Bhartiya Vidya Bhavan's

Sardar Patel College of Engineering

Use of Kitchen Waste for Generation of Fuel

Presented by

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Outline

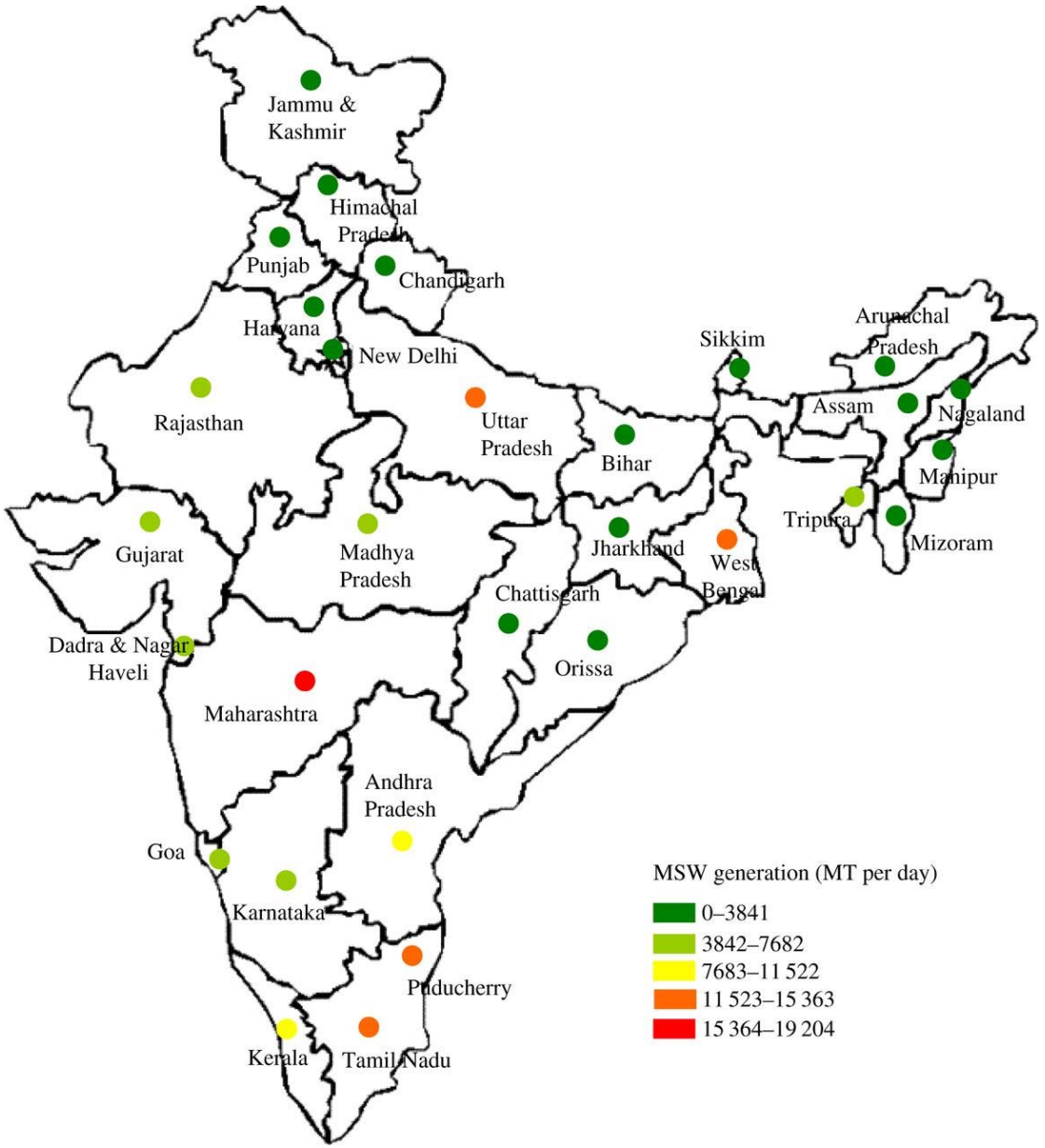
- Literature Review
- Motivation
- Goal and objectives
- Methodology
- Result and Discussion
- Economical analysis
- Conclusion

Literature Review

- Rapid urbanization, more waste
- 10 years ago waste generation rate was 0.64 kg/capita/day (*Hoornweg and Bhada, 2012*)
- Today, 3 billion urban residents generate 1.2 kg/c/d

Income Level	Waste generation (kg/capita/day)
High	0.7-14
Upper Middle	0.11-5.5
Lower Middle	0.16-5.3
Lower	0.09-4.3

(*World Bank Report, 2012)*


Jammu &
Kashmir
Himachal
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Pradesh
Chattisgarh
Orissa
Dadra & Nagar
Haveli
Maharashtra
Andhra
Pradesh
Goa
Karnataka
Puducherry
Kerala
Tamil Nadu
MSW generation (MT per day)
0–3841
3842–7682
7683–11 522
11 523–15 363
15 364–19 204

Literature Review

- MSW management in India shows that waste generation is estimated to increase rapidly at present from 490 gm per person per day to 945 gm per person per day which would result in 300 million tonnes per year from 48 million tonnes per year by the year 2047 (*CPCB*)
- According to the United Nations Development Programme, up to 40% of the food produced in India is wasted

Literature Review

Population	Waste Generation Rate kg/capita/day
Cities with a population < 0.1 million (8 cities)	0.17-0.54
Cities with a population of 0.1–0.5 million (11 cities)	0.22-0.59
Cities with a population of 1–2 million(16 cities)	0.19-0.53
Cities with a population > 2 million(13 cities)	0.22-0.62

MSW composition at generation sources and collection points, determined on a wet weight basis, consists mainly of a large organic fraction (40–60%), ash and fine earth (30–40%), paper (3–6%) and plastic, glass and metals (each less than 1%). The C/N ratio ranges between 20 and 30, and the lower calorific value ranges between 800 and 1000 kcal/kg (Sharholy, 2008)

Motivation

- The Andheri Bhavans' Campus has an area of 64 acres approximately
- Open dumping leads to environmental pollution and negative impact on public health
- Recovery of energy from kitchen waste can serve as a source of fuel in kitchens
- Productive utilization of waste

Goal of Project

- Goal
  - Characterize the solid waste and find its potential to be recovered in the form of energy from the large amount of food waste generated for Bharatiya Vidya Bhavan's Campus, Andheri (W)
  - Designing the biogas system for campus
  - Economical Analysis

Objectives

- Characterization of kitchen waste
- Design of biogas digester
- Gas production potential
- Rate analysis for the digester
- Break-even Point and Cost Recovery

Methodology

- Survey Questionnaire
  - A questionnaire was designed for collecting information about waste generation in all the canteens
  - Questions related to quantity and disposal
- Sampling
  - Sampling was carried on during peak hours of solid waste collection from the kitchens during autumn and spring season
  - An average sample of 1.5 kg of solid waste generated was collected in triplicate and characterized to find the quality
  - The characterization of solid waste was done to by finding total moisture content , organic matter, elemental analysis and calorific value (Parr oxygen bomb calorimeter) of solid waste

Methodology

- Economical Analysis
  - Digester design was carried out according to the "System Design Flowchart" given by Curry and Pillay.
  - An approximate area of 100 m^2 was proposed to be allotted for the biogas plant
  - A suitable location was scouted inside the campus so as to maintain proximity to the canteens
  - Approximate gas piping distances were measured from the proposed location to each canteen
  - A detailed quantitative survey and estimation gave the cost of the digester
  - A breakeven analysis was also carried out for the entire project

Results and Discussion

Canteen name	Bhavan's Canteen	Sardar Patel Canteen	Sardar Patel Mess	SP Jain Mess
Source/ Type of Waste	Mostly Organic with some plastic and glass	Food and Plastic Mostly organic.	Food and peelings (organic)	Food+ Plastic
Hours of operation	8 am to 6 pm	7 am to 7:30 pm	7 am to 2:30 pm and 5 pm to 9:30 pm	8 am to 2:30 pm and 8 pm to 11pm
Approximate quantity	100 kg	3 large cans= approx 75 kg	2 large cans= approx 50 kg	1.5 cans= approx 40 kg
Method of disposal	Municipality Van picks from outside campus bin			
Location of disposal	Outside Campus			
Time of disposal	7 pm daily			
Type of fuel	LPG	LPG	LPG	LPG
Daily fuel requirement	2.5 commercial cylinders	1.5 commercial cylinders	2.5 cylinders	2 cylinders

- Food waste generation rate was 0.1325 kg per capita per day
- It was observed that no proper disposal method is followed resulting into smell and fly nuisance in and around campus
- The collection bins are open with spillage around the area
- The total consumption of LPG gas for the campus is 8.5 cylinders amounting to 120.7 kg and the total monthly requirement as 3621 kg

Characterization of Waste

	Moisture Content (%)		Ash (%)		Volatile Matter (%)	
	Autumn	Spring	Autumn	Spring	Autumn	Spring
Bhavan's	66.8	81.51	8.43	5.44	91.6	94.56
SPCE Mess	76.4	73.98	23.3	15.48	76.7	84.52
SPCE Canteen	81.6	75.4	10.9	36.26	89.2	63.74
SP Jain Mess	76.6	75.23	19	9.45	81	90.55

Calorific Value

- CV=356.248 VM - 6998.497(kJ/kg) Eqn. 1
- CV= 356.047 VM-118.035FC -5 600.613 (kJ/kg) Eqn. 2
- Benton: CV=4.2*(44.75 VM-5.85 W + 21.2) Eqn. 3

Where,

CV- calorific value in kJ/kg

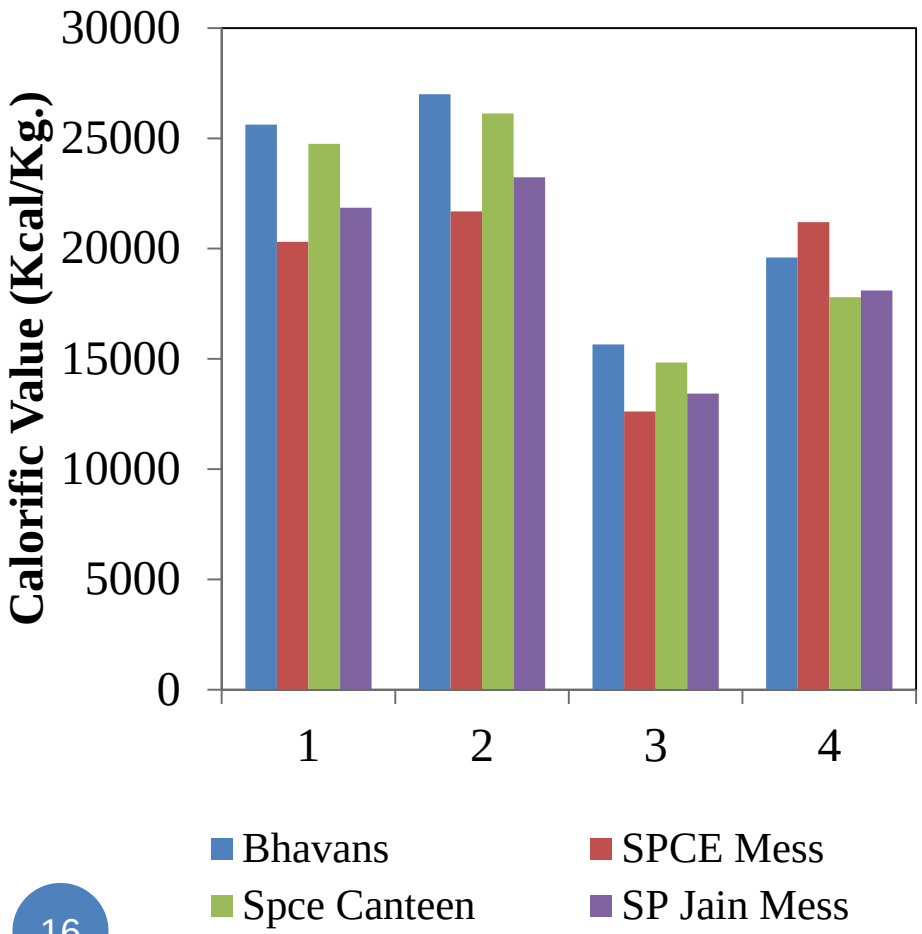
VM- Volatile Matter in percentage

FC- Fixed Carbon content

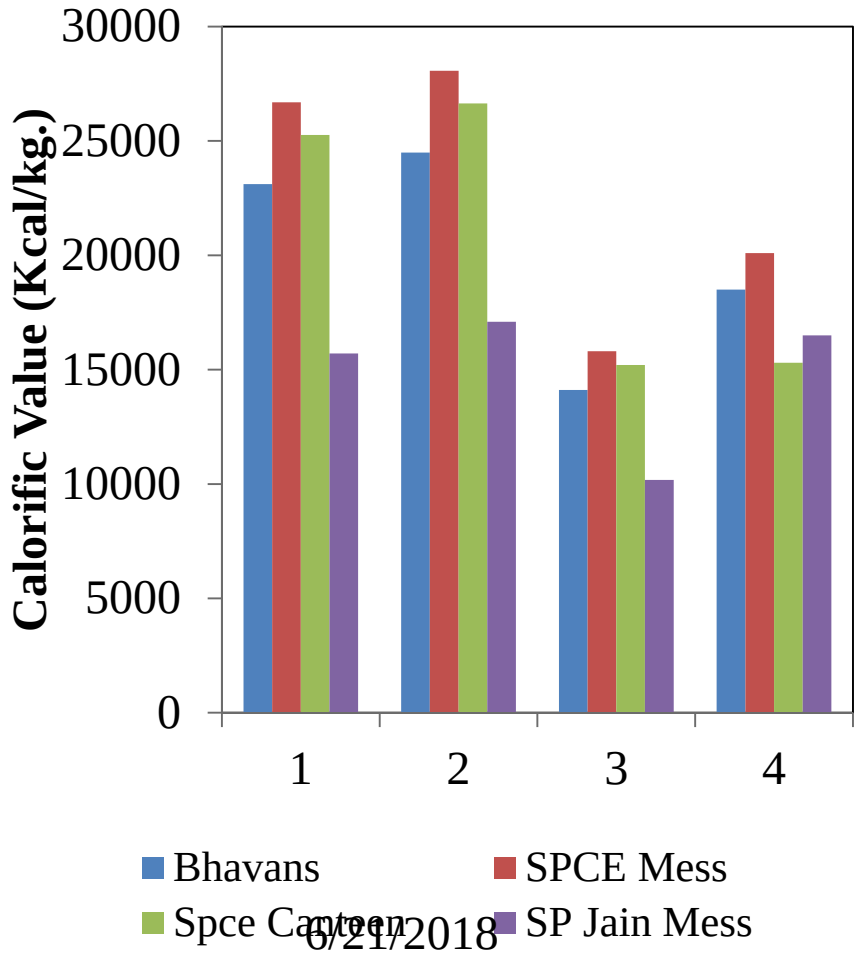
W- Moisture Content

Calorific Value of Kitchen Waste

Autumn



Spring



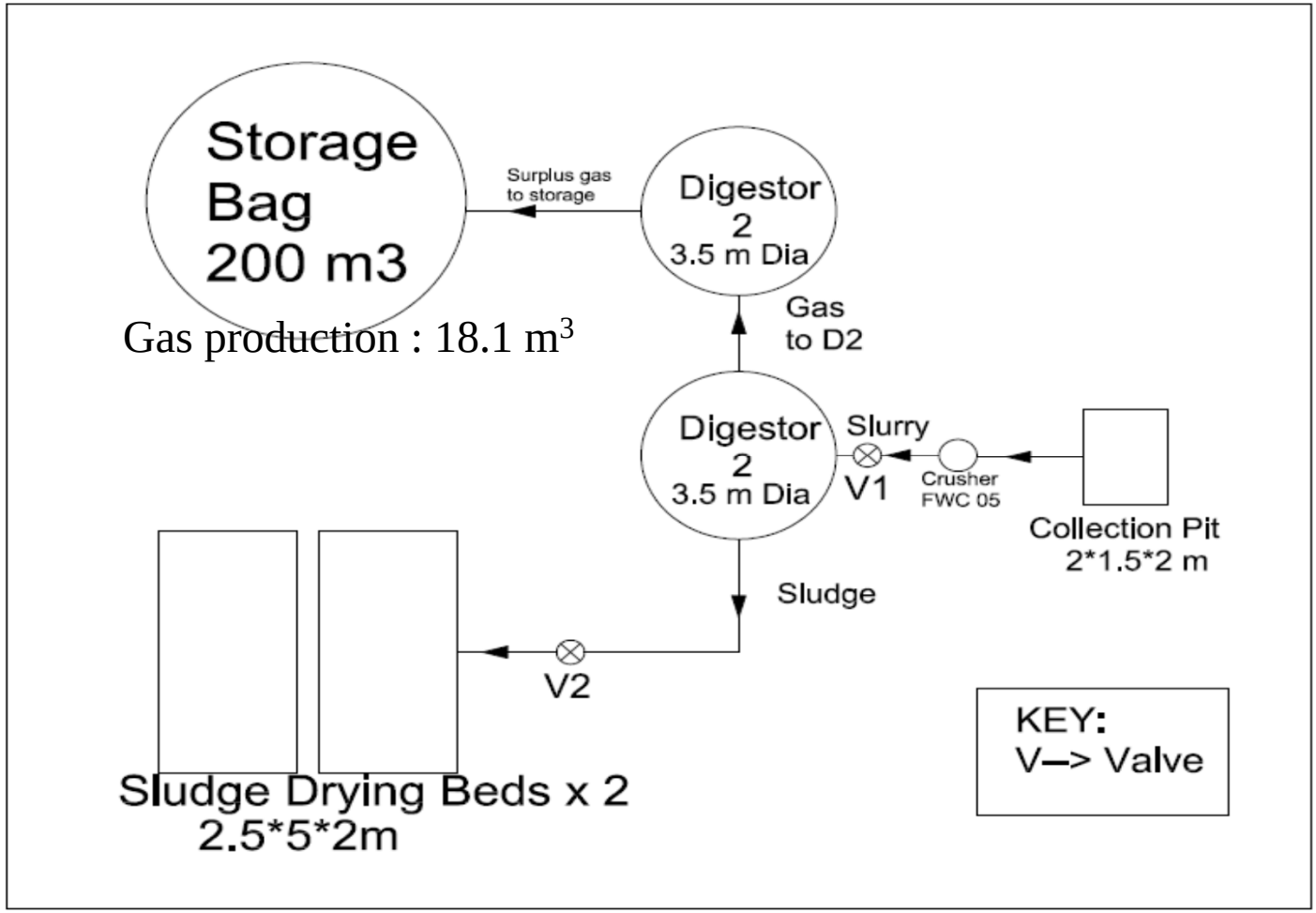
- The calorific value was 14000-18000 kJ/kg by actual measurement and by various equations in a range of 15000-25000 kJ/kg which were comparable to values Kalantaifard and Yang (Malaysia, 2011).

- The LPG commercial cylinders are used at a rate of 8.5 no/day , combining all the 4 locations

Economical Analysis

- Design of Digester
- Rate Analysis
- Estimation of quantities
  - Rate analysis
  - Material cost
  - Contingencies
  - Maintenance and operation cost

Design of Digester, drying bed and storage capacity



Estimation of Cost

Total cost to install biogas plant =	Rs. 7, 77, 385.35
	+ Rs. 18,000.00
	+ Rs. 3, 92,134.00
	Rs. 11, 87,519.00
Accounting 3% of total as contingencies,	Rs. 35,625.58
Hence, total cost is:	Rs. 12, 23,144.58
Assuming operation and maintenance cost as 15% of total cost:	Rs. 1, 83,471.69
Hence, Actual Total Cost:	**Rs. 14, 06,616.27**
	(approx 18,000 Euro)

Break Even

- For the calculations,
  - The cost of the average domestic LPG cylinder (14.2 kg) was considered as Rs. 450/- and that of a commercial cylinder (19 kg) was taken as Rs. 1600/-
  - Recovery period was 4-6 months

Conclusion

- Kitchen waste has excellent potential for energy recovery
- High MC, High VM, High Cal. Value; Anaerobic Digestion is most preferred method
- If biogas is used as substitute for cooking fuel (LPG), cost recovery is quick + surplus biogas
- Surplus biogas can be used for electricity generation: 1 cu.m. gives 1.5-2 kWh
- Employing twin recovery methods – cooking fuel and electricity, short break-even + truly usable renewable energy source can be obtained
- Potential for application in residential and commercial complexes in metro cities

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Thank You and Questions