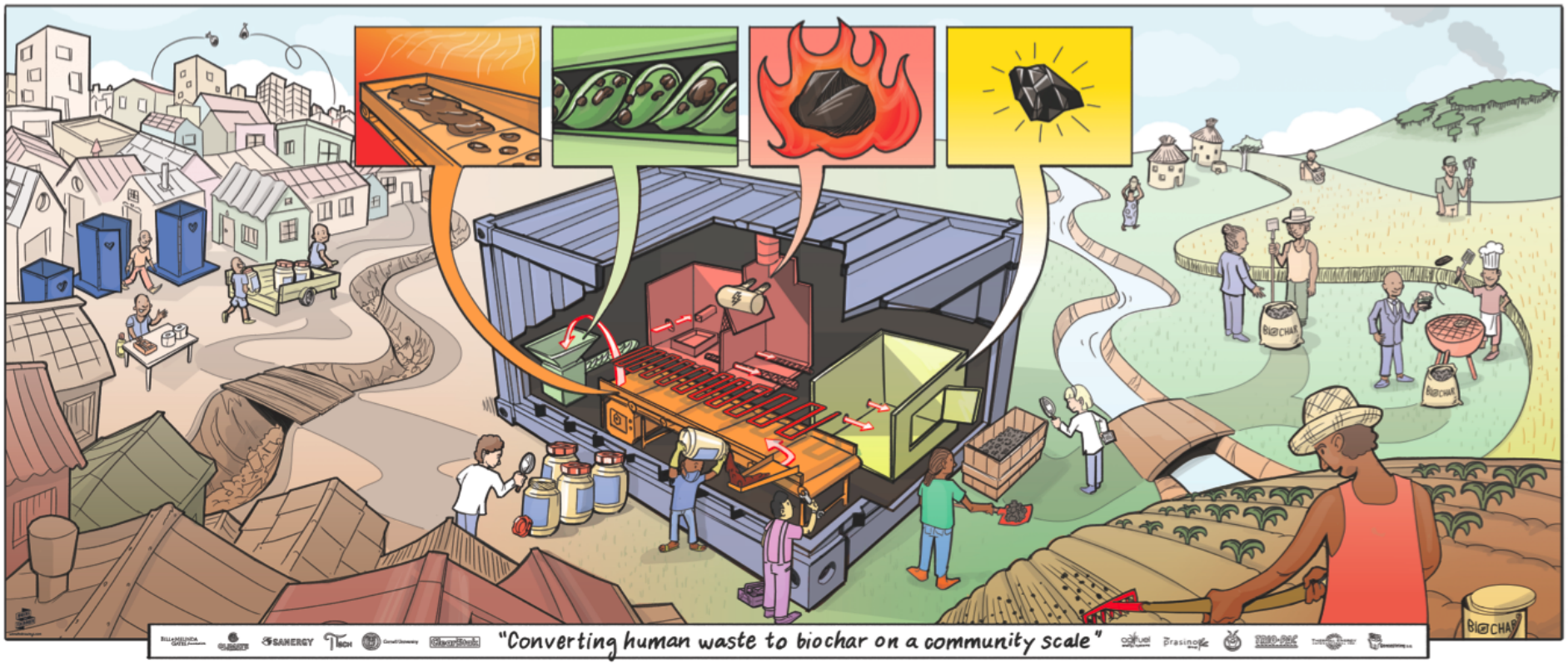


CLIMATE FOUNDATION

Adding missing links in the sanitation chain:

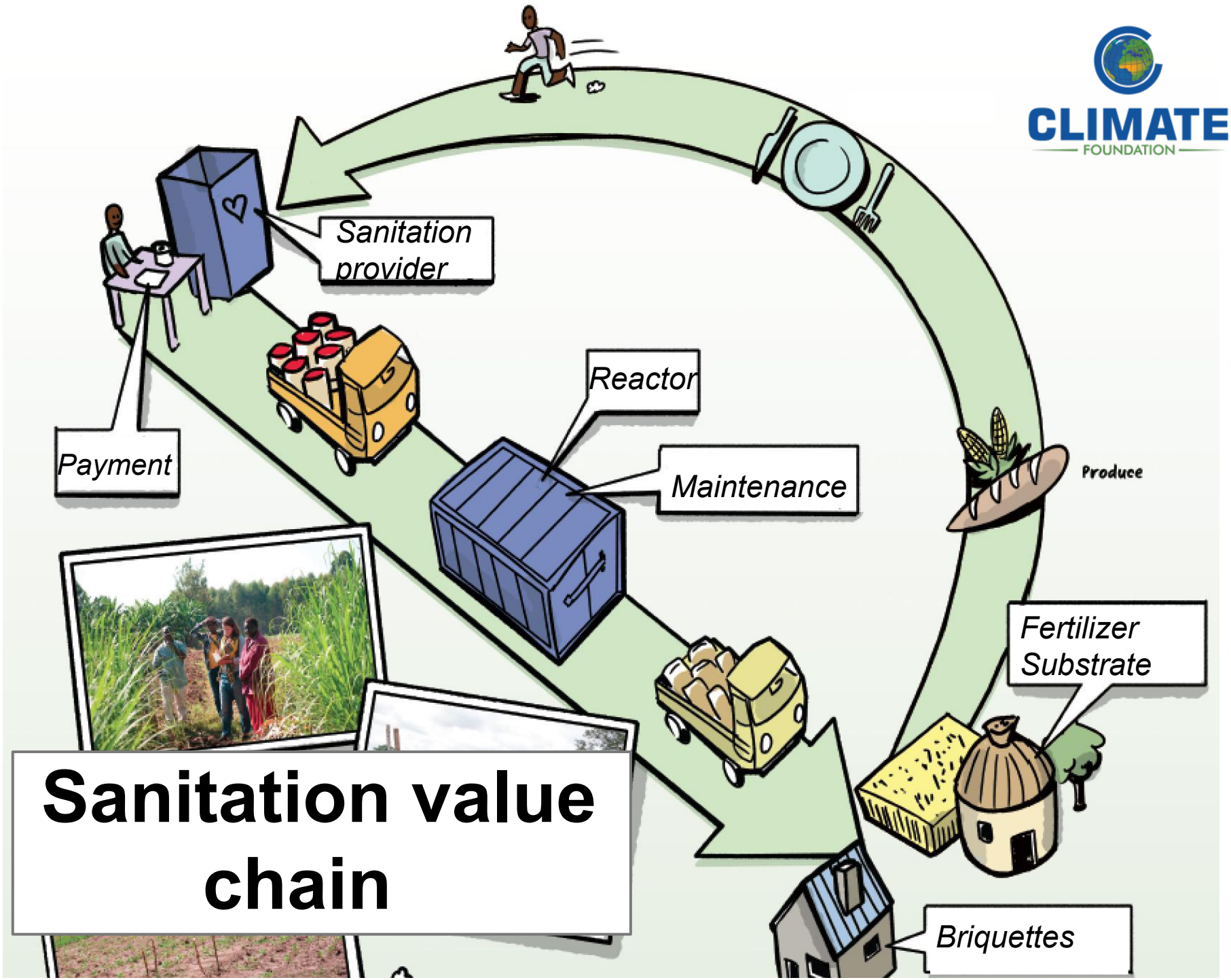
Community-scale facility to process faeces into safe biochar by pyrolysis

Susana webinar, April 29th, 2014

Climate Foundation, Sanergy, Tide Technocrats, Cornell University, Clearstak,
Agfuel, Prasino Group, Trio-Pac, Thermal Energy International, Prakruti

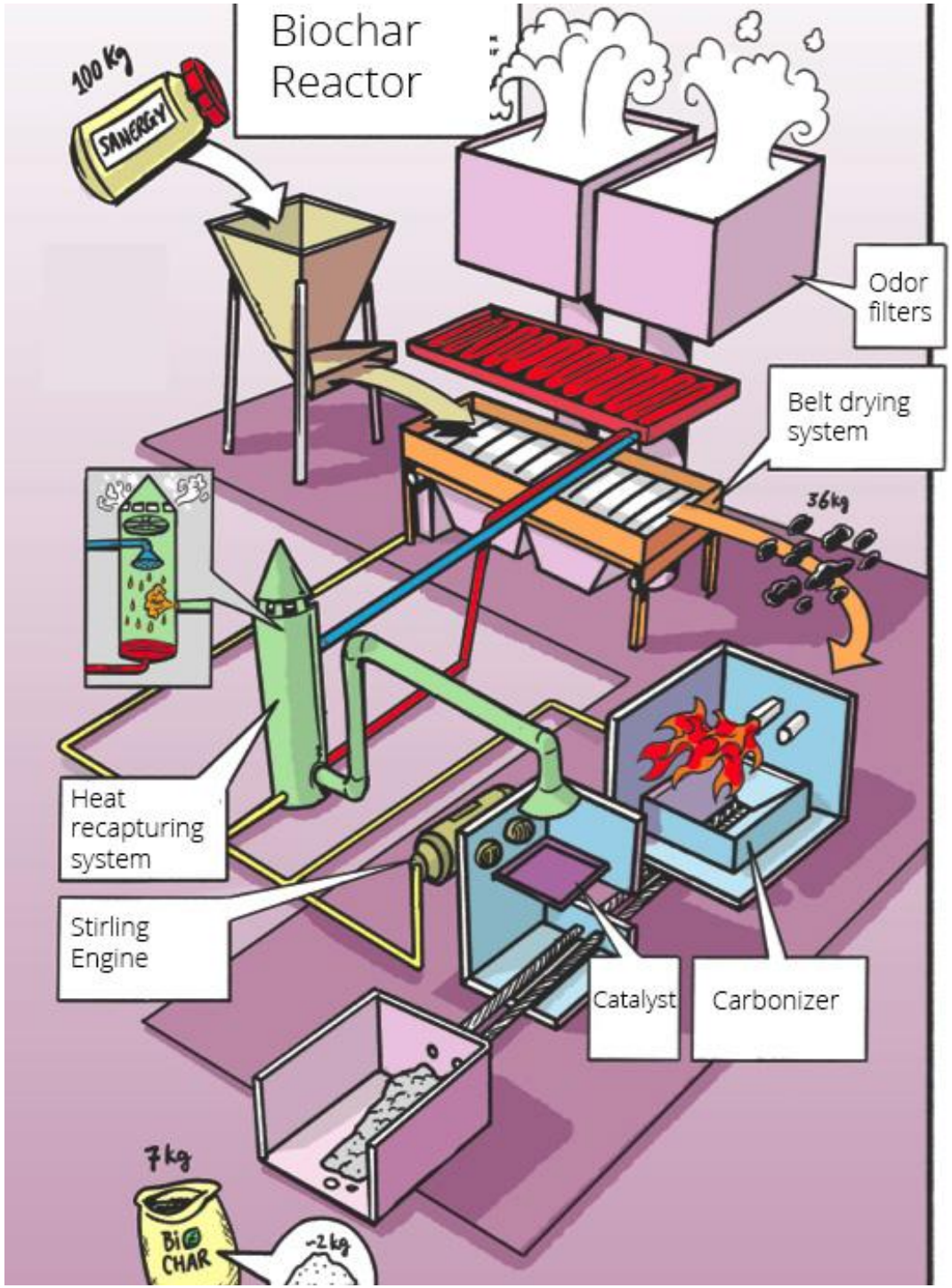
Research objectives of Reinvent the Toilet

1. Technology: develop a biochar reactor for feces that operates at <USD$0.05 per person per day
2. Grid: no net external power required
3. Lab: research optimal feces to biochar conversion and end products
4. Market: research and develop the markets for both biochar end products and the reactor in East Africa


Sanitation provider
Payment
Reactor
Maintenance
Produce
Fertilizer Substrate
Briquettes
Sanitation value chain

Biochar reactor

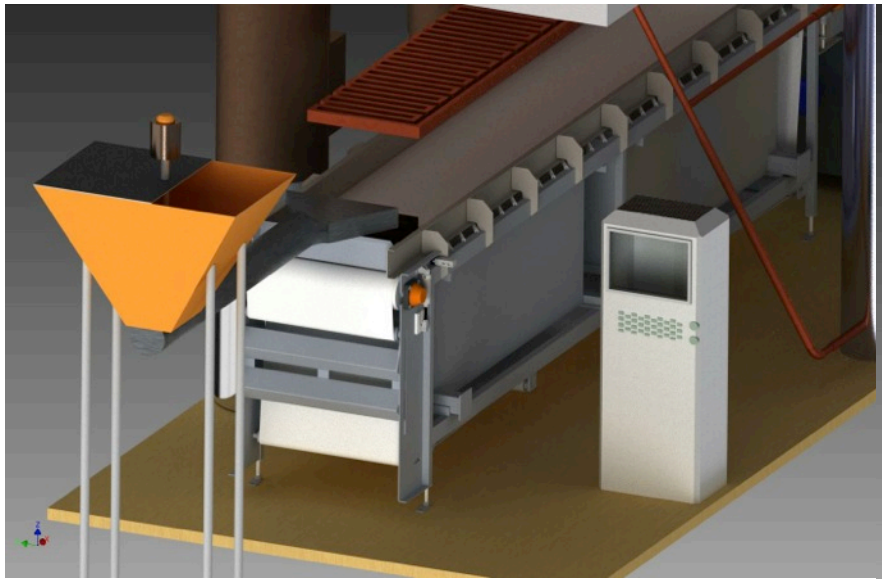
- The Feces from urine-diverting dry toilets (UDDT's) are the inputs to the reactor.
- Odor filters filled with biochar
- Heat from carbonizer used for drying
- Stirling engine produces electricity from heat



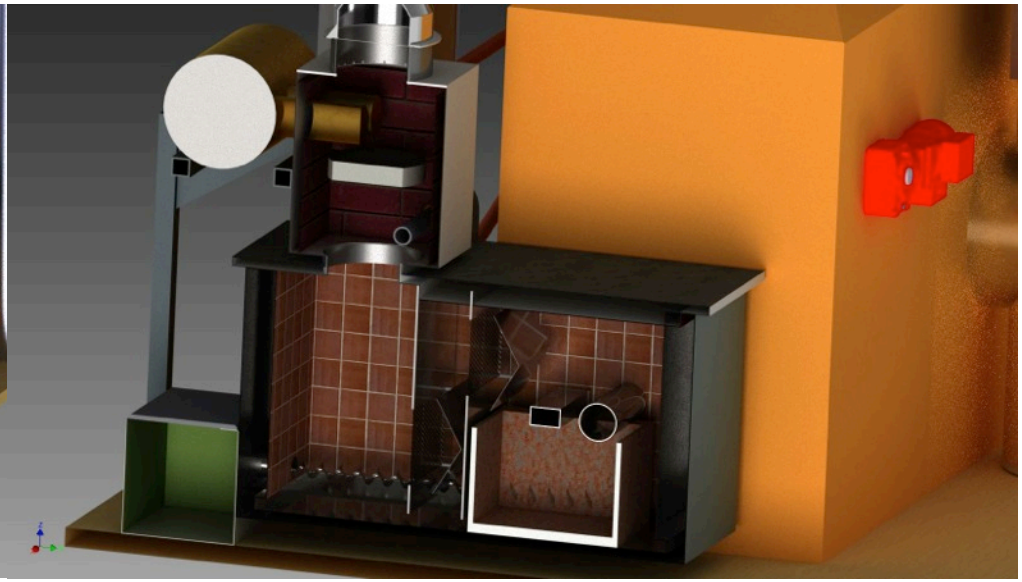
Technical summary - biochar reactor

System specs:

- Reactor processes 100 kg/human excreta/hour.
- Dryer system reduces moisture content from 75% to 30%.
- Up to half the carbon remains as biochar.
- Waste is sanitized at 300-700 degrees Celsius in carbonizer.
- Reactor does not require any net electrical power from grid or sewer.
- Initial heating can come from stored biochar from previous operation.
- Target cost for system is under $95,000.



Belt drying system

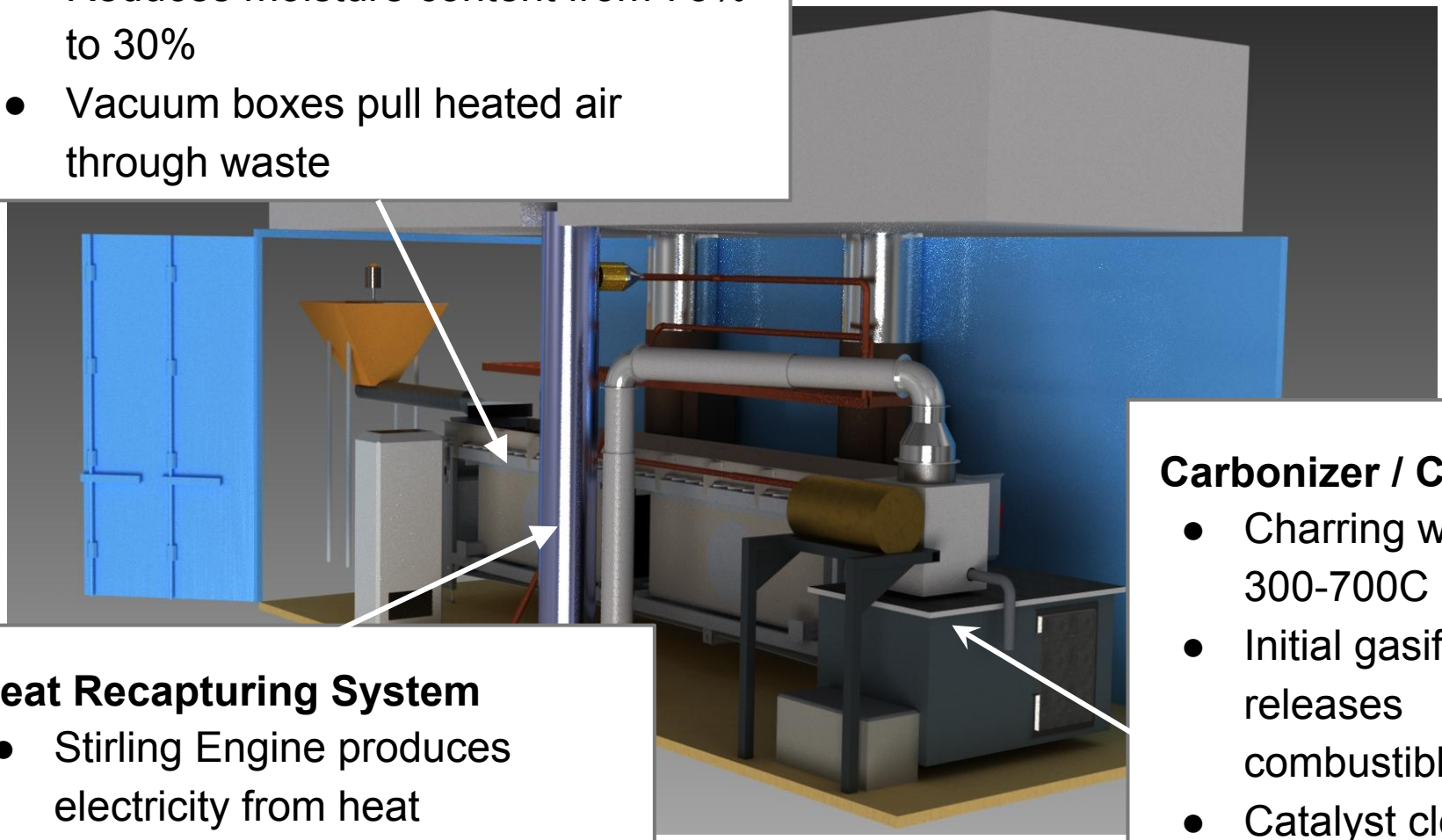


Carbonizer

System specs

Dryer

- Belt drying
- Reduces moisture content from 75% to 30%
- Vacuum boxes pull heated air through waste



Heat Recapturing System

- Stirling Engine produces electricity from heat
- Heat recapturing system uses heat of condensation/reactor for belt drying

Carbonizer / Catalyst

- Charring waste at 300-700C
- Initial gasification releases combustible gases
- Catalyst cleans exhaust by oxidation

Working biochar prototype in Delhi

Working biochar prototype in Delhi

Biochar accelerating agricultural production

Our labs at Sanergy and at Cornell research the relevant parameters in human excreta and the biochar produced.

- *pH* - buffer
- *Water retention capacity*
- *Carbon content*
- *Adsorption of nutrients*

Next steps in lab research:

- Continue research on human waste/ biochar
- Optimal charring temperature
- Adsorbing nutrients to biochar
- Growth trials with Kenyan soils and crops

Results so far

Technology

1. Building and testing of all subsystems
2. Engineering of system in US, prototype assembled and built in Bangalore, India

Lab

1. Setting up special lab at Sanergy for excreta and biochar analysis
2. Started time series on moisture content, caloric value, ash content

Market Development

1. Market scan Kenyan market: promising markets
2. Starting growth trials in Kenya

Reinvent The Toilet (RTT) Gates grant phases

Reinvent The Toilet Phase 1: $397k
Grantee: Stanford University, start June 2011

Reinvent The Toilet Phase 2: $2.9M
Grantee: Climate Foundation, start May 2013

Questions?

Summarizing

- Biochar reactor designed in the US with concurrent development in India
- Prototype testing in Bangalore and at Sanergy in Nairobi
- Value in sanitation, value in biochar products

Q: Suitability for other countries?

Q: Sanitation infrastructures we could work with?

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Biochar market development - Kenya