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The Feasibility of City Solid Waste for Energy Era and its Existing Administration Rehearses in Pakistan

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Abstract:: *Energy crisis and growing amount of solid waste at alarming rate have remained a challenge for every governing body of Pakistan. This study has been performed in order to evaluate the feasibility of municipal solid waste for energy generation and to assess its existing management practices. The review observes that solid waste is most certainly not appropriately overseen in Pakistan. All through the nation, it has been watched that the produced waste is straightforwardly either dumped in low lying regions or blazed in open condition with no built method for transfer. Countering this problem we will suggest some strategies as adopted by other countries to use solid waste to produce energy.*

Key words: *Municipal solid waste, Energy generation potential, Population, Environment*

INTRODUCTION:

At present, Pakistan is genuinely under energy crisis and confronting different natural and social issues which are related with metropolitan solid waste (MSW). Both have procured disturbing measurements in the nation these days also as in other creating nations. Mis management of waste leads not exclusively to corrupt condition additionally general wellbeing gets to be at hazard [1].

The major reason of generating waste and the shortage of energy at alarming rate are industrialization, over population, non-utilization of enormous indigenous energy resources and lack of proactive as well as integrated planning for production of energy. Increasing of population as well as economic activities and lack of training in modern MSW management have become responsible factors due to which efforts for improving MSW management system have remained more complicated [2].

The urbanization is all around quickening which prompts to create gigantic amount of solid waste. Around, six billion individuals would settle in urban zones in 2050 [3,4]. It has been anticipated that world population would be dramatically multiplied to very nearly nine billion by 2050 as it has turned out to be dramatically increased since 1960. [3,5]. The developing countries will observe 55% and 99% of urbanization and population growth rate respectively as estimated[3-6].

Pakistan additionally gets to be under creating district where population development is genuinely high as in other developing nations. The number of inhabitants in Pakistan is 188.02 million with urban and rustic population share of 72.50 and 115.52 million individually [7].

Government of Pakistan, Economic Advisor's Wing, Islamabad; 2014 Presently said, Pakistan stands at sixth position with respect to population in the world but its population is expected to become 363 million by retaining same sixth position in 2050 [7].

As indicated by [7,8] PGR (i.e. 1.92%) of Pakistan is higher than the provincial and Muslim nations aside from Afghanistan and Egypt. For looking occupations, offices, to give better instruction for youngsters and in view of numerous different components, the general population is moving from provincial territories to urban community which is the reason of developing urbanization quickly in Pakistan. The share of urban population in Pakistan has been expanded from 38.6% in 2014 to 39.2% in 2015[8]. This is at third number among the territorial nations. On account of over population, solid waste is created progressively and all the more universally which dirties condition either specifically or by implication if not appropriately discarded. Furthermore, urbanization requires mechanical development and agrarian request which eventually needs energy sources. The non-renewable sources have remained the discussion of world for quite a long time.

The energy crisis in the nation is quickening at the disturbing rate and energy sector is confronting numerous challenges day by day. Subsequently, expanding crevice between energy demand and supply has turned out to be primary reason of financial emergencies in Pakistan [9].

Pakistan is likewise confronting testing issues in MSW administration like other nations due to urbanization and restricted by absence of a

compelling reusing natural squanders into significant material, poor waste administration and dealing with foundation [10, 11, 12]. Creating nations in spite of bottomless amount of MSW era, are confronting energy crises which have postured to their socio-economic development [10]. Along these lines discharging of emissions from framework chipping away at non-renewable energy sources and burning of MSW have turned out to be mindful elements to produce environmental issues like greenhouse effect prompting to climate change.

There has been a developing world assessment for looking other options to non-renewable sources that would guarantee ecofriendly improvement from energy view point also expanding in cost related with conventional energy generation and improper waste transfer has all inclusive constrained to move towards waste to energy idea, as a more appealing and suitable arrangement now-a-days [14].

In this study, estimation of energy from MSW alongside its current administration practices in Pakistan is discussed with comparison of other countries management practices to cope up with energy crises in their country. MSW is producing at the disturbing rate with every year development rate of 2.4% [11]. Legitimate transfer of MSW is a genuinely difficult issue for Pakistan [7, 11].

By considering these realities, current study will also suggest solid waste to energy conversion management practices which must be adapt in order to deal with the current energy crisis in Pakistan.

Energy generation potential:

In 2010 Federal Bureau of Statistics (FBS) Government of Pakistan assessed 6.15 MT of MSW every year in ten urban communities of Pakistan (Table 3). Later on [16] assessed 9.42 MT of MSW every year in 12 urban communities of Pakistan (Table 3). Another review [17] assessed 4.25 MT/year of MSW created in ten biggest urban communities of Pakistan as per the populace, era rate and gathering rate of MSW in every city (Table 3).

The consequences of another most recent review [17] assessed also directed administration of MSW produced in eight urban communities of Pakistan show 5.32 MT of MSW every year produce in chose urban communities of Pakistan (Table 4). In show study, around 30.76 MT of MSW aside from perilous squander every year in the chose urban communities of Pakistan was assessed on the premise of population assessed in 2016 by Demographic World Urban Areas and era rate MSW (acquired from most recent reviews) as appeared in Table 4.

Table 3
Quantity of MSW generated in major cities of Pakistan in 2010, 2012 and 2013.

City corporation	2010 [50]			2012 [51]	2013 [52]		
	Population (millions)	GR (kg/capita/day)	TQ (MT/Year)	TQ (MT/Year)	Population (millions)	GR (kg/capita/day) [Collection rate %]	TQ (MT/Year)
Karachi	13.38	0.613	2.354	3.688	11.62	0.61 [53]	1.378
Lahore	7.21	0.7	2.419	2.149	6.29	0.61 [68]	0.953
Faisalabad	2.91	0.48	0.427	0.775	2.5	0.39 [65]	0.296
Hyderabad	0	0	0.073	0.449	1.39	0.56 [72]	0.375
Peshawar	0	0.5	0.183	0.286	1.24	0.49 [67]	0.149
Gujranwala	1.67	0.469	0.301	0.436	1.44	0.47 [52]	0.128
Quetta	0	1	0.274	0.222	0.73	0.38 [75]	0.1
Bannu	0	0.445	0.014	0	0	0	0
Sibi	0	0.57	0.014	0	0	0	0
Multan	0	0	0	0.462	1.45	0.45 [60]	0.325
Sialkot	0	0	0	0.123	0	0	0
Sargodha	0	0	0	0.134	0	0	0
Islamabad	1.049	0	0	0.155	0.74	0.53 [91]	0.225
Rawalpindi	2.01	0	0	0.543	1.77	0.58 [86]	0.32
Bahawalpur	0	0	0.091		0	0	0
Total	28.229	4.777	6.15	9.422	29.17	5.07 [69]	4.247

Table 4
Quantity of MSW generated in major cities of Pakistan in 2014 and 2016.

Citycorporation	2014 [53]			2016 [present study]		
	Population (millions)	Generation rate (kg/capita/day)	Total quantity (MT/Year)	Population (millions)	Generation rate (kg/capita/day)	Total quantity (MT/Year)
Karachi	14	0.572	2.92	22.825	0.572 [53]	4.765
Lahore	0	0.151	0.507	10.355	0.75 [55]	2.835
Faisalabad	2.7	0.53	0.522	3.675	0.45 [56]	0.604
Hyderabad	9.2	0	0	2.99	0.8 [57]	0.873
Peshawar	0	0	0	1.785	0.38 [58]	0.248
Gujranwala	1.85	1.08	0.73	2.195	1.08 [53]	0.865
Quetta	0	0	0	1.14	0.378 [52,59]	0.157
Multan	2.06	0.53	0.402	1.95	0.53 [53]	0.377
Sialkot	0	0	0	0.58	0.313 [60]	0.067
Islamabad	0	0	0	0.74 [52]	0.53 [52]	0.143
Rawalpindi	2.5	0.21	0.192	1.77 [52]	0.21 [53]	0.136
Khariyan	0.035	2.57	0.033	0	0	0
Lala Musa	1	0.027	0.01	0	0	0
Sukkur	0	0	0	0.585	0.45 [61]	0.096
Total	33.345	5.67	5.316	50.59	6.443	11.166
Remaining urban area	0	0	0	23.11	0.84 [17,31]	7.086
Rural area	0	0	0	114.32	0.30 [17,31]	12.518
Sub-total	33.345	5.67	5.316	188.02	7.583	30.764
Hazardous wastes		0	0	0	0	1.538
Grass Total			5.316			32.3

Characteristic of MSW components.

Waste Components	Density (kg/m^3)	Proximate analysis				Elemental analysis						NCV
		MC	TS	VM	FC	C	H	N	S	O	AC	
Cardboard	50.26	3.91	96.09	76.44	23.56	20.86	0	0	0.1	57.12	22.02	6784
Food waste	323.18	75.02	24.98	83.01	17.1	35.56	6.43	1.53	0.18	48.67	7.81	10
Leather	162.14	0.71	99.29	73.49	27	36.86	5.48	0.15	0.26	37.15	20.36	7457
Paper	82.69	4.82	95.18	85.12	15	40.98	7.44	0	0.08	39.13	12.45	7221
Plastics	64.85	0.24	99.76	97.01	3.72	71.92	0	0	0	23.15	4.93	17960
Rubber	129.71	0.18	99.82	91	9.73	58.34	0	0	0.17	15.23	26.43	15192
Textile	64.85	1.34	98.66	93	7.01	49.5	6.45	0	0	37.92	6.13	8016
Wood	243.21	4.71	95.29	88.43	12.81	44.73	2.92	0	0.15	49.29	3.06	6521
Yard waste	159.44	30.38	69.62	91.95	8.04	45.36	8.03	1.04	0.12	37.44	8.13	1352
Ash/bricks, etc	486.42	8	92	0	0	26.3	3	0.5	0.2	2.2	68	1375
Glass	196.19	2	98	0	0	5	0.1	0.1	0	4.1	98.9	18
Metals	575.6	8	92	0	0	4.5	0.6	0.1	0	4.3	90.5	211

MC (moisture content %); TS (total solid %); VM (volatile matter %); FC (fixed carbon %); C (carbon %); H (hydrogen %); N (nitrogen %); S (sulfur %); O (oxygen %); AC (ash content %); C/N (carbon to nitrogen ratio) and NCV (net calorific value in kcal/kg).

Characteristics of MSW Components:

Shown above are percentages waste of different MSW components and their density in kg/m^3 also their proximate and elemental analysis (moisture content %); TS (total solid %); VM (volatile matter %); FC (fixed carbon %); C (carbon %); H (hydrogen %); N (nitrogen %); S (sulfur %); O (oxygen %); AC (ash content
%); C/N (carbon to nitrogen ratio) and NCV (net calorific value in kcal/kg).

Results and discussion:

The consequences of all reviews demonstrate that MSW era in Pakistan is expanding as population and urbanization is enhancing. The immense amount of MSW needs administration legitimately in Pakistan it is straightforwardly dumped into low lying ranges, water bodies and even along the street sides. Like in other creating nations, appropriate consideration is most certainly not for the most part given to solid waste administration and socio-ecological issues because of its blunder in Pakistan.

Behind the inappropriate Consideration given to waste administration, there are different reasons counting the absence of money, human, framework and concerned assets to attempt successful endeavors for administration of MSW in creating nations [19].

In developing nations, MSW administration has multidimensional issues, for example, institutional, political, natural furthermore, socio-economic aspects [20] shows that Districts have been generally worked to give squander administration benefits in developing nations [21]. Nonetheless, efforts have been made by numerous districts to make squander administration in a supportable way in developing nations. These efforts as a rule either turn out to be sick overseen or even stop to exit because of different specialized, social and institutional requirements [20].

Strategies

There are many built up energy recovery or WTE advances for example, AD, incineration, gasification, pyrolysis, maturation, transesterification and RDF. WTE change is utilizing three principle transformation procedures, for example, thermochemical, biochemical, what's more, physicochemical procedures [27].

Thermochemical forms utilize high temperatures to change over carbonaceous waste feedstock to energy, regularly in the frame of power and warmth, and

esteem included items (VAP). Inside thermochemical change, three procedures are accessible: pyrolysis, gasification and ignition.

- Biochemical procedures utilize organic operators to change over biomass feedstock to energy, normally as fluid and vaporous powers. Biochemical transformation incorporates AD and aging forms.
- Physicochemical procedures utilize substance specialists to change over biomass feedstock to energy, ordinarily as fluid powers. Transesterification is generally utilized process in the physicochemical change pathway [5].

The determination of any WTE innovation relies on upon the waste classification, capital and operational costs, innovation effectiveness and unpredictability combined with work expertise necessities and geological areas of the plant [5].

A waste-based bio refinery in Makkah will generate enormous economic and environmental benefits from carbon credit, landfill diversion, renewable electricity generation and GHG emission savings
along with managing the waste produced by local population and pilgrims[4,11]. Same waste-based bio refinery can help Pakistan generate enormous economic and environmental benefits from carbon credit, landfill diversion, renewable electricity generation and GHG emission savings along with managing the waste produced.

China is the world's second consumer of energy and the third biggest merchant of oil [25]. MSW era has been expanding at a yearly rate of 8–10%, with more than 150 million tons of MSW being delivered every year now [26]. The current quick advancement of WTE in China has been driven by two components: the mounting pressure on MSW disposal and the new government regulations and policies advancing environmentally
sound technologies for MSW administration and renewable energy [24].

The Renewable Energy Law of China gives loan program, ensured duty for renewable electricity to the general population network, and bolsters measures for research and improvement of renewable power era.In spite of the noteworthy capital and working costs, a developing number of urban areas have developed or are planning to build WTE incineration facilities.

By adopting these, urban environment of each city would be sustainable for citizens as well as
energy crises would be resolved to some extent.

• The implementation of new policies & regulations regarding SWM at town, district and provincial level and also development of commission at national level is the need of an hour.
• Strengthen capability of institutions by allocation of sufficient funds according to current needs to manage MSW.
• Strict punishment for the violation of law.
• Fundamental awareness of social and environmental problems which are generated because of dumping and burning of MSW.
• Providing guidelines for environment friendly onsite handling, storage & processing, collection, transfer, transport and disposal of MSW.

Advancing source isolation for determination of transfer as well as treatment technique for solid squanders
• Development of ecological execution markers.
• Implementation of life cycle evaluation approach.
• Awareness with respect to adjustment of 3Rs standard.
• Hiring of talented staffs.
• Enhancing reusing framework by giving training and embracing fundamental reusing rules.
• Proper determination of transfer and additionally treatment technique by considering different parameters including waste volume lessening proficiency need of foundation, working and additionally portion cost and so forth.

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