Concept Note

Waste to Bio CNG Solution for Organic Waste- Coimbatore

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Details

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Acronyms and abbreviations

BWG	Bulk Waste Generator
CapaCITIES	Capacity Building Project on Low Carbon and Climate Resilient City Development in India
CBG	Compressed Bio Gas
CCMC	Coimbatore City Municipal Corporation
CGD	City Gas Distribution
CH_4	Methane
CNG	Compressed Natural Gas
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
Cr.	Crore
CRCAP	Climate Resilient City Action Plan
GGGI	Global Green Growth Institute
GHG	Greenhouse gases
ha	Hectare
HFCs	Hydrofluorocarbons
IA	Implementation Agency
INR	Indian Rupee
IS	Indian Standard
LPG	Liquified Petroleum Gas
MCC	Micro Composting Canters
MWh	Megawatt hour
N_2O	Nitrous oxide
NPK	Nitrogen, Phosphorus and Potassium or Potash
OMC	Oil Marketing Company
PPP	Public Private Partnership
RFP	Request for Proposal
RNG	Renewable Natural Gas
SATAT	Sustainable Alternative Towards Affordable Transportation, Ministry of Petroleum, Government of India
SP	South Pole
sq. km	Square Kilometer
t	Tonne
TPD	Tons Per Day
UNFCCC	United Nations Framework Convention on Climate Change

1. Background and Need of an Innovative Solution

1.1 Solid Waste Management- Daily Generation and Emissions

As of July 2020, Coimbatore city generated monthly average of ~900 tons of solid waste per day. The waste is primarily collected by CCMC from through containerized push carts by the sanitary workers and thereafter temporarily stored along the roadside in bins/containers. These bins/containers will be emptied and transferred to the transfer stations by CCMC's dumper placer vehicles / refuse collector compactors.

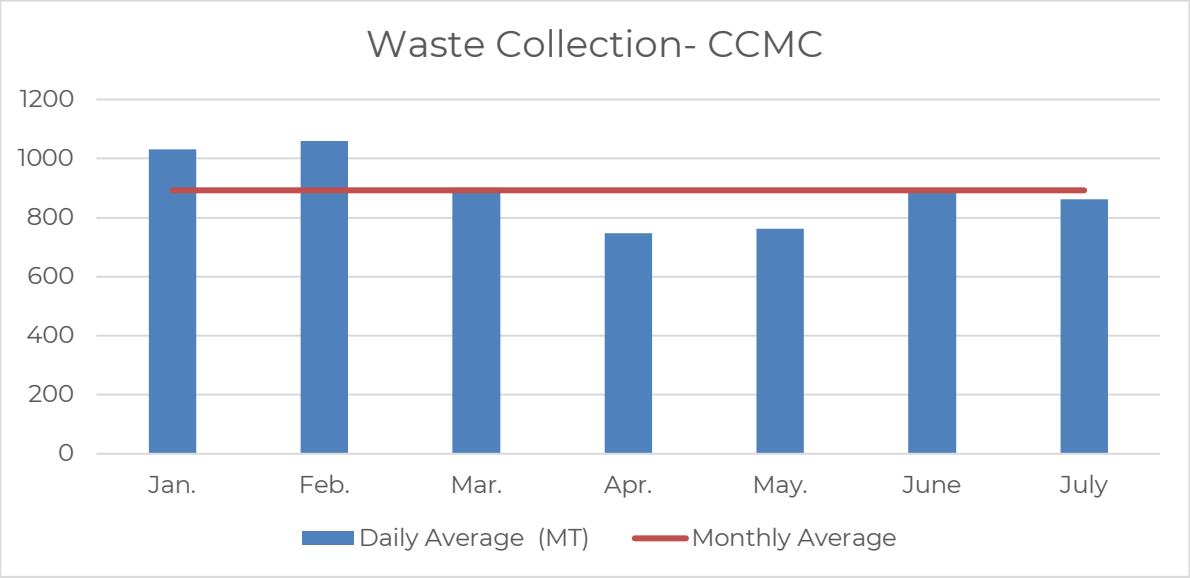


Figure 1: Monthly Daily Average Waste Collected, 2020

Source: Waste based on Transfer Station and Weigh Bridge, 2020

Solid Waste Management has been identified as a highly fragile sector for climate risk as per Climate Resilient City Action Plan (CRCAP) prepared during CapaCITIES Phase 1 (August,2018). According to the plan the sector generated **~363,000 tco2 emissions,** out of which approximately 80% emissions can be mitigated through improving waste management systems.

1.2 Solid Waste Management- Processing

Coimbatore City Municipal Corporation (CCMC) is responsible for overall waste management in Coimbatore city. In line with the CRCAP, CCMC has undertaken various initiatives to improve waste management in the city. While the responsibility of primary collection rests with CCMC workers, the corporation processes the waste through own plants and private sector participation, the chart below showcases month-wise processing of CCMC waste:

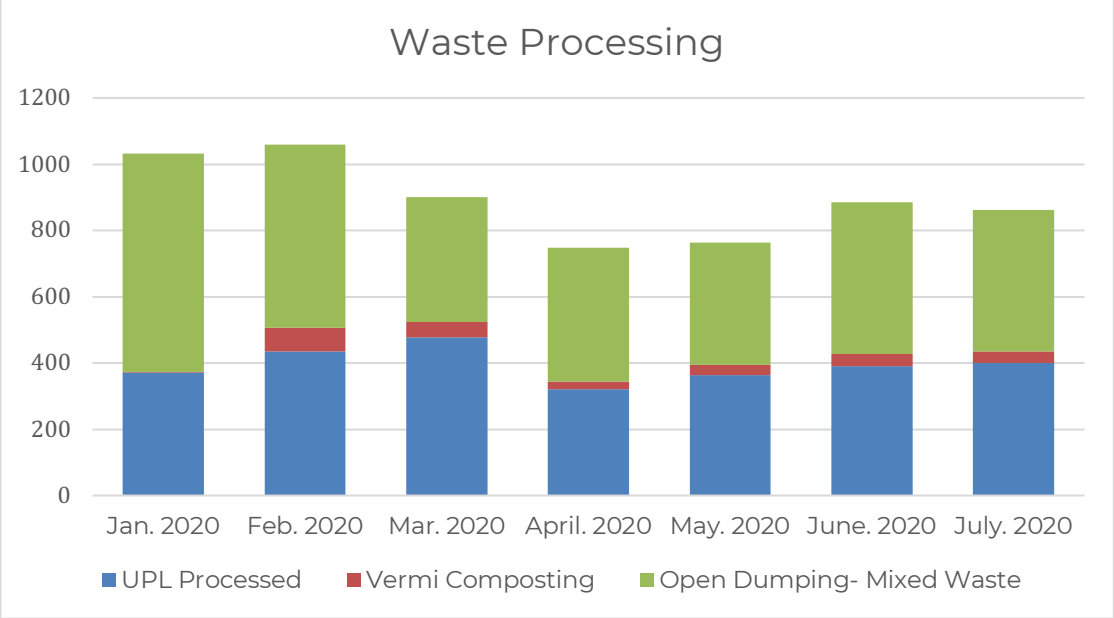


Figure 2:Current Scenario of Processing of Waste, 2020

Source: CCMC and Transfer Stations, 2020

1. **UPL-private sector processing:**
    a. Responsible for secondary transportation, treatment and processing of waste at Vellalore processing plant.
    b. Monthly average processing- **~ 400 TPD**

2. **Vermi composting and bio methanation:** plant operated by CCMC responsible for processing monthly average ~**70 TPD- Organic waste**
3. **Mixed waste open dumping:** openly dumped at Vellalore site ~ **490 TPD**

The mixed waste which is dumped openly is responsible for majority of the solid waste led GHG emission on account of methane and other GHG gases, it also leads to ground water contamination and health hazards with prolonged exposure.

1.3 Management of Mixed Waste

Almost 60% of this generated waste is organic, primarily generated from households and bulk waste generators i.e. food establishments, hotels and restaurants. Assuming the same composition for the mixed waste, ~290 TPD of organic waste is dumped along with the mixed waste at Vellalore site.

CCMC is looking for a long term self-sustainable solution for management of organic waste embracing the concept of circular economy. One such potential solution is Waste to Bio CNG Plant which was discussed and proposed by City Officials. Further, CCMC has requested CapaCITIES to develop a 200 TPD organic waste to Bio CNG project as a bankable project. This initial concept note summarizes the solution, its benefits, costs and suggest potential implementation models for the project.

2 Potential Solution: Organic Waste to Bio CNG

2.1 Waste to Bio CNG- Technology

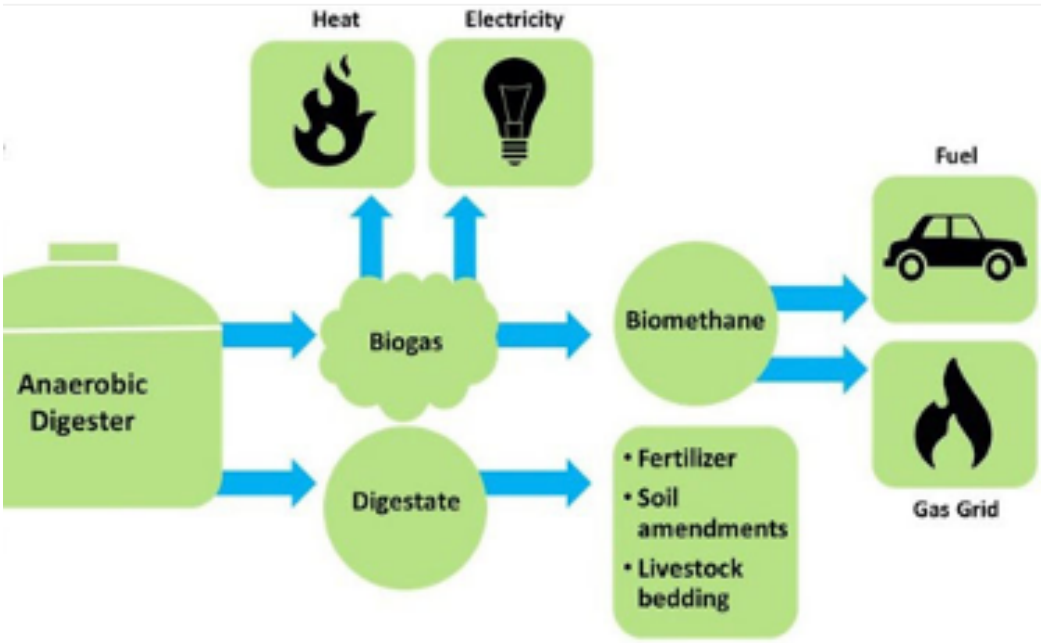


Figure 3-Diagrammatic Representation, Organic Waste to Bio CNG

Organic waste to Bio CNG is an emerging technology in which organic waste through anaerobic digestion is converted into Biogas and Bio fertilizers. The biogas generated is further purified by which contaminants (Co2, Sulphur, Vapor) in the raw biogas stream are absorbed or scrubbed, leaving more methane per unit volume of gas and the final product bio methane is formed. Bio methane is further compressed to form Bio CNG or Compressed Biogas (CBG). Bio CNG/CBG contains more than 90% pure CH and is similar to the commercially available CNG in terms of chemical composition but with higher energy potential.

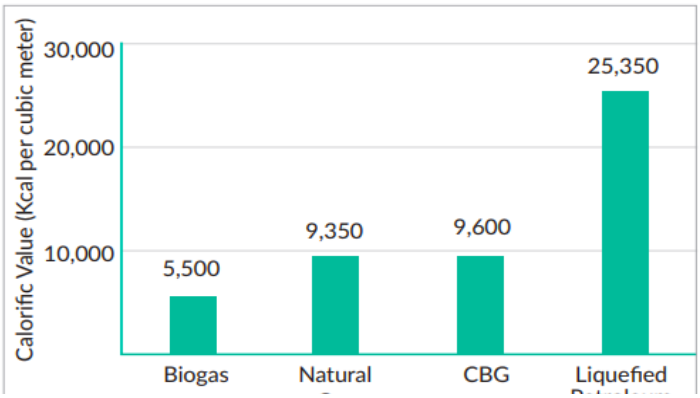


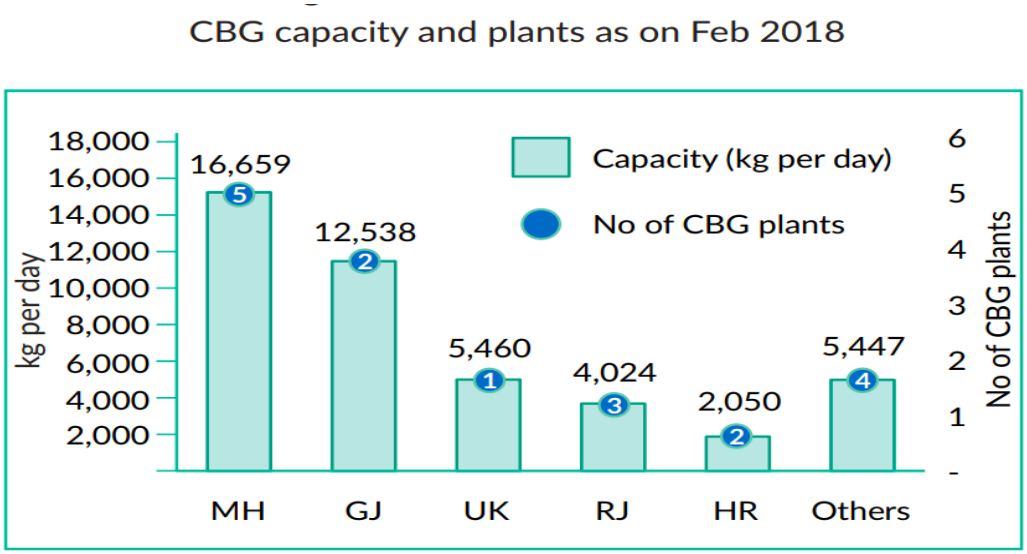
Figure 4: Comparison of Calorific Value, GGGI, 2019

In terms of chemical composition, CNG and CBG are similar, except that CNG contains higher alkanes. In addition, CBG favourably compares with Liquefied Petroleum Gas (LPG). In general, CBG/Bio-CNG has the potential to directly replace

CNG and LPG. CBG/Bio-CNG is also called Renewable Natural Gas (RNG) as it is a renewable source of energy produced from biomass and is relatively free from CO[1]. Figure below shows the comparison of calorific values of Bio CNG, CNG and LPG.

2.2 Bio CNG Plants in India

At present around 17 Bio CNG plants are operational in India with production capacity of ~46,000 kgs per day. Maharashtra has the highest number of Bio CNG plants followed by Gujarat and Rajasthan.



Source: Renewable Watch magazine (Note: MH – Maharashtra, GJ – Gujarat, UK – Uttarakhand, RJ – Rajasthan, HR - Haryana)

Figure 5: Bio CNG Plant across India, GGGI, 2019

Many municipalities in Maharashtra and Madhya Pradesh have already implemented Bio CNG projects for municipal organic waste. Many other municipalities of Tamil Nadu (Chennai), Karnataka (Bengaluru) and Uttarakhand (Rudrapur) are in process of implementing organic municipal waste to Bio CNG project.

[1] GGGI, Danish Embassy, Bio CNG Report, 2020

2.3 Application of Products from Bio CNG Plants

2.3.1 CBG/ Bio CNG

Being equivalent to automobile CNG and LPG, the CBG/ Bio CNG can be used for both domestic and commercial purposes, given below are some use cases:

Table 1: Application of Products from Bio CNG

#	Category	Usage
1	Domestic	Cooking- City Household Gas/ Cylinders
2.	Commercial	Hotel/ Resorts/ Restaurants/ Hostels- Cooking Public Transport, Autos & Private Transport- CNG Fuel Industrial Usage/ Societies

Key Benefits:

- Bio CNG meets IS 16087:2016- standard for CNG
- Environmentally friendly- Bio CNG is carbon neutral

2.3.2 Other By-products

The two major byproducts of the waste to Bio CNG process are slurry and CO_2, while the process is carbon neutral as the amount of carbon dioxide generated is equivalent to carbon neutralized while creating biomass. But both of the by-products have considerable market potential as individual products as outlined below:

Table 2: Application of By-Products

#	Category	Usage
1	Slurry	1.Organic fertilizer- replacing mineral fertilizer 2.Compost- currently sold it INR 1.7 per kg 3.Biomass briquette[2]- widely used in tobacco and tea industry of Tamil Nadu & Karnataka (traded at INR 3000-3500 per ton)
2.	CO_2	Industrial Application in Pharma, Agri,Oil and Food & Beverage industry

[2] Biomass briquette is a high-density solid biofuel made by compressing solid organic material, which is a substitute for coal and charcoal

3 Potential of Waste to Bio CNG- a sustainable solution for Coimbatore- Organic Waste

3.1 Waste to Bio CNG- Circular Economy Solution for Coimbatore

As discussed in the introduction section. At present the organic waste generated is partially converted into compost at Micro Composting Centres (MCC) owned by CCMC and operated by Waste Management Company. Waste Management Company is responsible for pick up, transportation and processing of this waste at the MCC.

The Waste Management Company is paid a tipping fee (viability gap) as the high O&M cost and small size of MCC make the operations unviable, further the output i.e. compost is found to be of sub optimal utilization of organic waste due to high moisture content and is sold at a price of INR 1.5 per kg making the whole process non-viable.

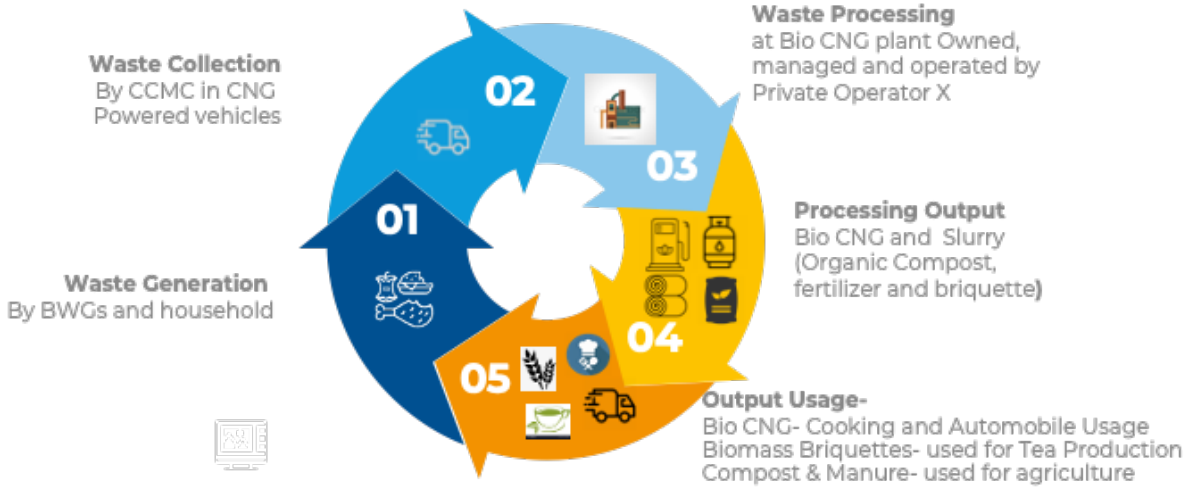


Figure 6: Waste to Bio CNG-Circular Economy

Therefore, an alternative approach of setting up Bio CNG plant for processing bulk and household organic waste is recommended. Based on preliminary discussions with CCMC, the corporation has recommended to explore potential of 200 TPD waste to bio CNG plant. It is proposed as an alternate self-sustainable solution, CCMC appoints a private player for management of organic waste by designing, building, financing, operating and managing a waste to Bio CNG Plant. A circular economy model is proposed below are the key elements of the solution.

- **Waste Generation:** Bulk waste and other municipal waste generators would be responsible to provide segregated organic waste.
- **Waste Collection and Transportation:** An agency appointed by CCMC would be responsible for collection of organic waste and transportation of the same to MCC sites. A secondary quality segregation would be undertaken at MCC and then the waste would be transported to the site of Bio CNG plant. It would be an endeavour to transport the waste in clean fuel powered vehicles. It would be the responsibility

of CCMC to provide segregated organic waste of pre-determined quality and quantity to the Private Bio CNG Plant operator.

- **Production:** Private Operator X would set up a waste to Bio CNG plant and the segregated waste through anaerobic digestion would be converted into slurry and Bio Methane. Bio Methane through Co2 purification process converted into Bio CNG. Slurry can be further converted into organic compost, fertilizers and biomass briquette.
- **Market & Distribution:**
    - **Bio CNG:** Private Operator would enter into pre purchase agreement with OMCs under Government of India's SATAT Initiative and transport the gas to the checkpoints at pre agreed price, additionally private operators may consider entering into pre purchase agreement with BWGs to supply gas for cooking. Further, institutional tie ups with hotels and public transport companies may also be explored.
    - **By Products**: For Slurry private operators may sell the compost at pre agreed price under Government Schemes. Additionally, the operator may enter into purchase agreements with tea production companies for supply of Biomass Briquettes.
- **Usage:** Based on viability and potential of above options, the Bio CNG may be used for automobile and cooking purposes, while slurry can be used in agriculture and tea production facilities.

3.2 Proposed Implementation Structure

The project is proposed to be implemented on Public Private Partnership (PPP), following implementation models could be evaluated:

1. DBFOT: Design, Build, Finance, Operate and Transfer (land provided by CCMC and transfer of asset is envisaged at the end of concession period)
2. DBFO: Design, Build, Finance and Operate (land brought by private operator transfer of asset is not envisaged)

4 Envisaged Benefits

4.1.1 Monetization of Emission Reduction from the project

The development of proposed plant would positively contribute towards reducing the GHG emissions as below:

- Upstream GHG emissions on account of methane avoidance due to proper processing of waste which was otherwise dumped in a mixed landfill
- Downstream GHG emission on account of displacement of conventional fuel by Bio CNG

The preliminary assessment suggests developing and registering the project under suitable methodology and obtaining carbon credits could result in a marginal increase in project viability and returns.

A detailed assessment of the same would be undertaken at the feasibility stage of the project.

4.1.2 Other Co Benefits

A preliminary assessment of the impact of Bio CNG plant in line with SDGs, figure below showcases the impact of this project across different SDGs:

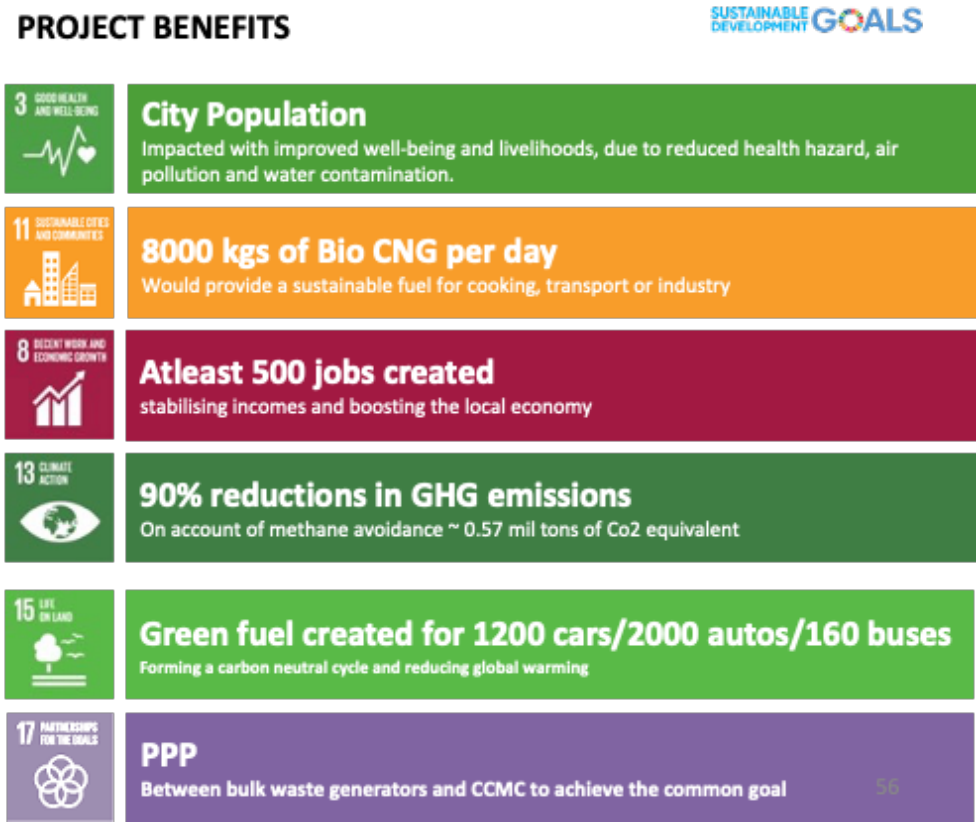


Figure 7: Envisaged Benefits-Aligned to SDGs

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