Production of Biopolymers from Biogas

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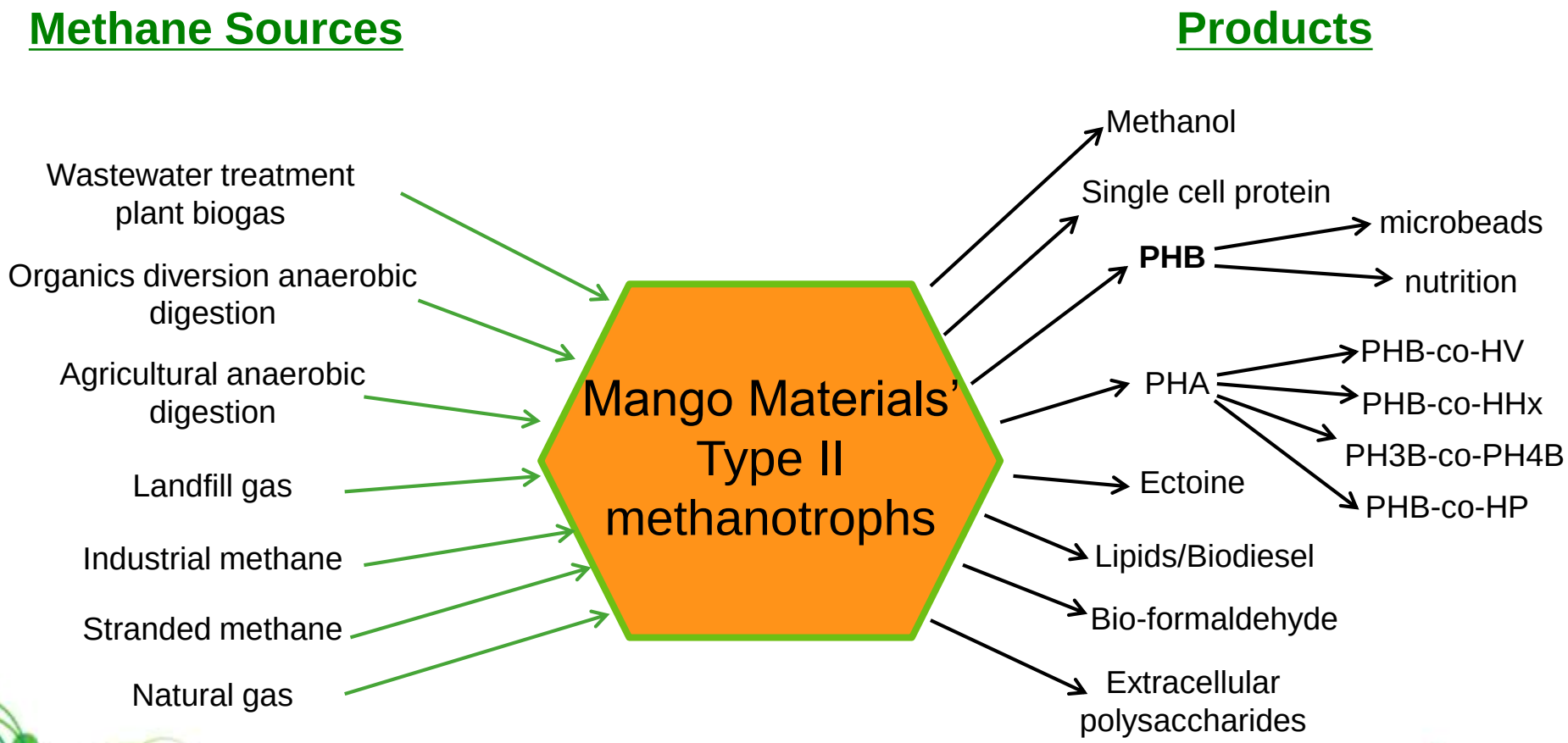
@MangoMaterials

Ziploc
VTECH
LUMILITE
LuxMaster
planet bike

MANGO MATERIALS

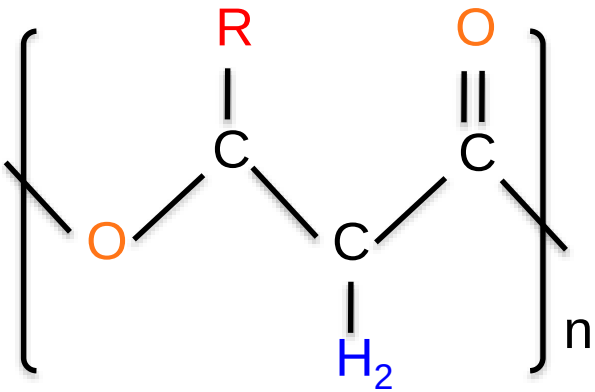
To turn waste into **ecofriendly**, **affordable** materials while creating a **positive** environmental impact.

Mango Materials' Platform Technology



Biopolymer

Polyhydroxyalkanoate (PHA)



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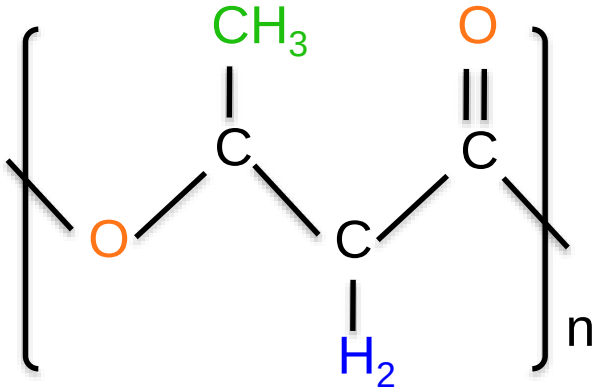
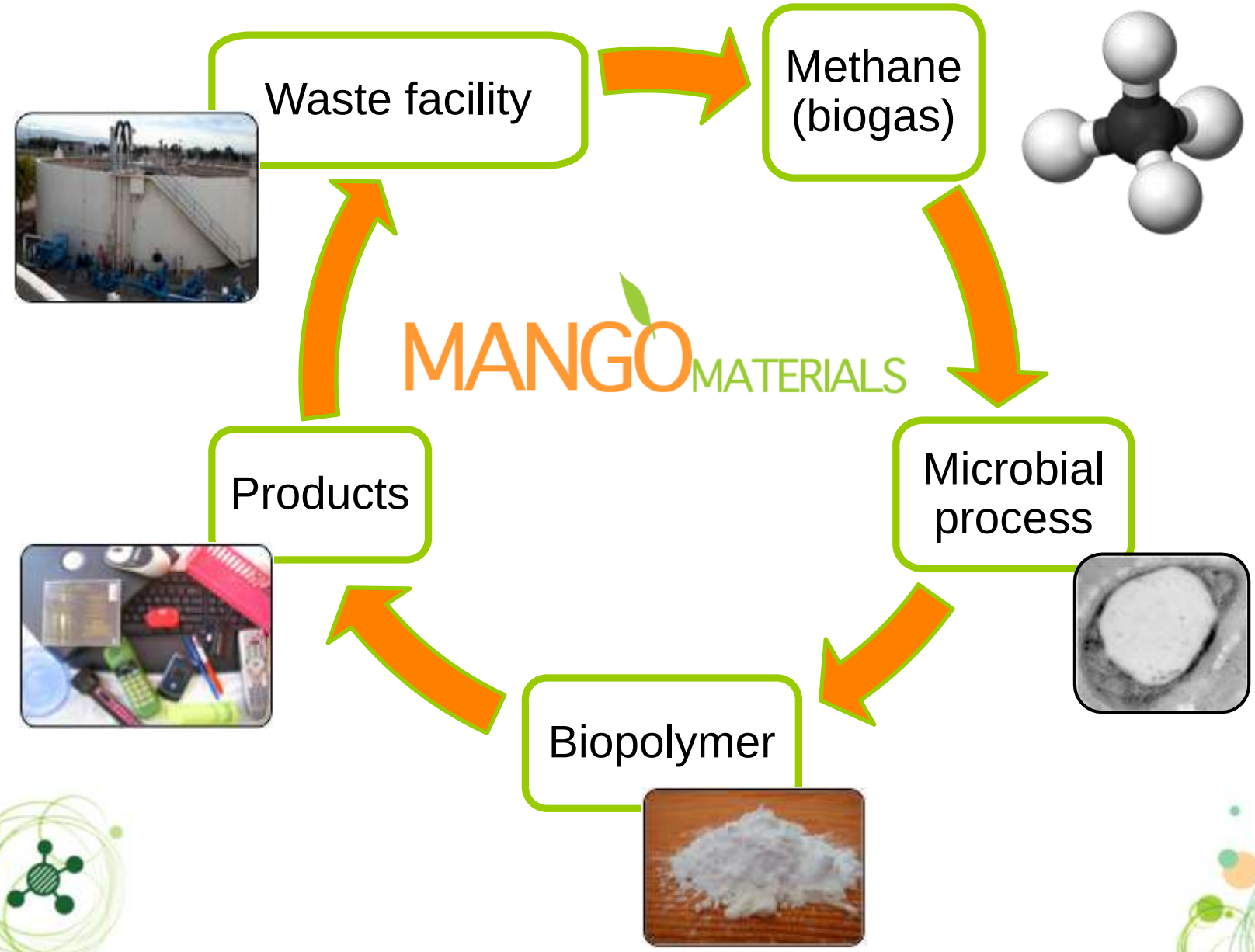


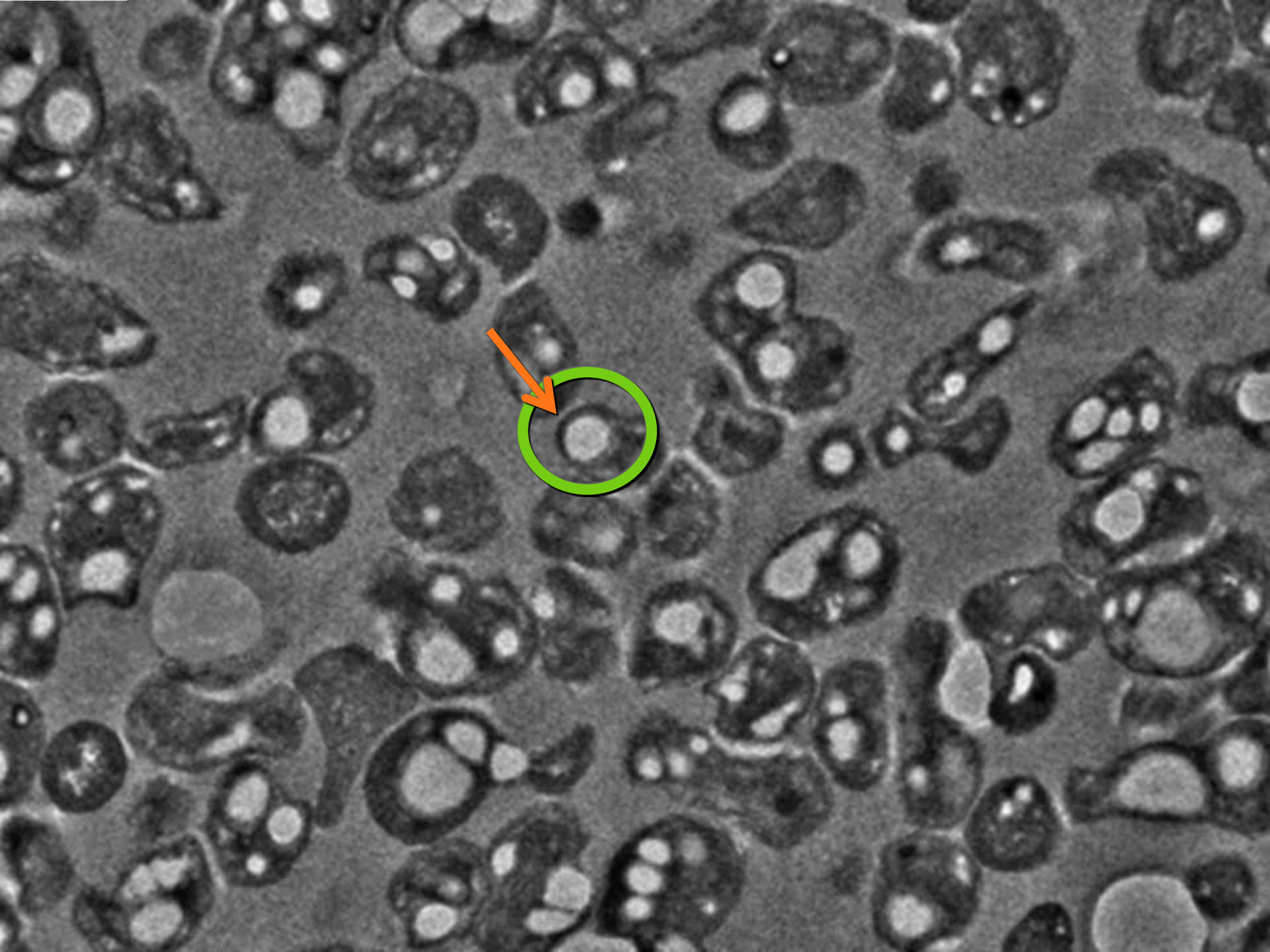
Poly-3-hydroxybutyrate (PHB)

PHB is one type of **PHA**

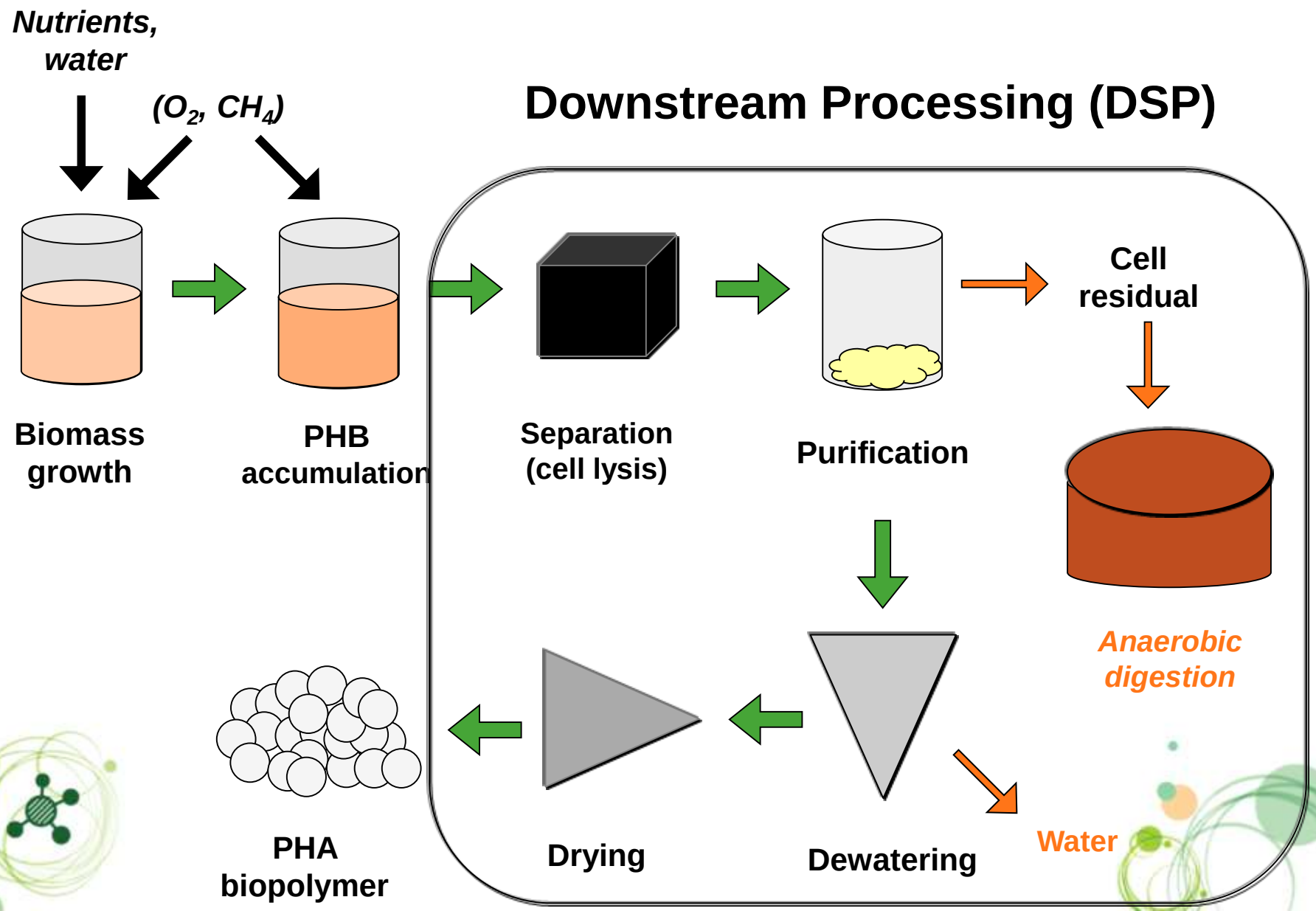

Waste facility
Methane (biogas)
Microbial process
Biopolymer
Products
MANGO MATERIALS

Waste methane → **Bioreactor** → **Biopolymer**

Patent-protected by IP licensed from Stanford University



Process overview



Material Properties

Typical Physical Properties	Polyhydroxy-butyrate (PHB)	Polypropylene (PP)
Physical Form	Powder	Powder
Color	White	Clear
Particle Size	<150 um	<150 um
Odor	Odorless	Odorless
Crystallinity	70-90%	70%
Melting Point Range	170-180 deg C	160-170 deg C
Glass Transition Range	0-4 deg C	-15 deg C

End-of-Life

Applications

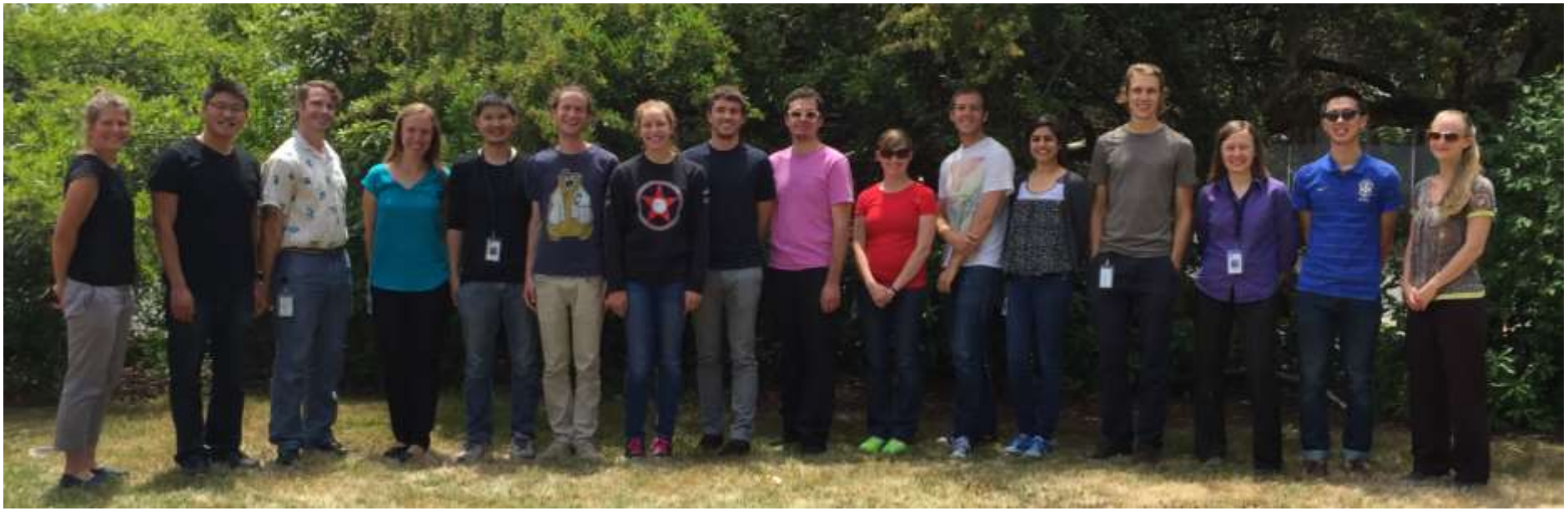
Marine

Agriculture

3D Printing

Microbeads

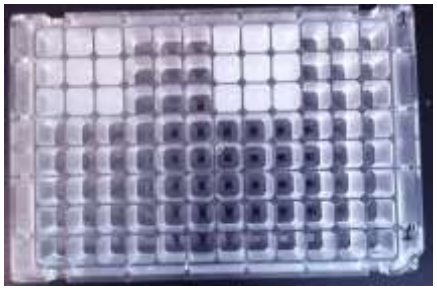
Team

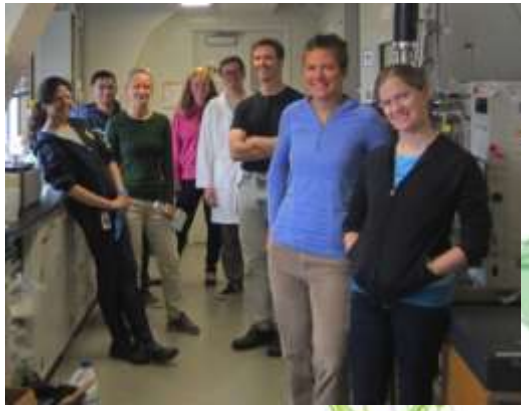


Pauchon Foundation

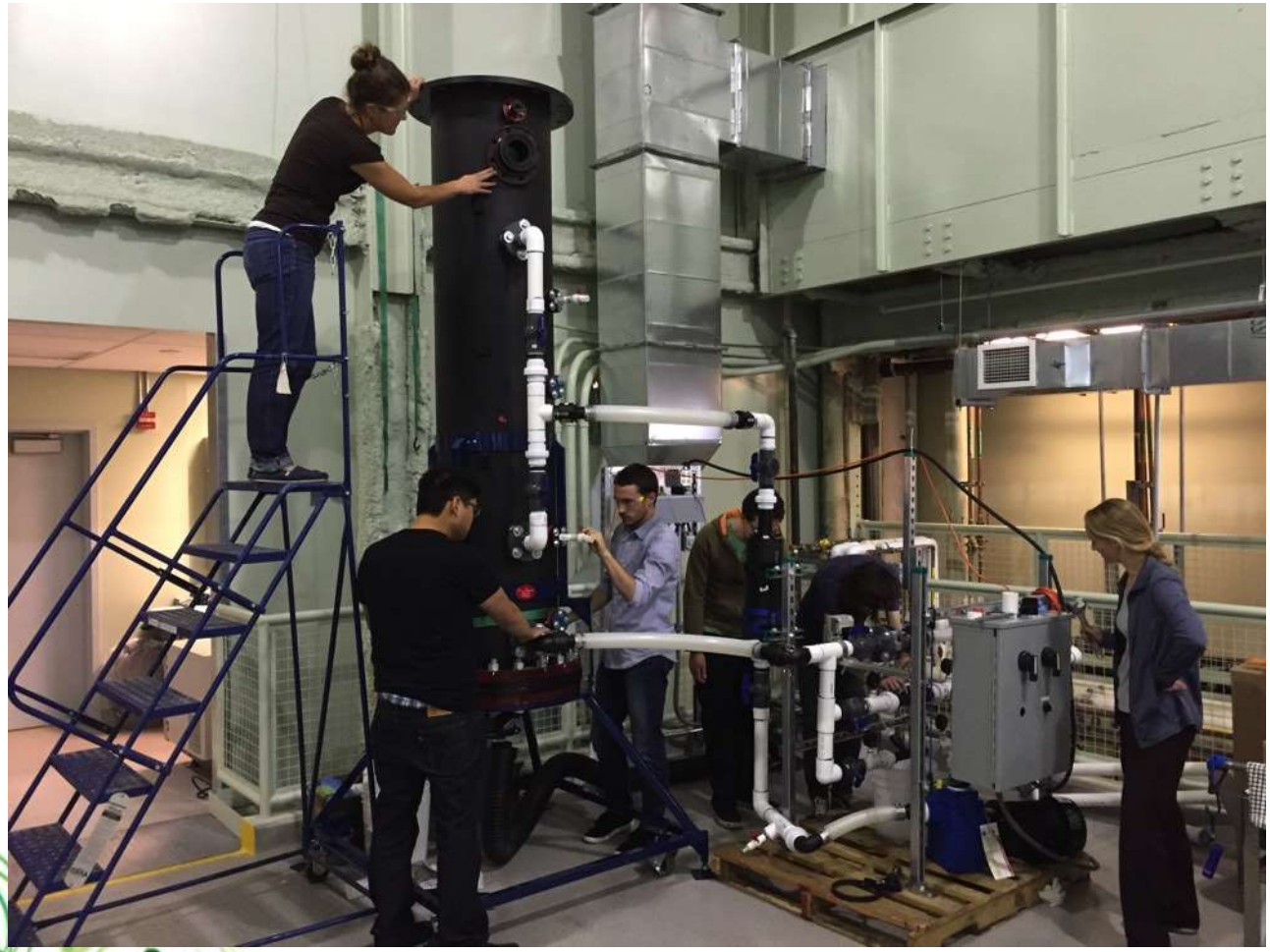
Bench scale work

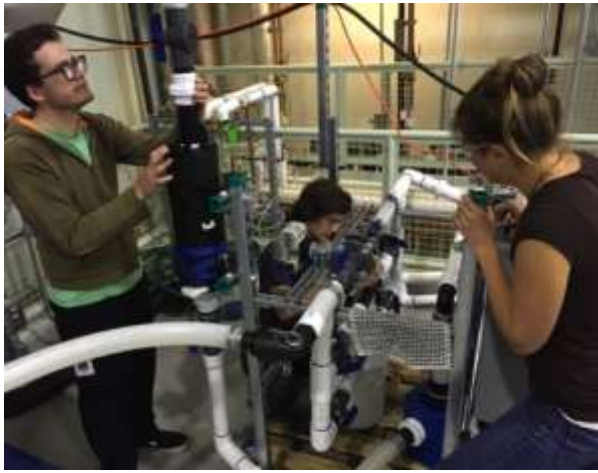
USDA ars





Pilot System





SVCW
Silicon Valley Clean Water

Candle Flare

Anaerobic Digester

VISITOR

Pilot System in the Field

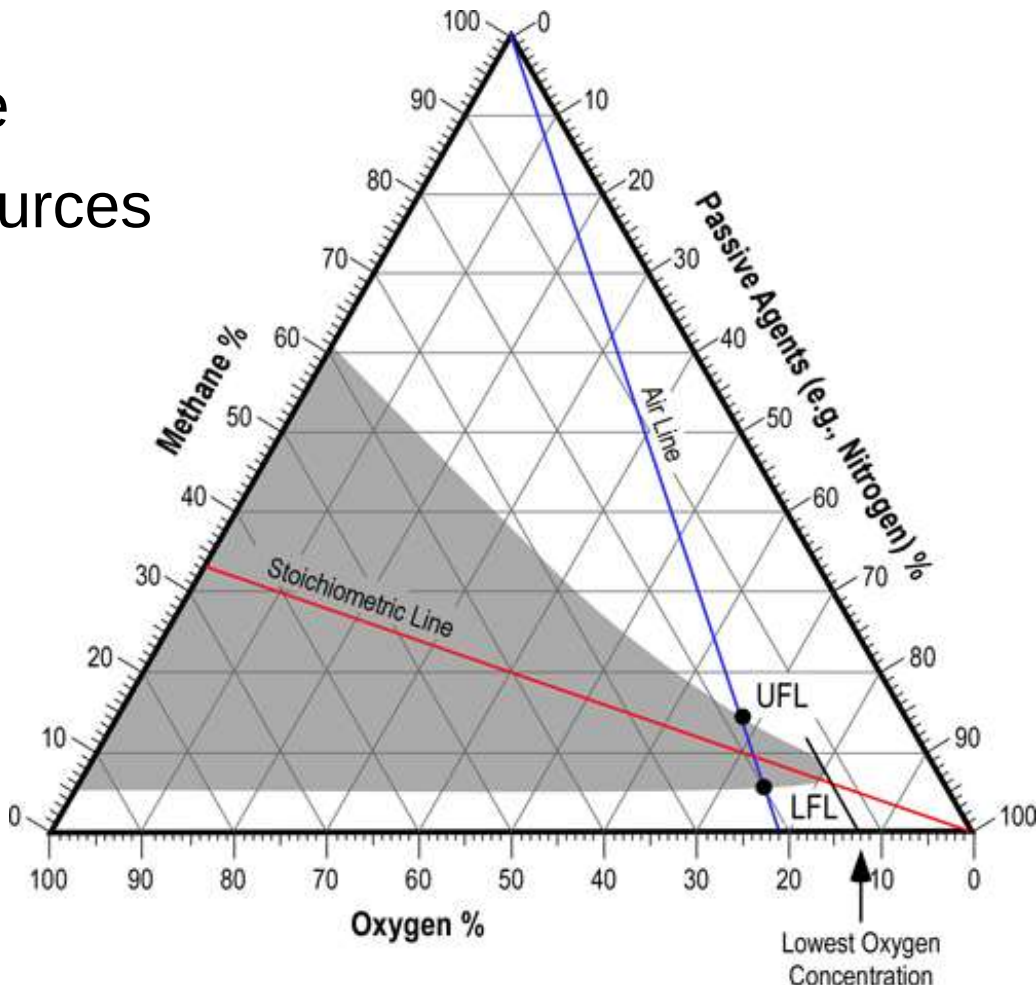
Dealing with impure gases

- CO_2
  - pH
  - Mass transfer
- Contaminants – sulfide, siloxanes
- Sterility
  - …at a wastewater treatment plant?

Safety

Methane is flammable!

- Stay out of explosive range
- Remove potential spark sources

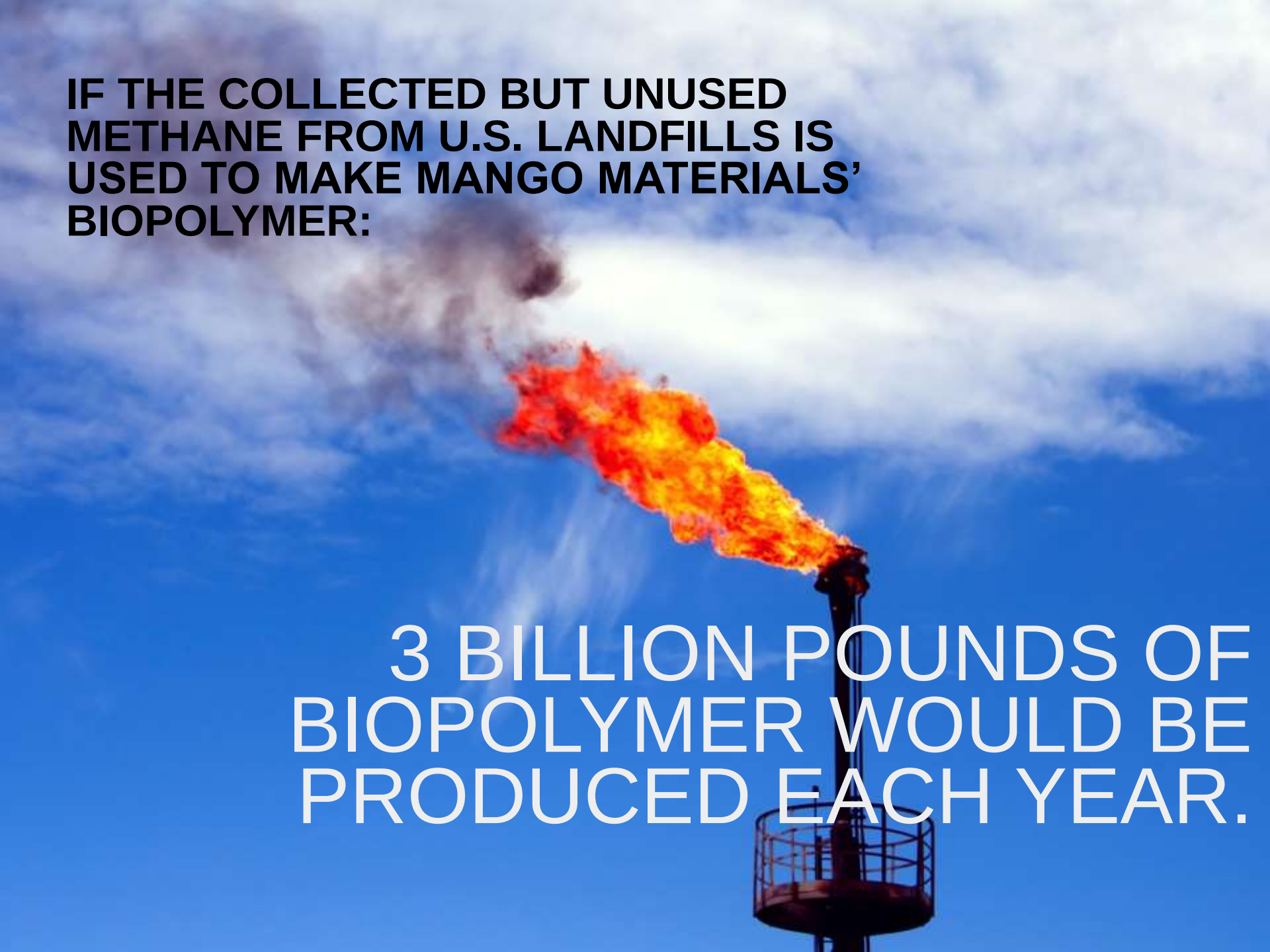


Safety: Mango

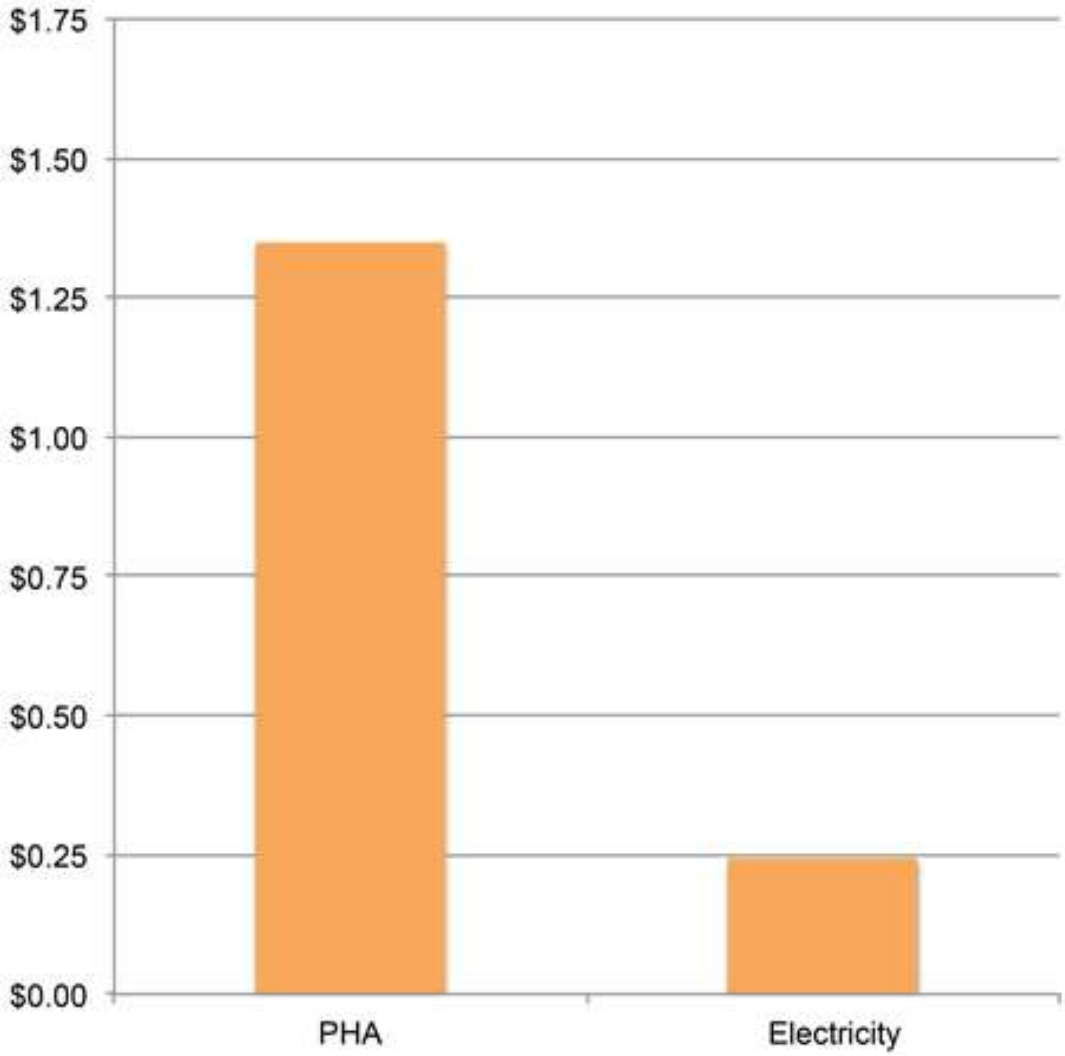
- Separate delivery for methane and oxygen
- Operate methane-poor or methane-rich
- Monitor offgas composition
- Nitrogen dump
- Avoid risks of over- or under-pressurization
  - Large-diameter exhaust
  - Vacuum-pressure release
  - Rupture disc

MangoStandard

Potential Location of MangoStandards


IF THE COLLECTED BUT UNUSED METHANE FROM U.S. LANDFILLS IS USED TO MAKE MANGO MATERIALS' BIOPOLYMER:
3 BILLION POUNDS OF BIOPOLYMER WOULD BE PRODUCED EACH YEAR.

Total Sales Per Pound of Methane



Decentralized Production

A CLOSED LOOP PLASTIC ECONOMY IS NOW POSSIBLE

– LET’S BUILD IT!

MANGO MATERIALS

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www.mangomaterials.com

MANGO MATERIALS

Mango Materials was founded off of IP exclusively licensed from Stanford University

Mango Materials begins field studies at SVCW using raw biogas to produce PHA

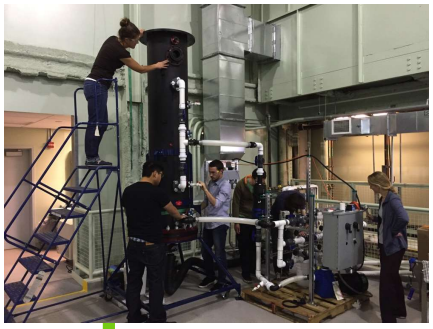
Mango Materials begins partnership with the USDA ARS Facility providing lab space and equipment

Mango Materials wins grand prize ($650,000) at 2012 Postcode Lottery Green Challenge

A Phase II NSF-SBIR grant increases yields and scale of Mango Materials biopolymer production

Mango Materials is named one of the top 10 Green Chemistry Innovators

Mango Materials builds and validates pilot unit in the lab



2010 2011 2012 2013 2014 2015 2016

Molly Morse (CEO) and Allison Pieja (CTO) study PHA production at Stanford University

Mango Materials is awarded runner up prize at 2010 Clean Tech Open

A Phase I NSF-SBIR grant determines waste methane can successfully be used to make PHA

Mango Materials awarded grant to explore further integration with water resource recovery facilities

Mango Materials dives deeper into application and product development

Field Pilot Operation