



GPS Renewables

Reinventing Biogas for Urban Spaces

What we started off to do..

An aerial photograph of a very dense urban area, likely a city in India, showing a vast expanse of high-rise apartment buildings and commercial structures. The city is situated near a body of water, with a bridge visible in the distance. The sky is hazy or overcast.

Create a Biogas plant that can
be deployed in Urban Dense
Cities & Towns

Why in Cities ?



Cities occupy **~3%** of the world landmass but consumes **66%** of world's energy and accounts for **70%** of global CO₂ emissions

Source: c40.org

India is Overwhelmed

Mumbai



132 hectares Deonar dumping ground. It became operational in 1927, two decades before Independence

20m^{avg} height of each garbage mound; at some spots, including near Rafiq Nagar, it goes up to **35m**

17.5 million tonnes of waste has been dumped on the site so far

WHAT HAPPENED
Monday, 3.30pm | Fire erupts in the pockets near Baba Nagar and Rafiq Nagar, spreads rapidly due to strong winds at night
Tuesday | Firemen 'reduce fire to a smoulder; confine it to one area', but thick smoke cover still in area

PREVIOUS D
2015 | bet ar...
Jan 28, 2016 | Major fire breaks out on Ghatkopar side of the dump; thick smoke covers

City generates over 7,000 metric tonnes of waste daily
4,000 metric tonnes is sent to Deonar

INDIA TODAY

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Ghazipur garbage dump almost as tall as Qutub Minar: Story behind Delhi's largest landfill site

Ghazipur garbage dump is now 65 metres tall which is just 8 metres less than that of Qutub Minar's height. Know all about the oldest and largest landfill site of Delhi.

Bengaluru's waste creates mounds of problems in Mavallipura

Mavallipura, which is some 30 km from Bengaluru, was once known for its greenery. People residing there were largely dependent on agriculture.

But over a period of time, when the landfill site was identified at Mavallipura to dump Bengaluru's garbage, the soil, water and air got polluted, making the lives of villagers in and around Mavallipura miserable. Around 10 to 12 villages were affected including Mavallipura, Guddadahalli, Jaragbandekaval and other places. There were a few deaths due to garbage that triggered protests. Many villagers suffered from skin allergies, respiratory diseases and other ailments.



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News / India / India needs New Delhi-size landfills for waste by 2050, says report

India needs New Delhi-size landfills for waste by 2050, says report

India needs to set up about 88 sq. km of precious land under waste disposal through landfilling by 2050, which is equivalent to the size of area under administration of the New Delhi Municipal Council.

THE HINDU

JUST IN 14 Pope declares war on sexual abuse but victims feel left down 15 Six couples in search of a safe home in Delhi 16 Here's the full list of winners

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TODAY'S PAPER

Wasted effort: half of India's waste-to-energy plants defunct

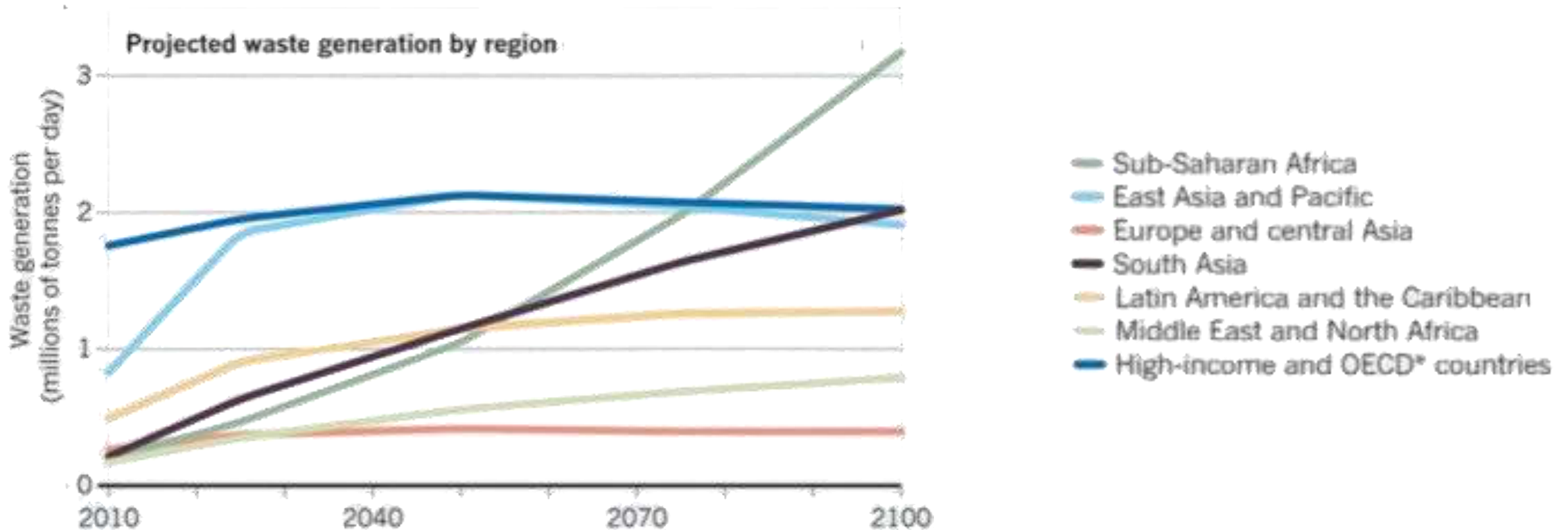
Jacob Koshy

NEW DELHI, FEBRUARY 15, 2019 10:46 IST
UPDATED: FEBRUARY 15, 2019 10:27 IST

Decentralized waste management is the need of the hour

The Future of Waste Management

- **Decentralized WM models** currently account for **<1% market share**. A significant chunk of the **future waste** is **expected to be processed by decentralized models, especially in emerging economies**
- Global waste expected to grow faster than human population growth | This **growth to come from emerging economies**, which have lower processing %age



Company Overview

WAMTECH (Waste Management TECHnology) firm based out of Bangalore | Established in 2012 by **IIM, IIT & NIT** graduates

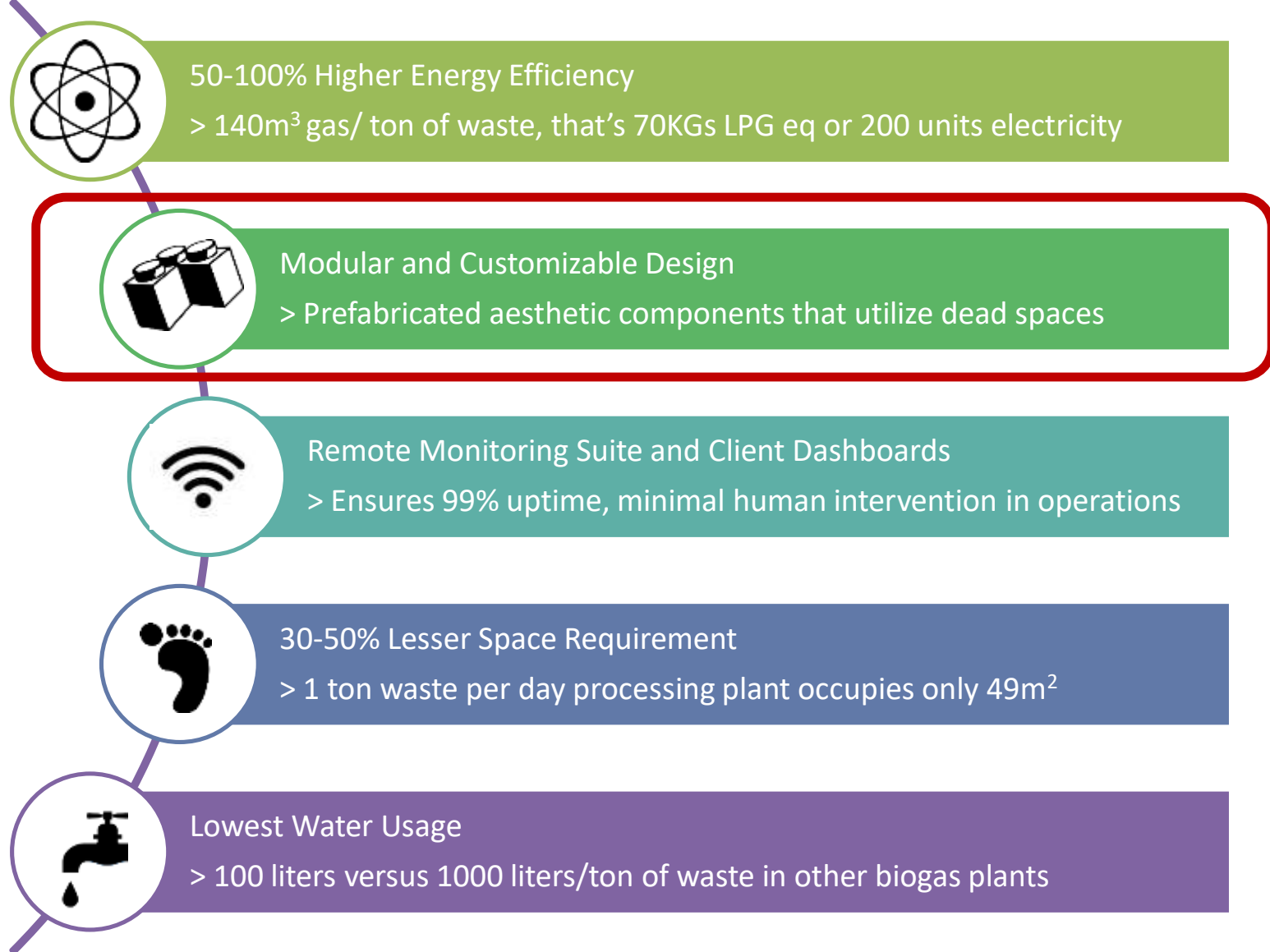
CLIENTELE



INTERNATIONAL AWARDS



What we created – The BioUrja™



Aerial view of Delhi Aerocity

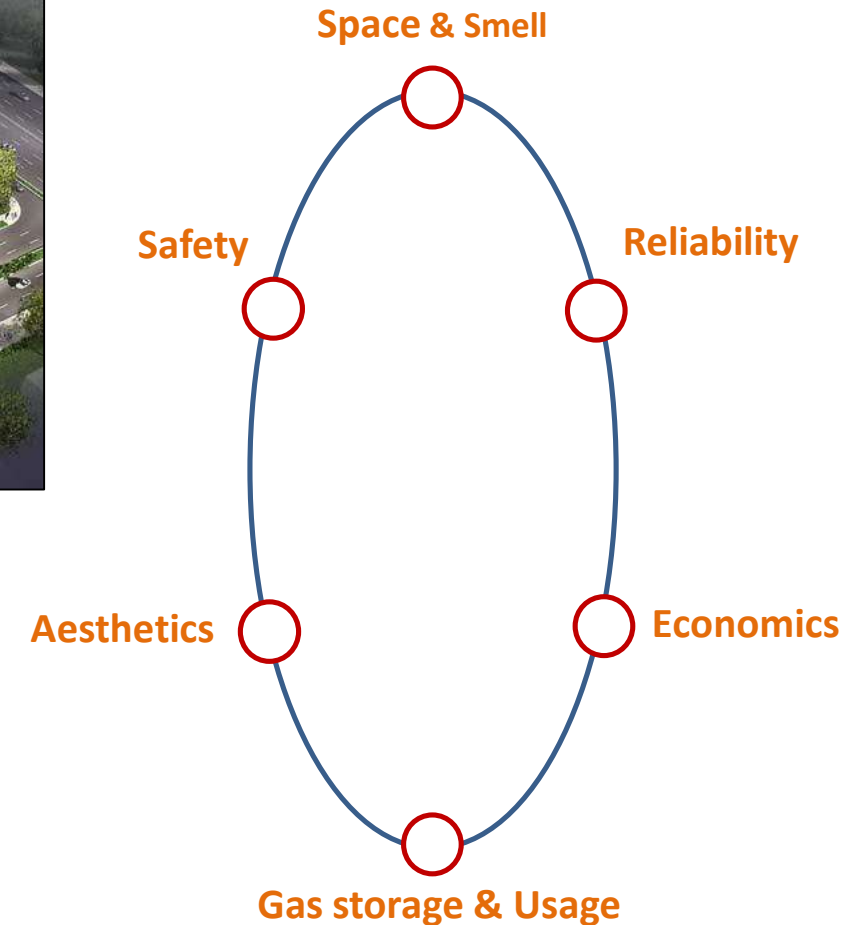


JW Marriott Delhi - The Problem(s)...



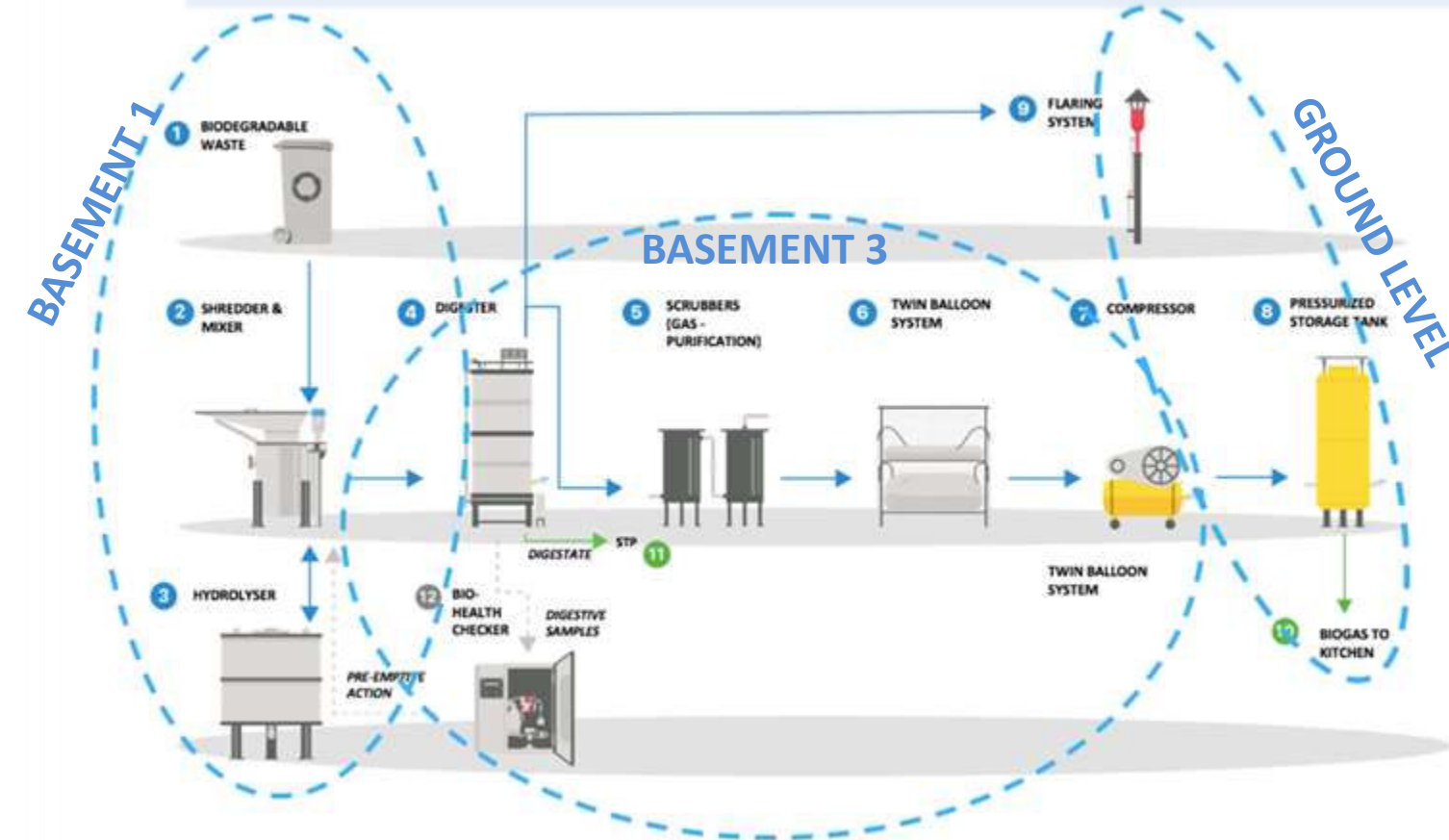
JW Marriott, Aerocity, New Delhi

JW Marriott, New Delhi did not have a single piece of land open to the sky for setting up a biogas plant. – which prevented such an institution from setting up a traditional captive biogas plant



BioUrja: ...the Solution ...

A state-of-the-art biogas plant with a disruptive layout. In case of JWM Delhi, based on the usable spaces, the plant has been **uniquely spread across 3 floors**. The plant can process 1 ton of food waste per day and replace up to 90 SCMD of PNG with clean fuel via dual fuel burners. The plant pays back for itself in 3-4 years



Space Utilization

- i. 28 sqm space in basement 3 with approx. 3.6m height clearance. Digester was site fabricated so that it could be accommodated in the basement
- ii. 17.5 sqm space in basement 1
- iii. 13 sqm space in ground floor



JW Marriott Basement 3: Digester & Hydrolyser

28 SqM



JW Marriott ground floor : Storage vessel

13 SqM

Impact at JWM



JW MARRIOTT NEW DELHI INDIA

625 T

Waste Processed

4543 T

CO2 Mitigated

\$40K

Money Saved

43736 KGS

Gas Generated

Plant cost \$55K to set up, will achieve 3 YR payback

Average capacity utilization has been 80%

1st JWM property in the world to have captive biogas

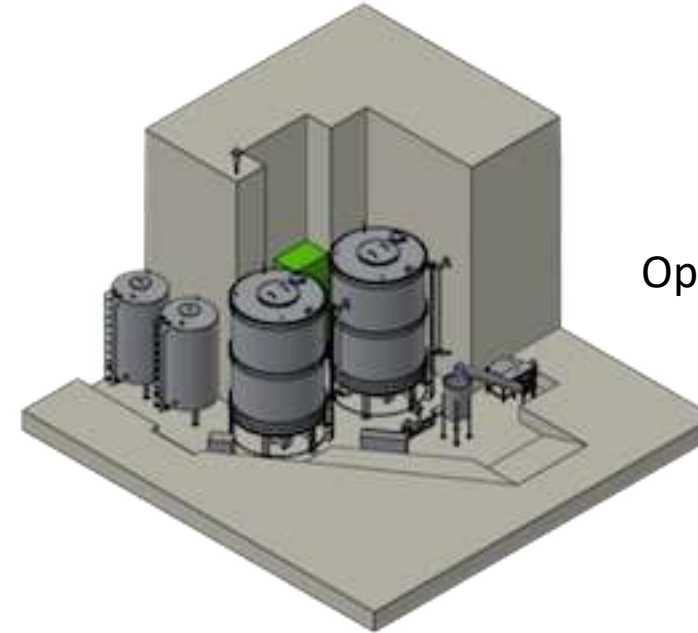
*CO₂ Mitigation has been calculated using IPCC AR5 20YR GWP of Methane

^ All data is pre covid lockdown



Some more examples where we have led with Modularity

Space Optimization at a Tech Park



Operational from 2015

2 tpd biourja setup @ Infosys, Bangalore (1/7 Infosys Sites)

clockwise from top right:

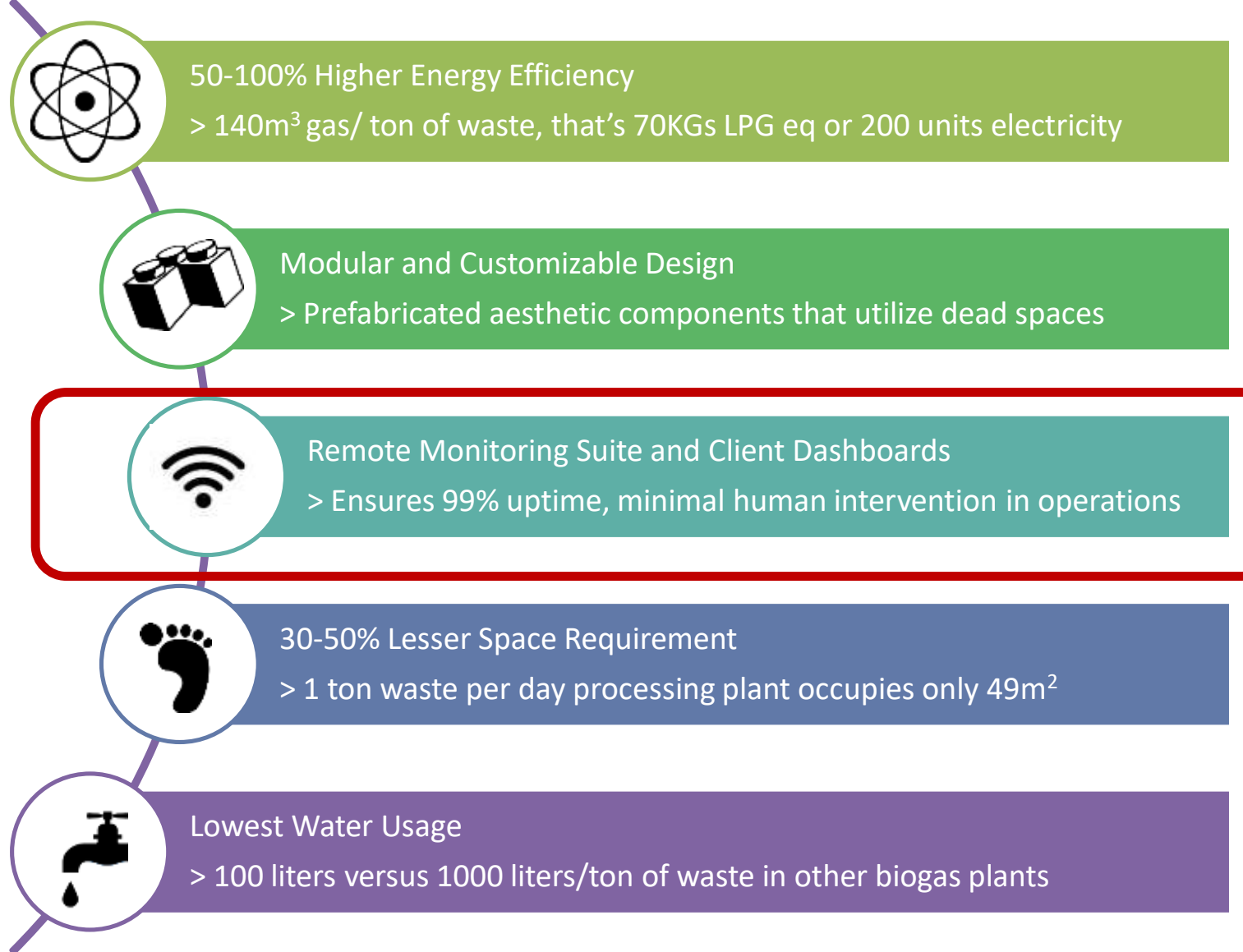
- 1) *view from outside of shed housing the plant*
- 2) *plant 3D layout*
- 3) *view from inside of shed*

Distributed layout across 2 floors of ITC Maratha



Operational from 2017

Case Study 2



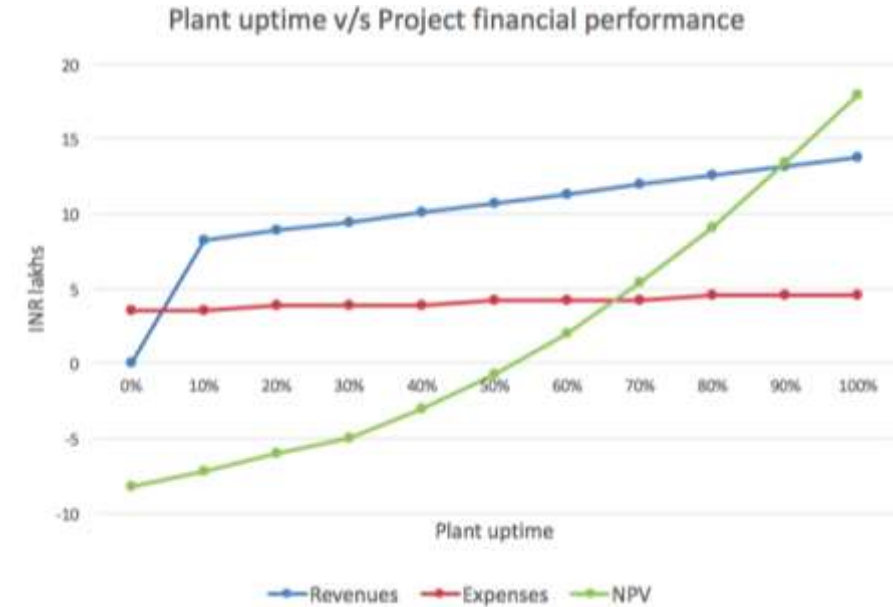
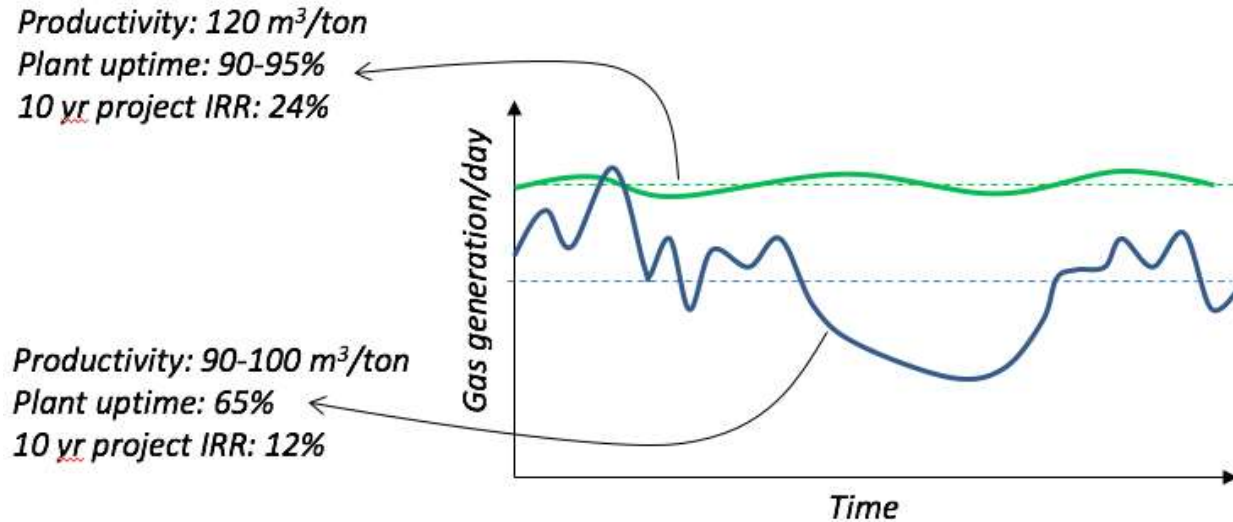
GPS' IoT & AI driven Solution for Plant Health Monitoring

The Reliability Problem



THE NEED FOR BIOMAINTEENANCE:

Biogas plants are prone to frequent breakdowns especially in fluctuating conditions. Can ruin project viability if not addressed



CHALLENGES:

- pH is a lagging indicator. Easy to measure, but not of much use
- Gas Chromatography (GC) is an apt health tracking device, but not viable at captive scales (<5TPD)
- Reactive action decision making very people dependant. Prone to human errors

GPS' Solution to the GC Challenge

- GPS' patented auto-titrator (Bio-health Checker) sits at every BioUrja plant, which can be operated by any unskilled person.
- At the push of a button, the Bio-health Checker performs titration, and automatically emails the titration results to GPS HQ. This data then is fed into a **statistical model, which tries to mimic a GC.**
- The model has been built upon years of data from multiple GPS plants and every additional plant added makes the system more robust (network effect)



Patented biohealth checker



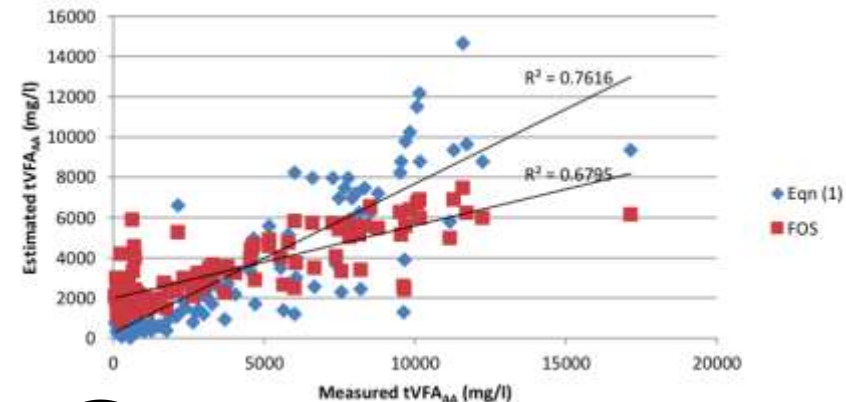
Titration data

Proprietary biohealth
parameter calculator



Regression

Results similar to GC



Sample total VFA estimate v/s actual data

$R^2: 0.76, p < 0.05$

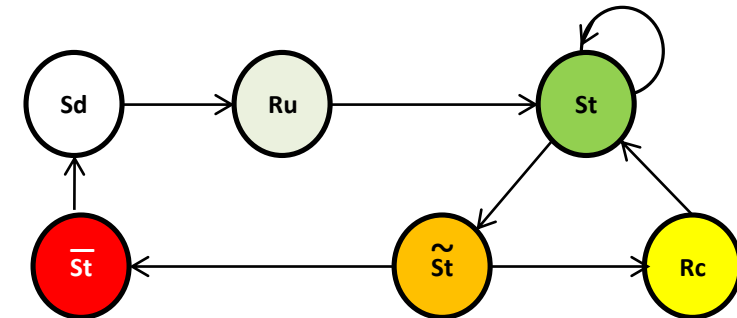
For healthy plants, $R^2 > 0.9$ and $p < 0.05$

GPS' Solution to the Human Challenge

- Once one has the GC (or GC replica) results, a supervisor (ideally a **biogas expert**) **needs to decide on the next actions**.
- **Every biogas plant is unique** – which makes monitoring & action decision making extremely challenging. If left to a team of people, the **actions can be non-uniform and prone to human errors**.
- GPS has addressed this problem by creating a **FSM (Finite State Machine) model** of different plant states: Seed (Sd), Ramp-up (Ru), Stable (St), Not so stable (\tilde{St}), Unstable (\bar{St}) & Recovering (Rc). The plant state movement (and corresponding action) is decided by the BiogasBot

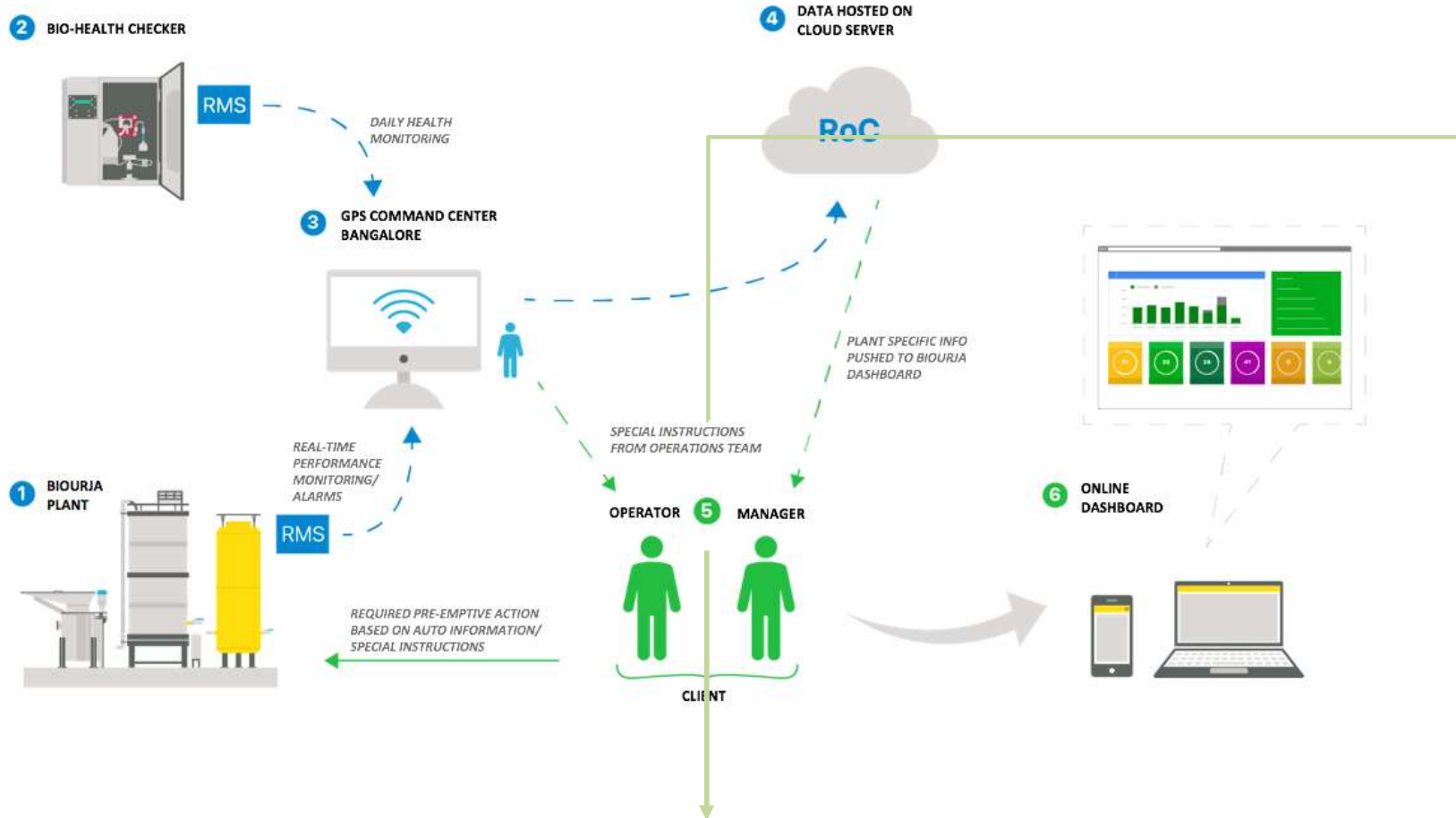
Solution Overview:

- Proprietary FSM model for plant biohealth status (*as shown on the right*)
- Chatbot based next state & corresponding action predictor | Works on local data (plant's own data trends, since every plant is unique) & global data (standard parameters)



Overview of the RMS System

IoT approach for tracking the health of the plant 24x7 -> Using proprietary statistical models to mimic Gas Chromatography -> And finally letting GPS' in-house developed BiogasBot, to arrive at the apt pre-emptive action and communicate it via chat to reduce human errors



biogasbot
Reactor is : "Vignan"
pH is : 7.40
Acidity is : 1160.04
Alkalinity is : 4650.00
Ratio is : 0.25
Last waste added is : 390
Gap in feeding : 1 days.

Waste Loading changes by 5%.
The waste to be added is : 410 kg

Relative Correction Advisory
10:45 AM

biogasbot
Reactor is : "INTEL BLR"
pH is : 7.78
Acidity is : 1179.96
Alkalinity is : 6363.00
Ratio is : 0.19
Last waste added is : 200
Gap in feeding : 1 days.

Waste Loading changes by 0%.
The waste to be added is : 200 kg

Relative Correction Advisory
12:15 AM

BiogasBot - GPS' Expert System, which mimics a biogas expert for decision making

GPS' proprietary backend data platform

Screenshots of GPS' backend data platform, which stores data from all plants, including the Biohealth Checker (titration raw) data as well as data points from other sensors such as pH, temperature, gas flow rate, etc.

Health and waste addition data

REACTOR	P H	ACID	ALKALINITY	HEALTH	DATE
TAJDELHI	7.57	1813.67	9732.38	0.186354	11-12-2018
TAJDELHI	7.69	1915.76	10116.8	0.189365	09-12-2018
TAJDELHI	7.52	2375.16	8563.88	0.277346	08-12-2018
TAJDELHI	7.65	2017.84	8118	0.248564	07-12-2018
TAJDELHI	7.76	2068.89	8963.62	0.23081	06-12-2018
TAJDELHI	7.63	2477.25	7702.88	0.321601	05-12-2018
TAJDELHI	7.77	2222.02	7087.88	0.313497	04-12-2018

REACTOR	DATE	WASTE NEEDED	WASTE ADDED	ADDITIONAL INFORMATION	SLURRY	ADDED FROM HYDROLYSER
TAJDELHI	11-12-2018	300	200	Shortage	25	275
TAJDELHI	10-12-2018	300	150	Shortage	25	275
TAJDELHI	09-12-2018	300	150	Shortage	25	275
TAJDELHI	08-12-2018	300	200	Shortage	25	275
TAJDELHI	07-12-2018	300	300	Fed Successfully	25	275
TAJDELHI	06-12-2018	300	150	shortage	25	275
TAJDELHI	05-12-2018	0	0	Maintenance Work	0	0

ADUGPRS

Limit data: 7

Date Filter: Start: End: Search

Waste addition entry

Titration manual entry

Alert

GPS Command

Visualize

Data Listing

REACTOR NAME	BALLOON 1 COUNT	BALLOON 2 COUNT	COMPRESSOR RUNTIME	MINUTES OF FLARING	GAS FLOW RATE	PRESSURE IN THE STORAGE VESSEL	DIGESTOR TEMPERATURE	VOLUME OF GAS FLARED	MESSAGE RECEIVED TIME	DIGESTER	PRESSURE #1	PRESSURE #2	VALVE POSITION
ADUGPRS	7	6	71	0	83	824	36.63	0	Thu Nov 16 18:33:11	55	136	137	85
ADUGPRS	7	6	71	0	83	823	36.63	0	Thu Nov 16 18:31:29	55	136	136	85
ADUGPRS	4	4	41	0	83	815	36.72	0	Thu Nov 16 17:28:27	56	136	133	89
ADUGPRS	2	1	13	0	90	883	36.49	0	Thu Nov 16 16:31:12	55	135	135	85
ADUGPRS	1	1	9	0	90	897	36.63	0	Thu Nov 16 16:24:22	56	137	135	85
ADUGPRS	50	51	579	2	90	920	36.53	116	Thu Nov 16 16:03:59	56	137	134	85
ADUGPRS	49	49	558	2	100	907	36.33	116	Thu Nov 16 15:20:17	56	134	135	85

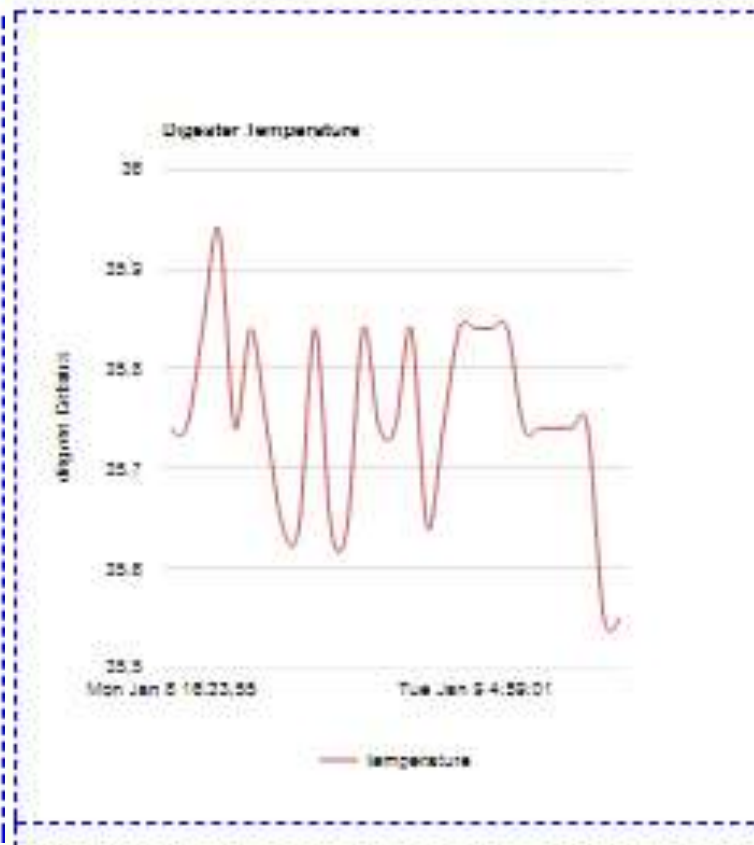
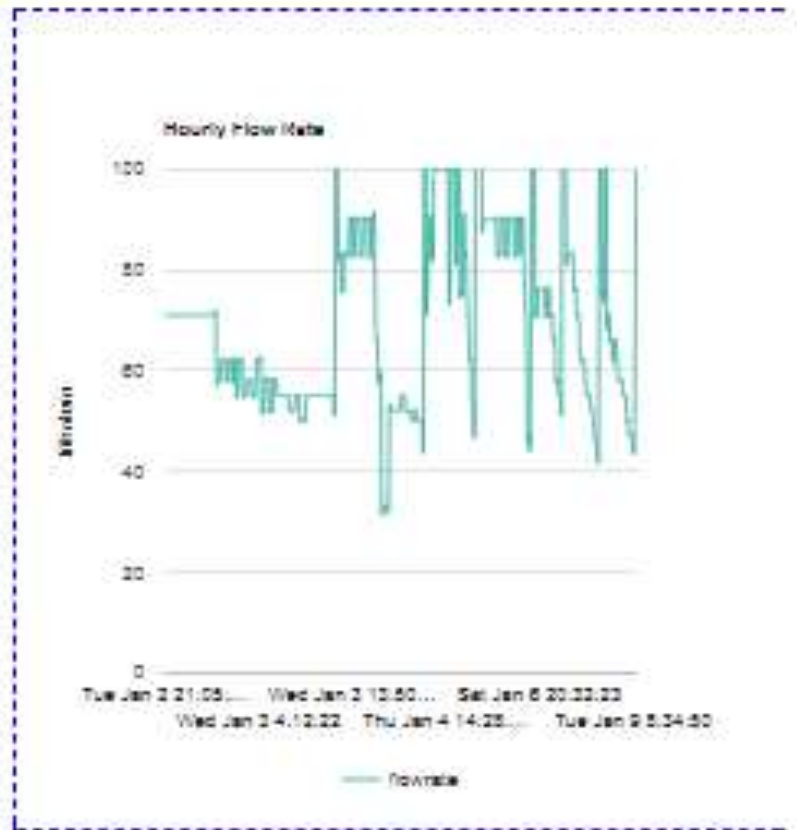
Health and waste addition data

REACTOR NAME	P H	ACID	ALKALINITY	HEALTH	DATE
ADUGPRS	7.4	2091	6445	0.324438	16-11-2017
ADUGPRS	7.33	1899	6395	0.296951	15-11-2017
ADUGPRS	7.35	2043	6885	0.30561	14-11-2017
ADUGPRS	7.52	2164	6750	0.320593	13-11-2017
ADUGPRS	7.44	1947	6641	0.293179	12-11-2017
ADUGPRS	7.48	1730	6990	0.262519	11-11-2017
ADUGPRS	7.42	1638.04	6800.5	0.243811	10-11-2017

GPS' proprietary backend data platform

Visualize

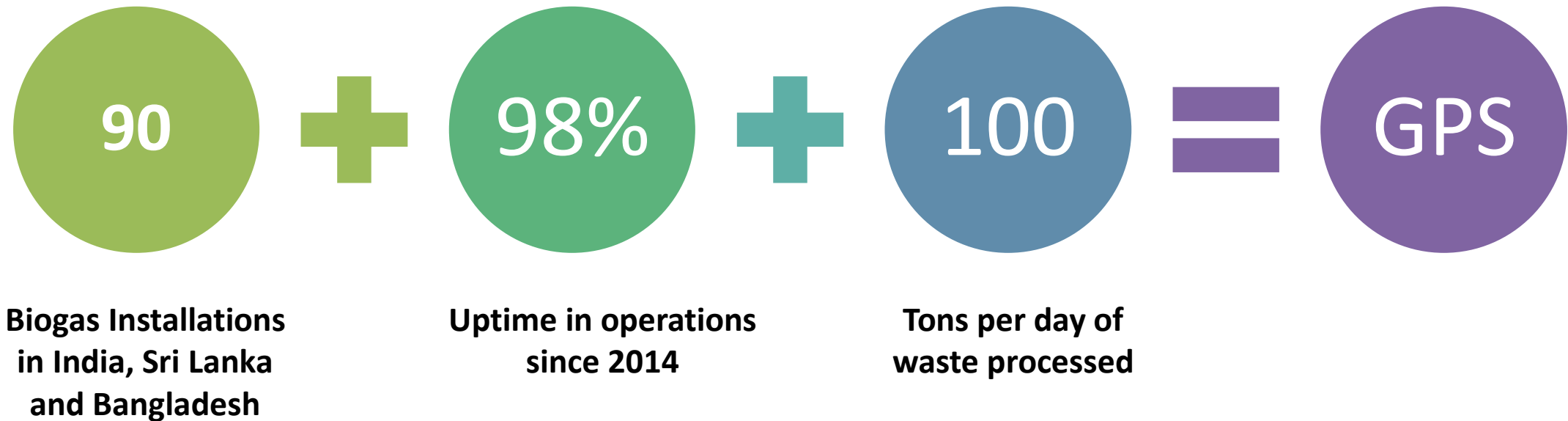
Reactor Name:



RMS is key to scaling captive biogas plants and makes even small 100 KPD plants viable and scalable across geographies and creates a Network Effect

Investment in cloud based RMS systems have led to minimal disruption of our plants even in the midst of a 2 month lockdown in India on account of COVID19

Where we are today



Impact Potential

Methane Emission

- **75%** of organic waste is **openly dumped** in South Asia, leading to high methane emissions

Waste Generation

- India already generates **40 Mn Tons of Organic Waste** per year and civic infrastructure is unable to cope

Energy Substitution

- Can replace **fossil fuel based LPG** and **coal based electricity** at meaningful scale to be a viable urban fuel source

Key Trends

Regulation

- Solid Waste Management Rules 2016 in India mandate in-situ processing of waste by bulk waste generators. This is a trend across South & South East Asia

Carbon Pledges

- From Microsoft to Google, many global firms are driving the carbon neutral pledge and we see captive biogas as a key component to deliver that

COVID

- From wanting to create minimal contact self reliant facilities to enabling a green recovery, we believe that COVID could give a fillip to captive biogas



THANK YOU

gps renewables



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