. However an integrated design could be actualized in the processing of waste to energy conversion and can harness this waste for local energy generation (through recycling).

The types of facilities the respondents identified as available for the collection of waste is found in the figure below.

Among the facilities identified in figure 3, only 22.3% of the respondents said they have access to incinerators. Though 32.6% of the respondents could not answer the question but the dominant answer given or the facilities identified as available could not be associated to effective official provisions. For example 20.7% of the respondents said they made use of old reservoir while 7.8 identified old septic tank and 11.9% identified metal drums. These other facilities generally could not be placed with the official dimension of wastes management.

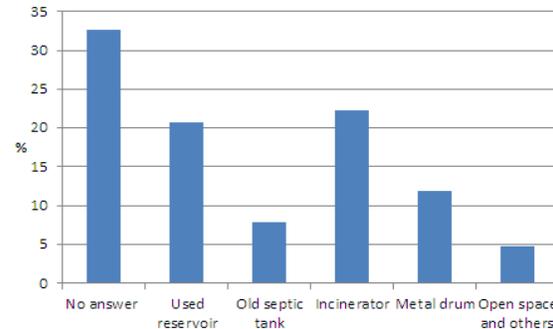


Figure 3: Respondents' opinions on the types of wastes management facilities in the campus Source Field survey 2012

This clearly means that the wastes generators are responsible for their disposal and thus made use of whatever is available to them as long as there are no official prohibitions. This comes to effect because the number due to physical count by the researcher reveals the inadequacy of facilities provided by the management this standing at open dustbins (6), incinerators two (2) and reservoirs two (2). To determine the adequacy of these identified facilities for wastes management in the campus, a cross tabulation of the respondents' occupations in the campus and the type of waste facilities they used was carried out. A test of association was conducted with the Chi-square procedure to establish the association between the two variables.

Table 4: Test of association between occupation and mode of waste disposal

Occupation	Throw it out	In an open dump	In the dustbin	Take away	Total
Students	23.3	10.4	34.7	2.1	70.5
Staff	9.8	6.2	6.7	0	22.8
Business in campus	3.1	0.5	0.5	0.5	4.7
Tenants on campus	0	0	2.1	0	2.1
Total	36.3	17.1	44.0	2.6	100

Pearson Chi-Square = 20.526, DF = 9, P = 0.015 (Significant)

Source: Field survey 2012.

The result revealed that the available dustbins for the collection of wastes in the campus were generally not adequate ($P < 0.05$). The table revealed that 45 or 23.3% of the students and 19 or 9.8% of the staff usually throw away their wastes with no specific goal for collection. Most of the Business respondents 66.6% of them throw away their wastes indiscriminately. Though 20 or 10.4% of the students take their wastes to the designated dumping point but only 67 or 34.7% of them actually make use of the dustbin. This trend is partly followed by the staff with only 67 or 6.7% of them having direct access to dustbin provided in the campus. One observation that is clearly distinct in the expressed opinion is that respondents who reside within the campus actually make use of dustbin or are provided with the facilities. The implications of these observations then

are that among others, the available facilities for the management of wastes in the Yelwa Campus of the ATBU, Bauchi are not adequate.

The study also assessed the level of awareness on campus waste management. The research question formulated to guide this investigation was cross tabulated using the respondents stated occupation. Table 5 presents the awareness of the respondents by their occupations and the types of waste disposal method they adopt in the campus.

Table 5: Respondents' occupations and wastes disposal methods

Occupation	% Wastes disposal method on campus					Total
	Used reservoir	Old septic tank	Incinerator	Metal drum	Open space and others	
Students	39.9	3.1	16.1	8.3	3.1	70.5
Staff	10.9	4.7	3.1	3.1	1.0	22.8
Business on campus	1.6	0.0	2.6	0.5	0.0	4.7
Residing on campus	1.0	0.0	0.5	0.0	0.5	2.1
Total	53.4	7.8	22.3	11.9	4.7	100

Pearson Chi-Square = 23.867, DF = 12, P = 0.021 (Significant)

Source: Field survey 2012

The table revealed that most respondents actually use the most available facilities accessible to them for wastes disposal as long as there are no prohibitions in such usage. This is clearly demonstrated in the table since only 22.3% of the respondents actually make use of the incinerator. Though 11.9% made use of metal drums but these could not be said to be officially sanctioned for such purposes. And the use of old septic tank, used reservoir and open space cannot be official designation for wastes disposals. This could imply a low awareness level on wastes management and the deficiency earlier observed in resources for the efficient management of such wastes in the campus.

3 Conclusion

The research has identified the types of waste generated by the campus community and the management pattern. This is consistent with the report of [12] where it was opined that waste management is given a very low priority in most institutions and as a result, very limited funds are provided for waste management to this sector by the authorities and that the level of services required for protection of public health including the environment are not attained.

Equally these waste when generated are left at the mercy of the generators, meanwhile many more activities are abound on the campus that can contribute greatly to

waste to energy generation particularly the student hostel, restaurants, and administrative offices are good source of waste which when properly harnessed with the quantum generated in the faculties can give rise to an integrated energy option that can warrant a good designed integrated energy plant that will service the yelwa campus of the university sequel to the dart of energy on this campus.

Due to the fact that most architects in this region design and build structures without the slightest consideration of how the waste generated in such structures can be managed, the research therefore recommends that wastes management design be included in the curriculum of study for students in the design/construction inclined courses. This will enable designers designate chutes or other means of efficient waste management during the design stage of any project to avoid the problem of waste management after the completion of the buildings.

Finally our campus and construction activities are generator of waste without standard disposal options rather smaller incineration units or dump points scattered all over and making a nuisance of the campus. Campuses are able to able to recover up to 20-25% of their waste[13] through recycling this will lead to successes in waste to energy though at a community level, it will lead to generation of Electricity for the campus.

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APPENDIX 1: Some plates showing waste dumped on campus



4 Waste dumped in s reservoir



5 Open dump area on campus

6 Open dump area on campus