Design and development of a portable KVIC type biogas plant for colder regions

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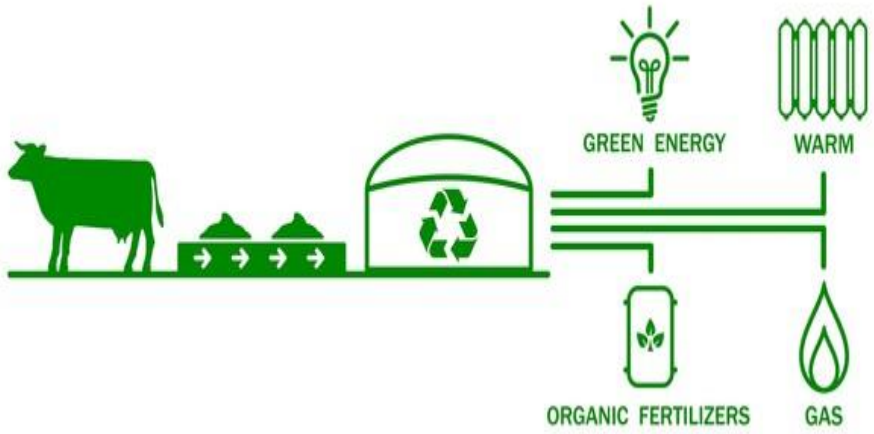
Introduction

- Biogas: Renewable Natural Gas (RNG)
- Composition: Methane (50–75 %), carbon dioxide (25–50 %), smaller amounts of nitrogen (2–8 %), and trace levels of hydrogen sulfide
- Resources of biogas
  - Agricultural plant waste products
  - Animal and human digestive waste
  - Municipal Solid waste
  - Kitchen and fruit waste



Need of the project

- **Temperature:** Key determinant for AD
- **Temperature ranges:** Psychrophilic (10-27°C), low-mesophilic (30 ± 3°C), mesophilic digestion (35 ± 3°C), and thermophilic (55 ± 3°C)
- **Challenging in cold region areas**
- **High altitude Uttarakhand regions:** facing low temperature issues in winter season, resulting into inactivation of methanogenic bacteria leading a sudden fall in biogas production
- **Solution and Novelty:** The present idea proposes two innovative solar techniques:
  - heat trapping within the digester using greenhouse during daylight hours
  - utilizing solar heater with a heat exchanger to elevate digester temperatures

Objectives

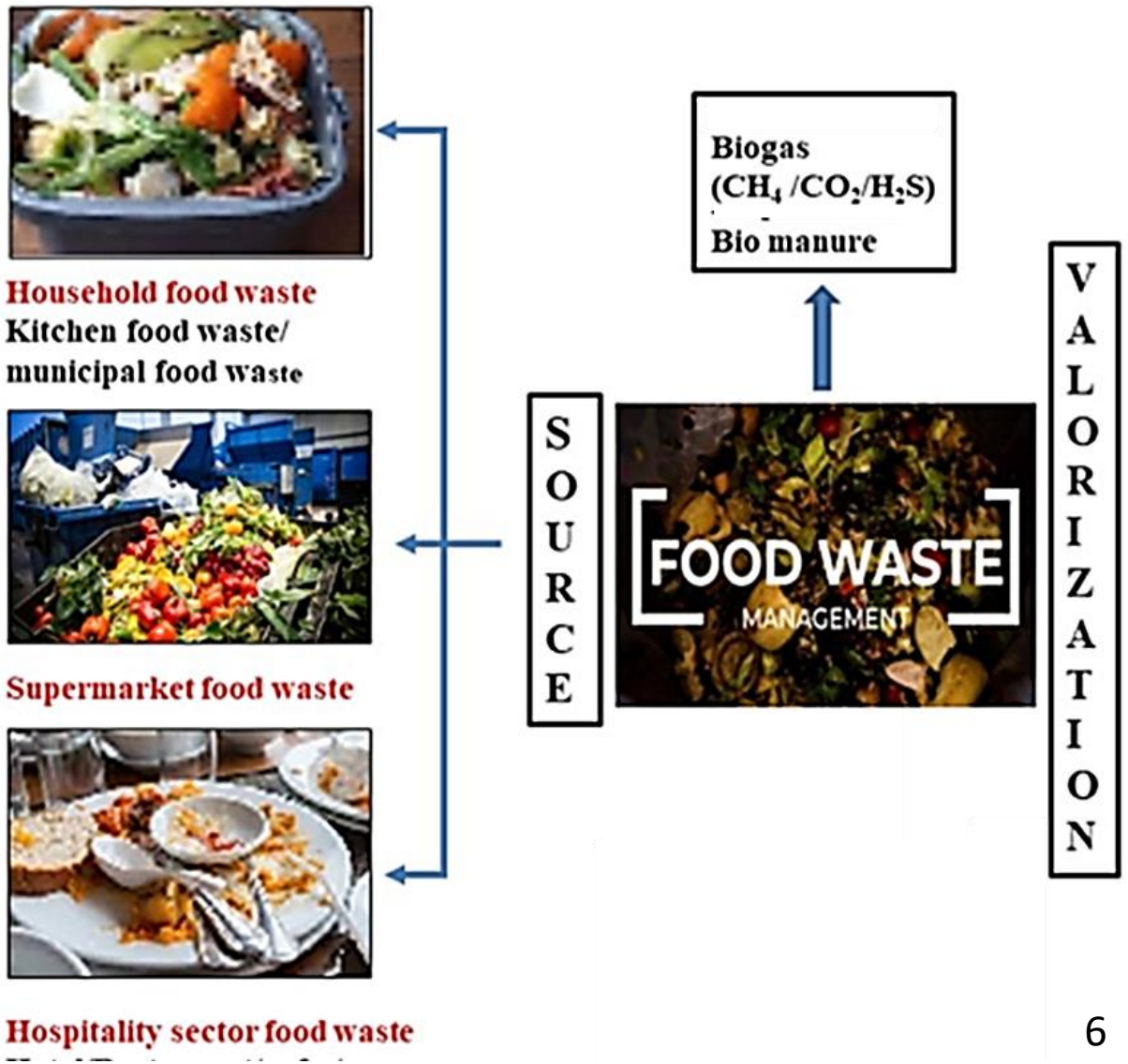
- Investigation of mixed organic feedstock (food waste, cattle dung, agriculture waste etc.) for its conversion to biogas in a single biodigester

- Integration of solar thermal technology with biogas digester to improve biogas production efficiency under colder climatic conditions

Proposed methodology

1. Investigation of mixed biodegradable waste for biogas generation at lab scale

- **Wastes identified:** Kitchen waste, cattle dung, agriculture waste, animal/ human digestive waste and sewage water
- **Physico-chemical analysis:**
  Biochemical composition, proximate and ultimate analysis
- **Processing for AD:** Grinding and biomethanation
- **Product analysis:** Quantitative and qualitative



Proposed methodology (contd..)

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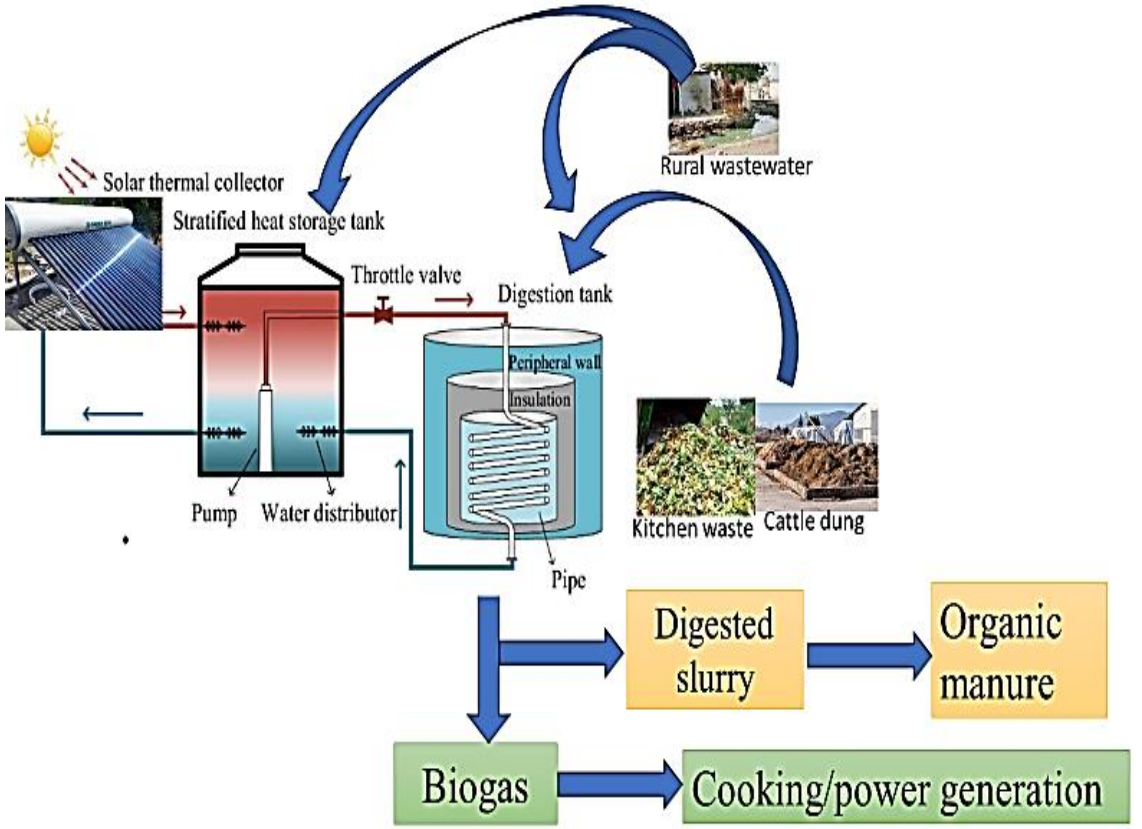
2. Design and fabrication of portable KVIC type biodigester equipped with solar energy trapping and thermal insulation facility

- Application of two solar energy techniques to heat the slurry within the digesters:
  - A solar greenhouse insulated at north wall
  - A solar water heating (SWH) system

- **Minimized heat losses:** System will comprise a capillary heat exchanger (HE), a layer of sand for efficient heat storage, and an inner layer of cotton glass wool insulation within the greenhouse to minimize heat loss from the capillary heat exchanger during SWH system operation



Proposed methodology (contd..)

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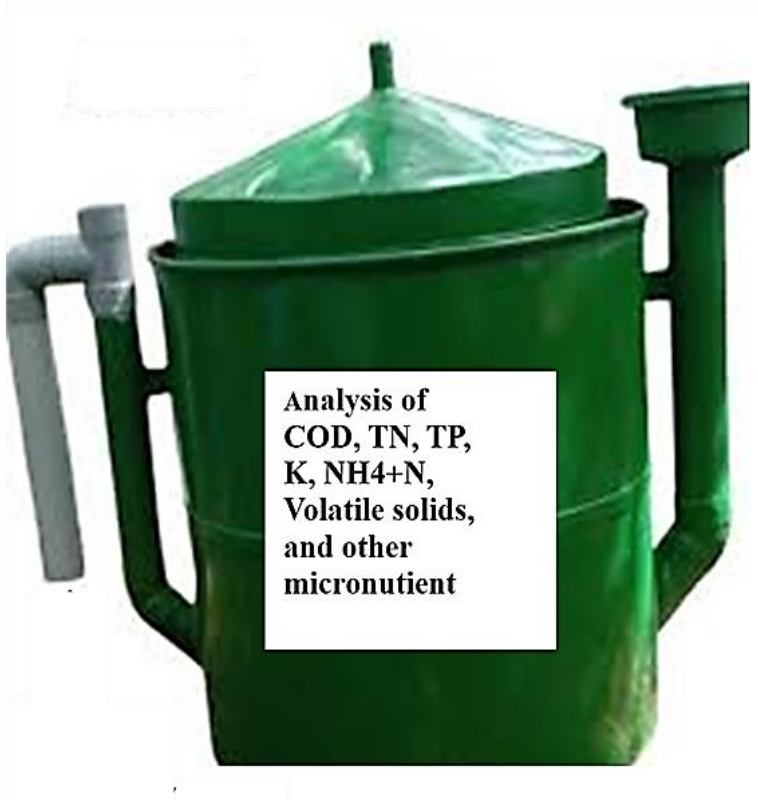
3. Analytical methods

Total Solids (TS), Volatile Solids (VS), and Chemical Oxygen Demand (COD), Total Nitrogen (TN) and Total Carbon (TC) Total Ammonia Nitrogen (TAN), Volatile Fatty Acids (VFAs)



4. Demonstration of the newly designed plant

The newly developed bio-digester based upon KVIC model (portable) will be demonstrated to the KVIC officials with all the details.

5. Trainings of users for the operation and maintenance of the upgraded plant

Trainings will be organized for the beneficiaries, identified by the KVIC for the installation of the bio-digesters equipped with the thermal insulation facility.

Scientific and Technical interventions envisaged

- Efficient portable Biogas Digesters
- Solar Thermal Integration
- Co-digestion Strategies
- Nutrient Recovery
- Climate Change Mitigation and Greenhouses Reduction

Expected outcome of the project

- Biogas and nutrient rich organic manure generated by the anaerobic digestion of kitchen waste, cattle dung, agriculture waste (Fruit-vegetable waste)
- **Novel technology for converting waste to wealth specifically for colder regions**
- Minimization of LPG requirement for rural areas by its replacement with biogas
- Upliftment in the socio-economic status of the residents of Uttarkashi and other hilly areas
- Support to Swatch Bharat Abhiyaan and Gobardhan yojana

Proposed Budget

S.no.	Item of expenditure	Ist year	IInd year	IIIrd year	Total
1	**Man power**	2,40,000	2,40,000	1,20,000	6,00,000
2	**Travel**	25,000	50,000	25,000	1,00,000
3	**Training programs**	-	25,000	50,000	75,000
4	**Contingencies**	35,000	50,000	40,000	1,25,000
5	**Equipment and consumables**	6,00,000	-	-	6,00,000
	Total	**9,00,000**	**3,65,000**	**2,35,000**	**15,00,000**

Time schedule (month wise action Plan) for implementing the project

Project activity	0-3 months	4-6 months	7-9 months	10-12 months	13-15 months	16-18 months	19-21 months	22-24 months	25-27 months	28-30 months
Recruitment project staff										
Literature review										
Physico-chemical analysis of mixed biodegradable waste used for biogas generation										
Investigation of mixed organic feedstock for biogas generation										
Design and fabrication of portable KVIC type bio digester equipped with solar energy trapping and thermal insulation facility										
Optimization and demonstration of the designed system										
Trainings of users for the operation and maintenance of the upgraded plant										
Project completion report										

Facilities available at UPES, Dehradun to carry out project

- **STP Plant:** For collection of wastewater
- **Hostel:** For collection of Kitchen waste
- **Biogas Plants (3, 6, 40 and 85 m^3)** at UPES campus
- **Gas Chromatography with TCD:** For analysis of biogas
- **Nutrient value** of organic manure (NPK) will be analyzed in CIC and Biofuel Research laboratory
- **Solar dryer:** For drying slurry
- **Atomic absorption spectroscopy:** For analysis of water quality

Experience of the team in the area of biogas

S.No.	Title of the Project	Start date-Completion Date	Name and Full address of Funding Agency	Amount Sanctioned	Amount Received
1.	Biogas Development and Training Centre, Dehradun	2009 – 2014	MNRE, New Delhi	Rs. 1.2 Cr	~ Rs. 1.00 Cr
2.	Integrated Research, Development and Demonstration of Biogas Generation from Leaves, Fruit-hull and De-oiled cake of Jatropha using CSTR Digester and its Purification/Upgradation for Utilization in Vehicle	2011 – 2014	MNRE, New Delhi	Rs. 46.9 Lakh	Rs. 46.9 Lakh
3.	Establishment of Jatropha Oil Cake based Biogas Plant	2009 – 2012	UCOST, Dehradun	Rs. 8.34 Lakh	Rs. 8.34 Lakh

Biogas infrastructure at UPES, Dehradun

Training for biogas plant construction

CSTR biodigester at UPES

Biogas yard at UPES

Thank You