Journal of Mechanical Engineering Research and Developments
ISSN: 1024-1752
CODEN: JERDFO
Vol. 43, No. 5, pp. 08-16
Published Year 2020

Analytical Study of The Economic Feasibility of Waste Incinerator Investment To Generate Electricity For Dijlah University College In Baghdad

Hamzah D Alobaidi, Mohammed H Alobaidi* Zaid Ali Hussain

Refrigeration and Air Conditioning Technical Engineering Department, Dijlah University Collage, Baghdad, Iraq

*Corresponding Author Email: mohmed_hd2007@yahoo.com

ABSTRACT: The idea of research included investing the thermal energy of municipal waste to generate electric power. This research has done to meet the daily needs of the Dijlah University College of electricity and save the amounts of money, which were spent to buy electricity from the state. Also to save the amounts that were spend in running the diesel generators, when electric power outages from the national grid. This is always happening. The research proved that the establishment of a station to burn 450 tons of municipal waste daily can generate more than 3MW. This electric power covers the total needs of the college for 24 hours per day. The project provides annual amounts of (2310000) two million and three hundred ten thousand dollars annually.

KEYWORDS: waste energy, investment of municipal waste

INTRODUCTION

Today, electric power is the main artery for sustaining life and achieving practical daily demands. Many countries in the world suffer from a severe shortage of electricity production, especially poor countries that do not have natural energy resources such as oil and others, which makes the production of electric power expensive for them and this is reflecting in the purchasing capability of the citizen. Large foundations use electric power at a very large scale and expensive cost. Therefore, many countries and companies resorted to the investment of alternative and renewable energies to meet the needs of electricity. The process of using municipal waste as a source of electrical energy is by burning it and using the resulting heat to generate steam as a kinetic energy to rotate turbines generators. The exploitation of municipal waste as a potential energy gives good material benefits and works as a source of clean energy for electricity. In addition it is a way to eliminate the problems of waste accumulation and avoidance of environmental and health risks. Hence the idea of establishing such a station is to meet the needs of a large scientific institution (Dijlah University College in Baghdad) of electricity and contribute to the completion of cleanliness of the surrounding areas through the continuous disposal of municipal waste and its problems.

Many researchers had been done in the world to invest the municipal solid waste and to save people from its pollution. The average amount of municipal solid waste (MSW) generated in large cities is about 1.7 Kg/ person/ day in small cities the amount is 0.5-0.7 Kg/ person/ day [2]. In this work, the author found the energy potential from an incineration plan average calorific value of 2200 Kcal/ Kg in Malaysia. So for similar citizen city like Baghdad can generate not less than 3 thousand tons of municipal solid waste per day. This is not small quantity so waste, which requires thinking how to make useful output from it.

Mahdi et al. [6] studied the investigation and reviewed sensitivity analysis of different scenarios for choosing an effective and efficient technology using incineration system from municipal solid waste in Iran. Generation of electricity from (MSW) is one of it.

Gulherme et al. [7] studied the incineration of municipal solid waste and the electricity prediction through steam cycles evaluating the influence of (MSW) composition. The (MSW) generated in Santo Andre city, Sao Paulo state, Brazil, was adopted for this study.

Conference paper [8] shows, that the total number of waste to energy plants in the 18 European countries is 455. This paper present the waste to energy plants installed in 10 European cities, which have been selected among the most sustainable cities or among the best cities to live.

THE PURPOSE OF THE RESEARCH

The purpose of the research is determining the economic feasibility of the investment of a waste incinerator with an appropriate burning capacity for municipal waste to generate electricity for covering the needs of Dijlah University College in Baghdad to get electrical energy and material benefit.

THE AMOUNT OF ELECTRICITY REQUIRED PER HOUR TO OPERATE ALL FACILITIES AND BUILDINGS OF DIJLAH UNIVERSITY COLLEGE IN BAGHDAD (DESIGN AMOUNT)

University infrastructure: - Based on the architectural plans of Dijlah University in 2018. The University has the following infrastructure, figures (1) and (2) shows the plans of main buildings distribution of the University (A, B).

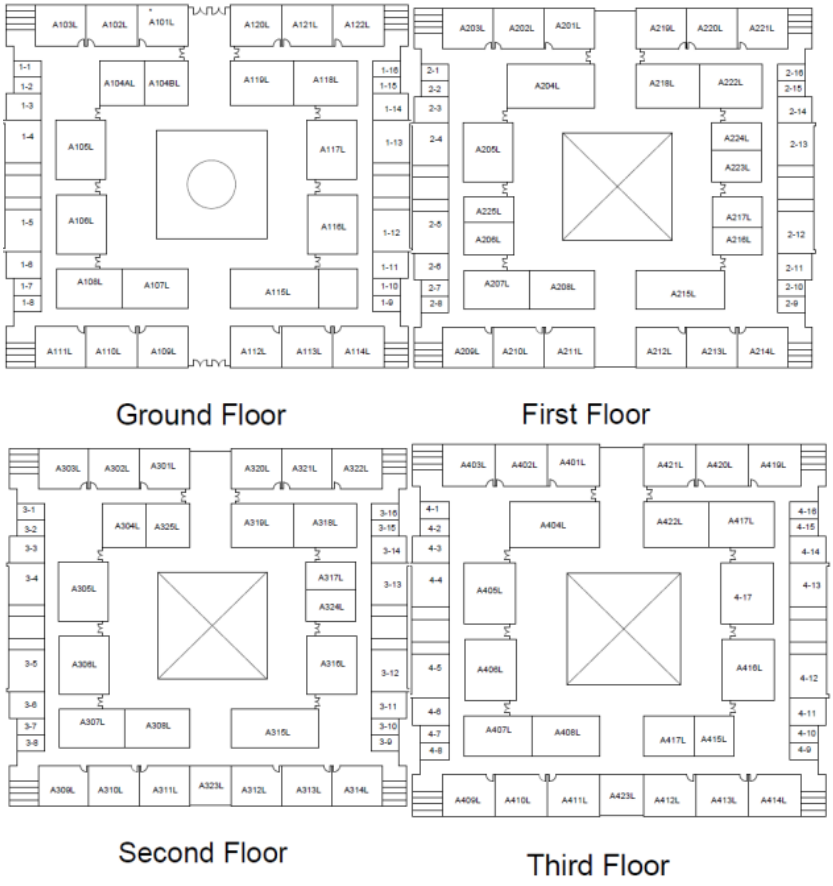


Figure 1. Building A. Plan of scientific departments.

Figure 2. Building B. Plans of Scientific laboratories.

THE DEANSHIP BUILDING

It consists of four floors with a total area of (2140) square meters. It has (3) large office rooms, (3) meeting rooms,(15) secretarial office and services,(1) electrical elevator capacity of (7) kilowatts and sanitary facilities of (7) aggregates in addition to the corridors and other accessories. All offices and meeting rooms are equipped with air-conditioning units. One hour electrical needs are (181.5) KW.

Table 1. Required electricity for deanship building

Rooms	Large offices	Small offices	Meeting rooms	W.C	Other accessories
The number of rooms	3	15	3	3	2
Room requirements of ampere (Amp)	45×2+120	25×15	50×2+45	2×25+20	25
Total KW	46.2	82.5	31.9	15.4	5.5
Total one hour requirement of energy				181.5 Kw	

BUILDING OF SCIENTIFIC DEPARTMENTS

It consists of four floors with a total area of (18445) square meters. It has (12) administrative headquarters for the scientific departments, each office consists of (3) administrative rooms, (76) classrooms, (19) scientific

laboratories, one store for administrative materials,(32) quadruple group of four health facilities(WC). Each floor has also internal and external corridors and two electric elevators capacity of (15) kilowatts each. all administrative offices, scientific laboratories and classrooms are equipped with air conditioning equipments. The one hour electrical energy requirements for lighting, operation of laboratories equipment, air conditioning, etc. are (1446) kW. Table (2) shows the details of the need.

Table 2. Required electricity for building of the scientific departments.

Rooms	Departments headquarters	Classrooms	Scientific labs.	W.C.	Corridors	Elevators & others
Number of rooms	16	76	19	32	4	19
Room requirements of ampere (Amp)	120×16	76×35	40×19	20×32	60×4	19×15+70
Total KW	422.4	585.2	167.2	140.8	52.8	78.1
Total 1 hour requirement of energy					1446 Kw	

SCIENTIFIC LABORATORIES AND OTHER ACCESSORIES BUILDING

It consists of four floors with a total area of (12,846) square meters. It has (43) scientific labs., a restaurant and a cafeteria for students, a large library, three large conference and seminar halls, two administrative headquarters for the Students Affairs Section, an Accounts Section, and (15) quadruple WC. Each floor also has internal and external corridors. All offices, administrative offices, laboratory halls, conference rooms, library and restaurant are equipped with air conditioning equipment. The one hour need of electrical energy for lighting and operation of various appliances is (732) KW. Table (3) provides details of requirements.

Table 3. Required electricity of scientific liberators building.

Rooms	Scientific labs.	Conference rooms & library	Administrative offices	The restaurant & accessories	W.C.	Other accessories
Number of rooms	43	4	2	3	14	1
Room requirements of ampere (Amp)	378.4	105.6	52.8	127.6	61.6	5.5
Total 1 hour requirement of energy					731.5 Kw	

DENTAL HOSPITAL BUILDING

It consists of six floors on an area of (5833) square meters and has (3) large classrooms,(10) Large laboratories, (22) Large medical clinics, (15) Small clinic, (7) Small office, Laboratory of satisfactory and consultative analyzes and (9) groups of health facilities(WC) as shown in appendix. The one hour building needs for electrical energy for lighting and operation of various appliances are (574) kW. Table (4) shows details of requirements.

Table 4. Required electricity of hospital building

Floors	ground floor	1st floor	2nd floor	3rd floor	4th floor	5th floor
Floors requirements (Amp)	490	410	470	380	500	360
Total Kw	107.8	90.3	103.4	83.6	110	79.2
Total 1 hour requirement of energy					574.2 Kw	

FRONT AND REAR RECEPTIONS AND SERVICE ROOMS

Each building consists of one floor with a total area of (242) square meters and inside each building (3) rooms and health facilities (WC).There are three other rooms for services and drivers. All these rooms are equipped with air conditioning units and there are two water pumping stations. The one hour requirement of the electrical energy of these buildings with all the external lights of the university is (140.8) KW. Table (5) shows the details of energy requirement.

Table 5. Required electricity of receptions and service rooms.

Rooms	Two reception buildings	Water pumps	Outdoor lighting	Extra elevator
Items	2	2	-	1
The two buildings need of ampere (Amp)	200	60	100	70
Total KW	44	13.2	22	15.4
Total 1 hour requirement of energy			94.60 Kw	

The above one hour requirement for the distribution of electricity to the infrastructure is taken from the distribution of electricity in circuit breakers, which represents the maximum energy to feed the infrastructure. Certainly the actual one hour use is less than planned, because of the operation and turning off the electricity consumable according to the immediate needs of the occupancy of rooms and other facilities. In addition, there is always a safety ratio in the circuit breakers.

TOTAL ONE HOUR REQUIREMENT OF ELECTRICAL ENERGY

The total one hour requirement (planned) for the university as a whole is (3029) KW, as detailed in Table (6).

Table 6. The total one hour requirements of university facilities of electrical energy.

Facilities	The deanship building	Building of scientific sections	Scientific labs. building	Hospital	Reception & other accessories	Total
Total Kw	181.5	1446	731.5	574.2	94.6	3027.8

WASTE INCINERATOR AND POWER GENERATION

It is clear through the one hour requirement of electricity of Dijlah University, which is estimated at (3.03) Megawatt (MW), that there is a need to secure a power plant capacity of not less than (3) megawatts. Such electrical power required for generation through incinerators comes from the burning of about (450) tons of municipal waste per day [1].

POWER GENERATION CAPACITY CALCULATIONS

As the waste incineration plant operates 24 hours a day without interruption, the thermal energy generated is calculated as follows [2, 3, and 4]:

$$450\ tons \times\ 2000\ pound\ /ton\ =\ 900000\ pounds\ Daily\ waste\ weight \ldots\ldots \quad (1)$$

For one hour generation:

$$900000\ \div 24\ =\ 37.500\ \ pound/h\ special\ waste\ weight\ to\ burn\ within\ an\ hour \ldots \quad (2)$$

$$37.500\ \times\ 7446\ BTU/\ pound\ =\ 279225000\ BTU/\ hour\ -\ Waste\ energy \ldots. \quad (3)$$

With the full burning efficiency of the selected burner type Canadian (KDS) (100%) and the efficiency of boiling water (82%) used to rotate turbines generators.

THE STEAM ENERGY IS CALCULATED AS FOLLOWS WITH EFFICIENCY OF 0.82 [9]

$$279225000\ \times\ 0.82\ =\ 228964500\ BTU/\ hour \ldots\ldots \quad (4)$$

The resulting steam energy can be converted into electrical energy with the 45% efficiency [9].

By converting the resulting measurement unit to the unit of measurement of electrical energy, we get: (1 MW = 32000 BTU):

$$(228964500 \times 0.45) \div 32000 = 32.2MW/hour \ldots\ldots \quad (5)$$

The calculations above are without the use of any additional fuel. These are the specifications of the process of total combustion of the serialized combustion chambers (more than a room) for modern combustion stations such as (KDS) station. The traditional incinerators only give (4500) BTU/ Pound.

Therefore, modern incinerators are highly efficient for the production of energy. Fig. (2) Shows an illustration of the station plan. Such a station also meets the requirements of environmental health and according to the International Laboratories Report [5].

Through the above calculations, it is clear that the use of KDS waste incinerator with the capacity of burning (450) tons of waste per day is sufficient and that it is possible to cancel the purchase of national electricity.

ECONOMICAL FEASIBILITY OF ESTABLISHMENT OF A WASTE INCINERATOR AT THE UNIVERSITY

University monthly costs for electricity fees: The value, which the university pays monthly as electricity wages to the state is at the rate of (5000) dollars, in addition to the use of five diesel generators with a total capacity of 3.1 megawatts due to the frequent national power cuts and the urgent need to maintain the electricity supply to ensure the safe process of teaching at the university. The university is spending in average for the fuel and generator oils about (15000) dollars per month. This is except the maintenance and repair of these generators and their accessories. The total of $(20,000) per month is considered to be a saving to the University, if the generation of electricity from the waste incinerator is invested.

Municipal waste resources: An agreement should have with the Municipality of Baghdad to receive the waste in the incinerator and burn it. Municipality should pay the wages for this process as practices in many countries of the world in terms of collection and disposal of waste. Normally pays ($ 10-20) per ton of waste to burns in the incinerator .If we assume that the municipality will pay (10) dollars per ton, at a minimum, the costs of burning and disposal of waste will be the financial return of the owner of the incinerator (Dijlah University College), as follows:

$$450\ tons\ \times\ 10\$\ \times 30\ days\ =\ 135000\ dollars/\ Monthly \ldots\ldots \quad (6)$$

Feasibility of investment: According to this research the university can set up a municipal waste incineration station and invest the electricity generated from it and will provide an monthly amount of up to (155,000) dollars. The station is operated by the cadres located in the university and according to the required specialization. If the university recreates the summer vacation of two months (July and August), it can sell part of the produced electricity to the state or to the neighbouring institutions and houses in about of (2.5 MW). This will be an additional financial amount (the sale is a part of the produced energy and the other part to operate small parts of the university):

$$2500\ kw/hour\ \times\ 0.15\ dollar\ \times\ 24\ hour\ \times\ 60\ days\ =\ 540000\ dollar \ldots\ldots \quad (7)$$

Total Annual saved amount:

$$155000\ \$\ \times\ 12\ months\ +\ 540000\ \$\ =\ 2{,}310{,}000\ dollars\ per\ year \ldots\ldots \quad (8)$$

STATION COST AND DURATION OF INTERPOLATION

The cost of the station is (20 million) twenty million dollars [1]. The saved amount from the operation of the waste incineration plant is enough to interpolate the total cost of the plant after 10 years. During this period, the university will meet its electricity requirement free of charge and earn profits from subsequent years in about (2310000) $ per year.

CONCLUSIONS

The research revealed, that there is economic feasibility of the establishment of a municipal solid waste incineration plant (450 tons) per day and through the process of burning, generate the electricity to meet the needs of Dijlah University throughout the year and in 24 hours a day with the annual provision of (2310000) two million and three hundred ten thousand dollars. This amount is due to the profit of the costs of electrical energy used in the college and the financial imports coming from the burning of municipal solid waste, the city's waste disposal and the sale of electricity produced during the months of July and August of each year, which is the period of university holiday after each academic year.

REFERENCES

[1] Kearns Waste Science Group Inc." Technical Proposal of Kearns Disintegration System in Capacity of 150 & 200 Ton Per Day". *Website* <kwsg.ca>.

[2] S. Kathirvale, M.N.M. Yunus, K Sopian. and A.A. Samsuddin "Energy potential from municipal solid waste in Malaysia". *Renewable Energy*. Vol. 29, No. 4, Pp. 559-567, 2004.

[3] A.L. Leâo and I.H. Tan "Potential of municipal solid waste (MSW) as a source of energy in SâoPaulo: its impact on CO2 balance". *Biomass and Bioenergy.* Vol. 14, No. 1, Pp. 83-89, 1997.

[4] A Muhammad, NA Farid, and K Ab Saman " The energy potential of municipal solid waste for power generation in Indonesia". *Jurnal Mekanikal*, No. 37, Pp. 42-54, 2014.

[5] AMEC Earth and Environmental, 160 Traders Blvd. East, Suit Mississauga, Ontario L4Z 3K7.Prepared for Environmental Service laboratory ,Sydney , Nova Scotia " Peport source of kearns disintegration system inc.(kds)municipal solid waste pilot scale disintegration unite , North Sydney , Nova Scotia". 2000, tv 20029.

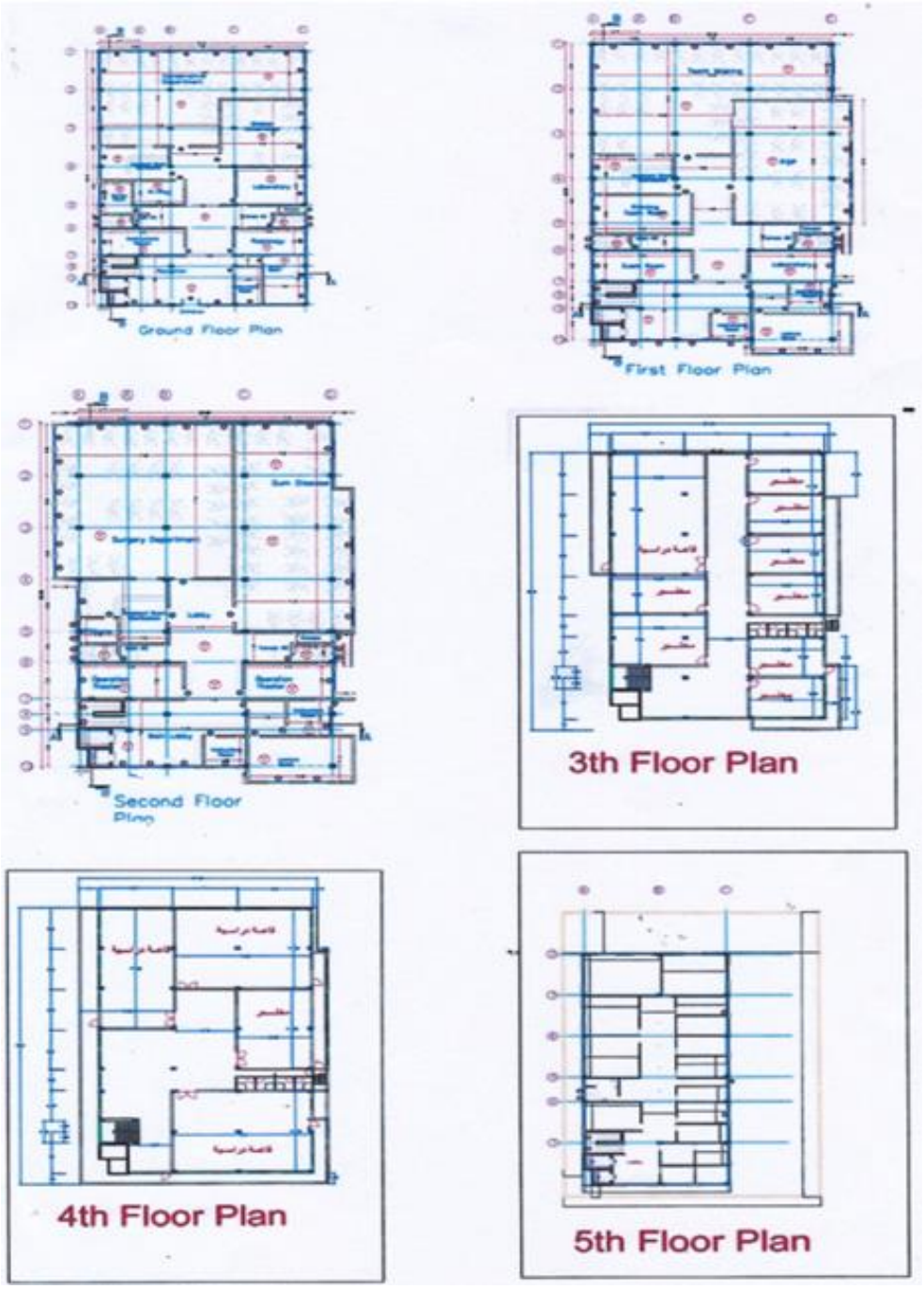
[6] R Mahdi, G Barat, S Seyed Hashem, "Electric power generation from municipal solid waste: A techno economical assessment under different scenarios in Iran" *Elsevier*, vol. 152, Pp. 46-56. 2018.

[7] HN Guilherme, J Mertagi and L Markos, "Electricity production from municipal solid waste in Brazil" WMR, 2017.

[8] 12th international conference on protection and restoration of the environment, WTE plants installed in 10 European cities, *Conference Paper*, June 2014.

[9] C Thomas, "Efficiency and power in energy conversion and storage – basic physical concepts" *CRE press, Taylor and Francis group*, Oct, 2018.

APPENDIX 1


Ground Floor Plan
First Floor Plan
Second Floor Plan
3th Floor Plan
4th Floor Plan
5th Floor Plan