Mainstreaming Citywide Sanitation
Opportunities & Challenges in Excreta Management
Gulmohar Hall, India Habitat Centre, New Delhi, 4-5 April, 2016

Technological options for fecal sludge treatment in urban areas: case study in Beijing

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Centre for Sustainable Environmental Sanitation

RTTC-China

BILL & MELINDA GATES foundation

Reinvent The Toilet Challenge ($ 5,020,000)

12 sub-grantees (5 companies + 7 universities)

厕所创新创意大赛——中国区（Reinvent The Toilet Challenge，RTTC-China）由美国比尔及梅琳达•盖茨基金会（Bill & Melinda Gates Foundation，简称“盖茨基金会”）资助，北京科技大学负责整个大赛活动的组织实施。厕所创新创意大赛分为创新大赛和创意大赛两部分。

比尔及梅琳达•盖茨基金会（以下简称“盖茨基金会”）于2011年启动了“全球厕所创新大赛”（reinvent the toilet challenge,RTTC)。这项由盖茨基金会计划在5年内（2011-2015）投资3亿8000万美元于清洁水、卫生设施领域，以促进该领域在技术研发、政... 浏览全文

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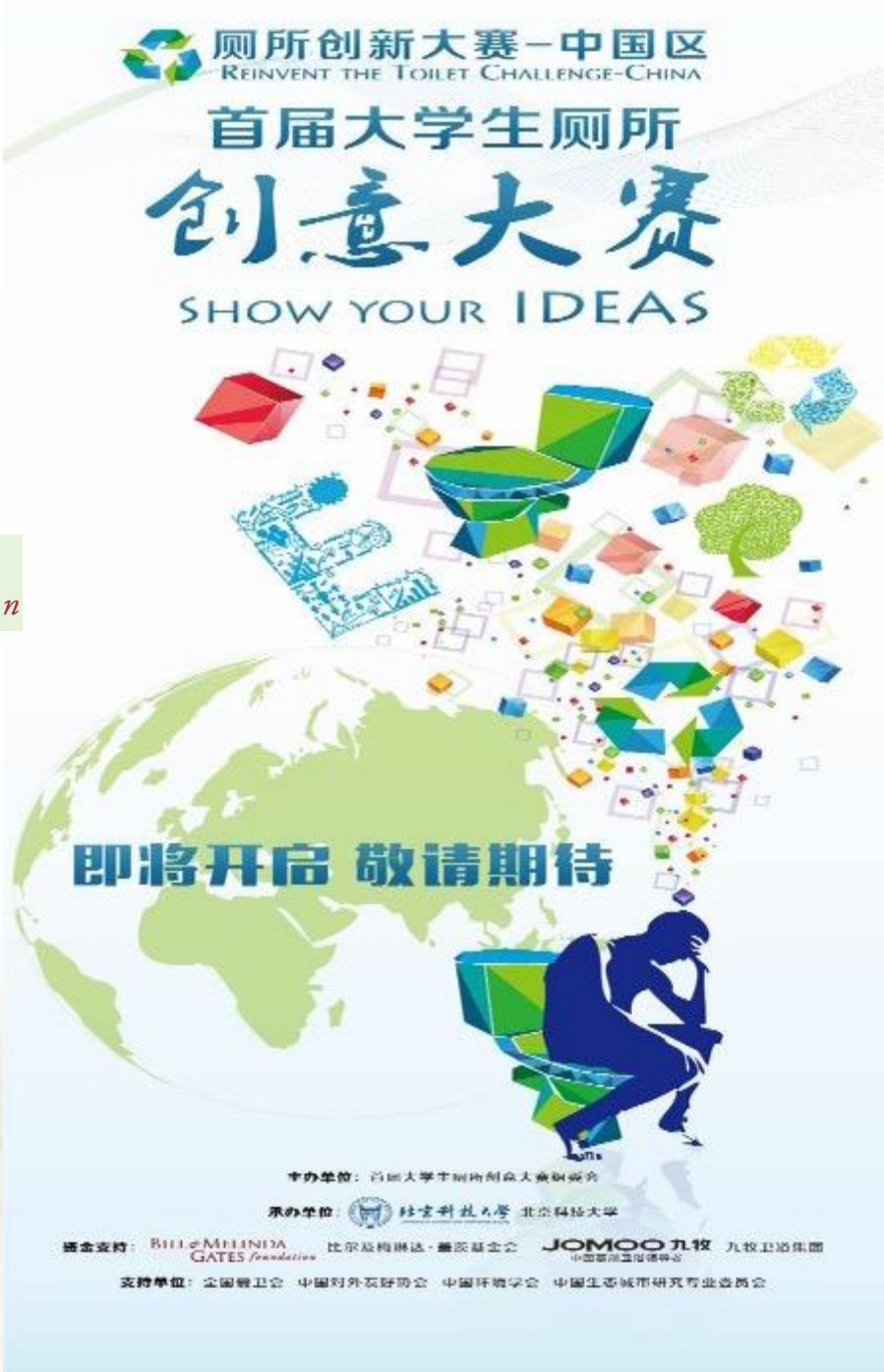
1st Reinvent Toilet Contest for Chinese Students

Awards: ¥300,000

JOMOO

BILL & MELINDA GATES foundation



VISION

Contribution to the capacity building of Chinese and International Young Professionals in the area of **environmental sanitation** through "learning by doing" in international team working together with experienced multidisciplinary Senior Experts from the **integrated** fields of :

1. wastewater management
2. biogas & waste
3. sustainable sanitation
4. biomass energy

KEY STAFF

Experts and Professor

Prof. Dr.-Ing. Zifu Li

Director of CSES, expert on sustainable sanitation and wastewater management, study and work experience in China (23 years) and Germany (8 years).

Prof. Heinz-Peter Mang

German Senior Expert, Manager of CSES, Guest professor of USTB, 35 years of work experience on sustainable sanitation, food security and bioenergy in 5 continents.

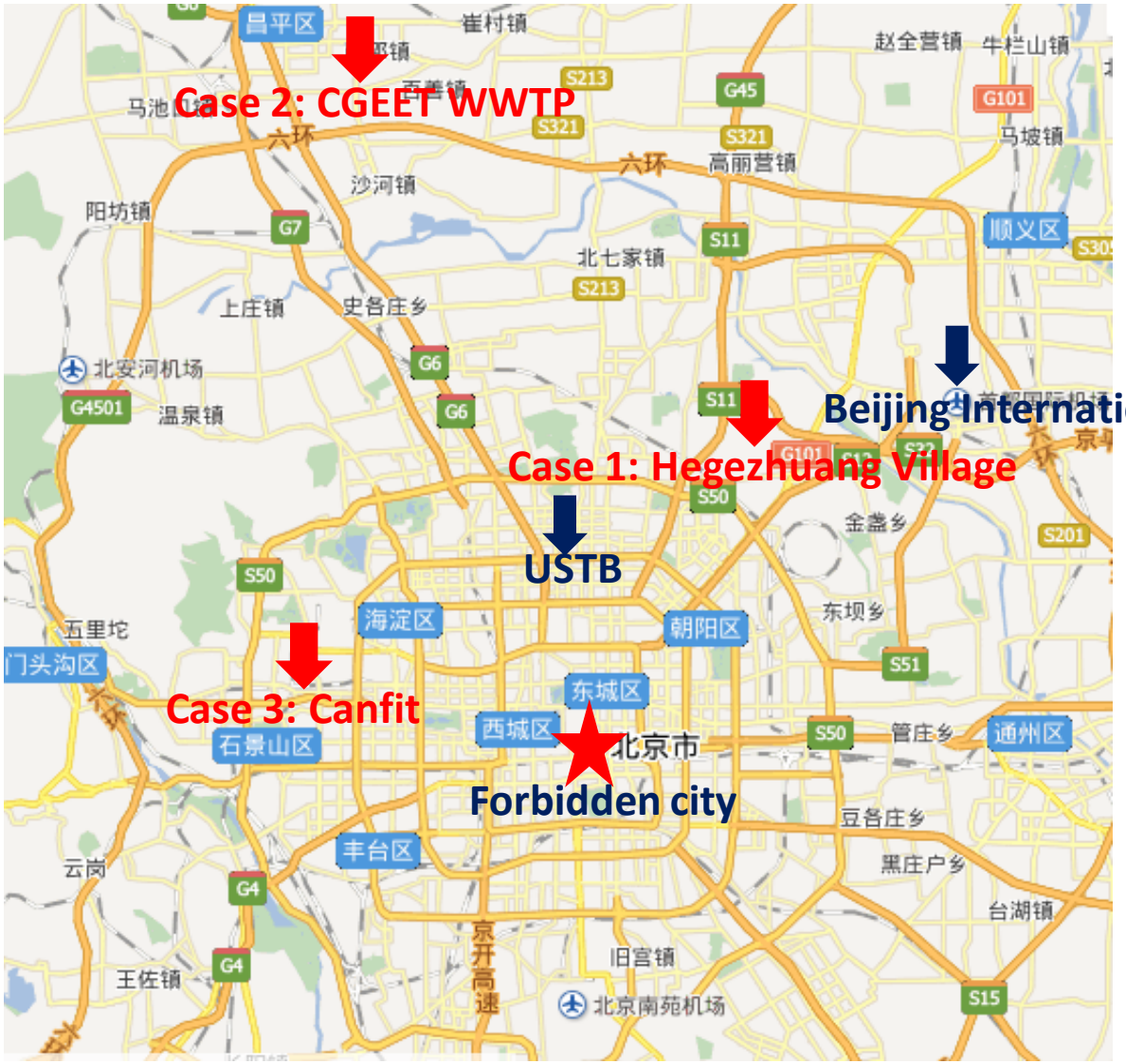
Global Work

Projects in 20+ countries

What we do

International students for master and Ph.D degree from about 20 countries

Case studies



Case studies

- Case 1: Hegezhuang Village – biogas plant, greenhouse, biogas generation
- Case 2: CGEET – composting, biogas, WWTP
- Case 3: Canfit – landfill, biodiesel, biogas – bio-methane, biochar, WWTP

Hegezhuang biogas plant

Capacity: 20t FS/d

Process: 2 steps –

1st: thermophilic ,

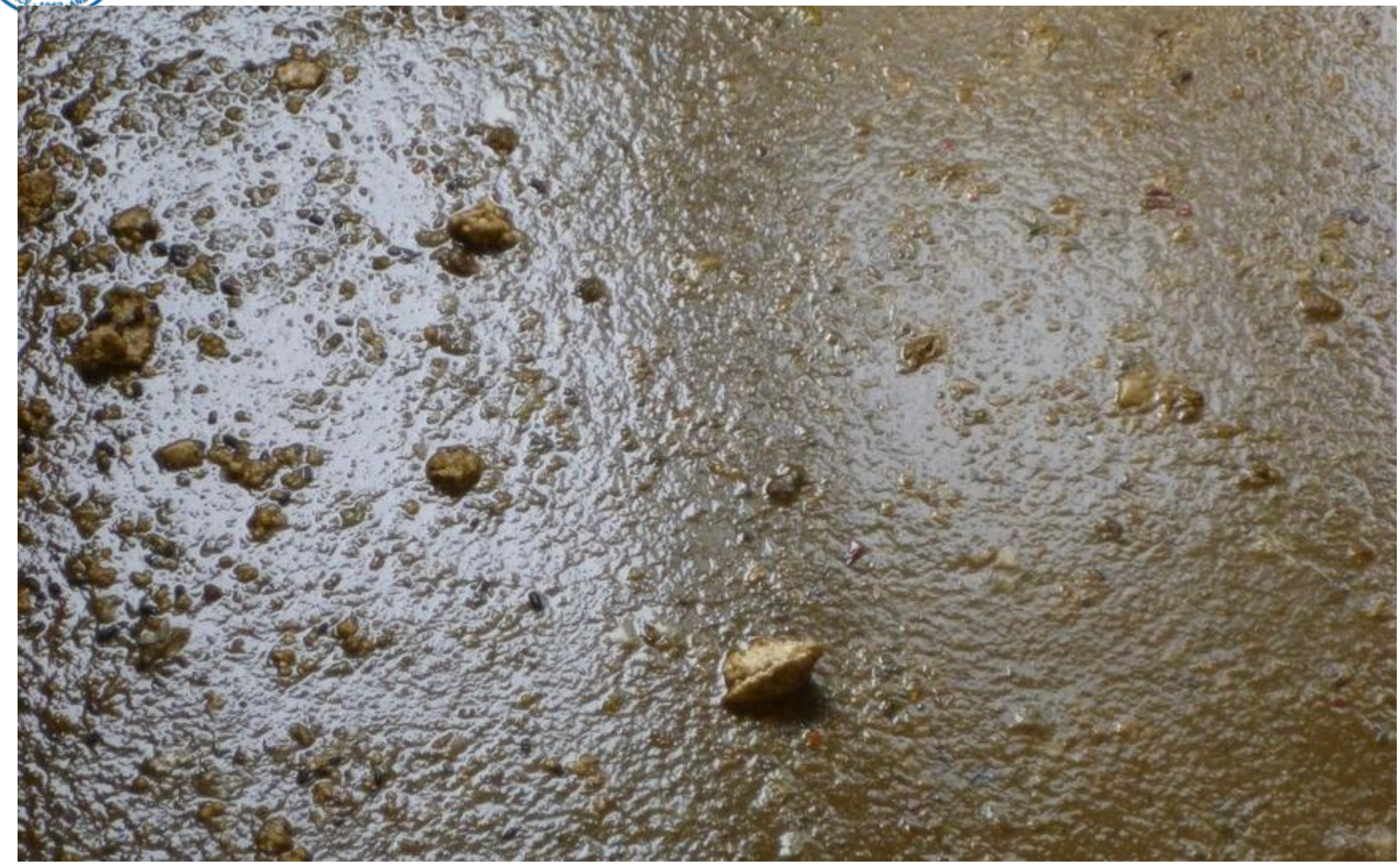
19 days RT,

central vertical stirrer

Hegezhuang biogas plant

Manual screening of plastic waste, homogenization mixer

Homogenization (ca. 5%DM)



Heating water to more than 70℃ with 2-rings biogas burner

Or with coal - when biogas is not enough or consumed in greenhouses

Pre-heating and pasteurization batch basin (70oC keeping for some hours), covered and insulated, slow mixing for sand separation – ammonium emissions (heavy smell)

Pre-heated water tank for circulation of heating water, solar paneles (tubes)

Gravity flow from CSTR to 2nd step

2nd step – mesophilic - with double-membrane gas storage, gravity overflow, under/over pressure valve

Gravity overflow – air blower for double membrane

Digestate storage tank with stirrer

Digestate pump and hose for filling distribution trucks

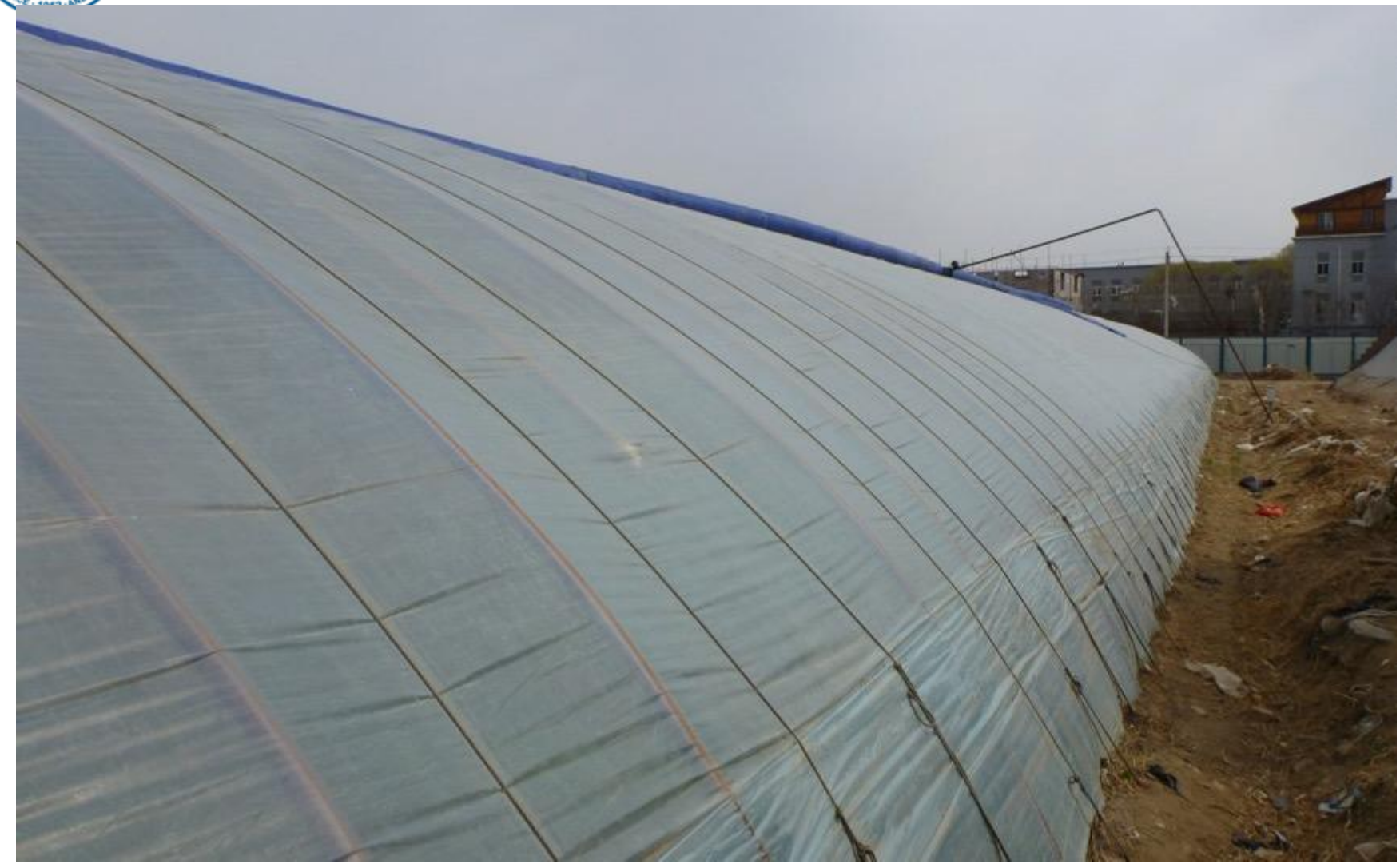
Biogas generator (25 KWel) as emergency stand-by to keep feeding pump and stirrer running

Biogas heaters installed with flexible pipes

Infrared biogas heater

Biogas heaters distributed in greenhouse

Greenhouse with night cover *(blue roll)*



Backsite clay wall of greenhouse to store the heat

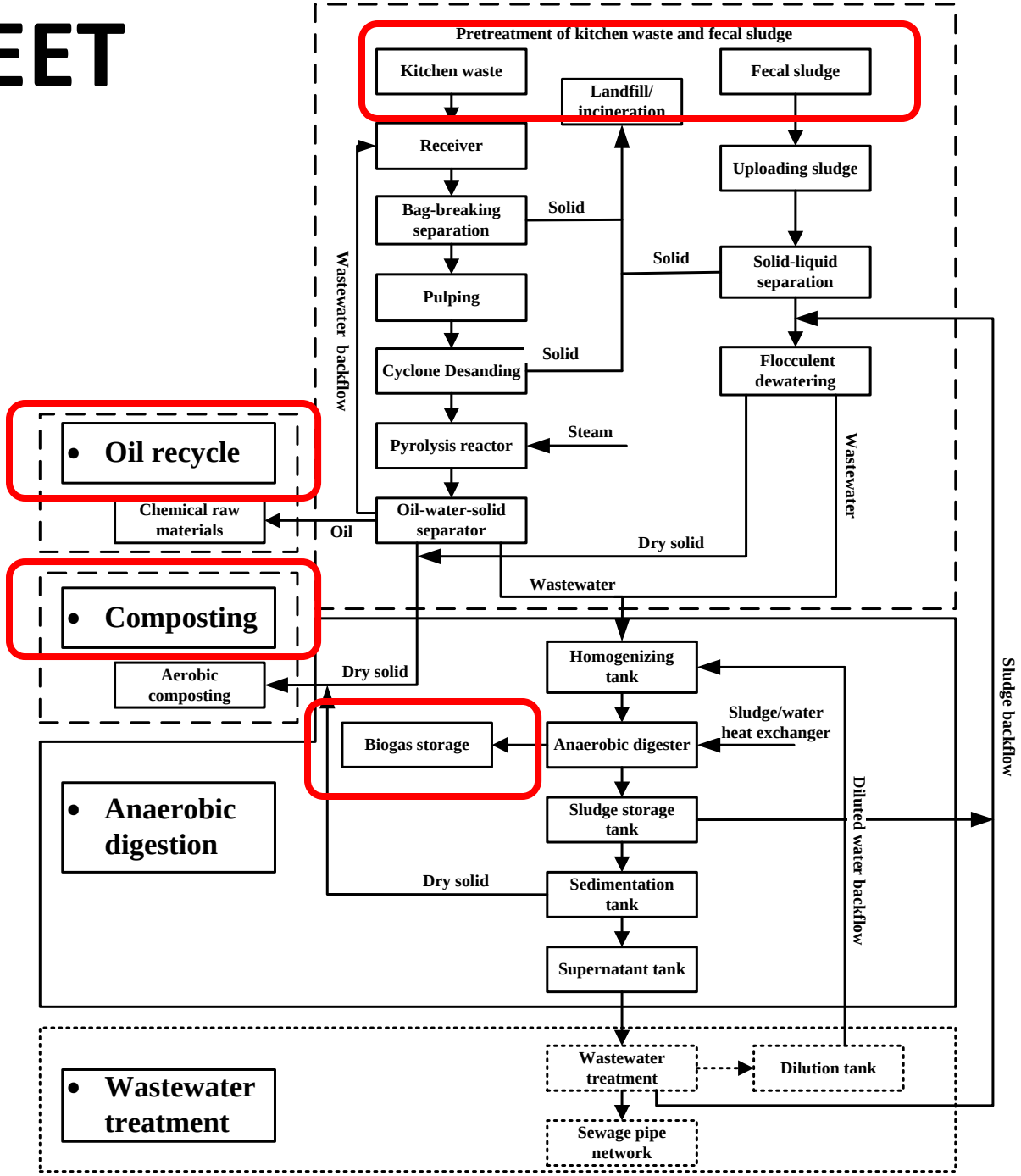
Greenhouses for application of biogas for heating and CO_2 enrichment and liquid digestate as fertilizer

Lessons learnt

- Good agriculture model – combining biogas plant with vegetable plantations in greenhouses
- More environmental sanitation impact than energy output
- Ownership of biogas plant and nearby greenhouses is different – conflicts between biogas plant (village government) and greenhouses (recently privately owned)
- Corrosion issues after few years operation

Case 2 - CGEET

- Start: 2009/2014
- Feedstock: 300 ton FS/d and 50 ton kitchen waste/d
- Organic fertilizer: 10-15 ton/d
- Biogas: 800-1500 m3/d



Pretreatment of Kitchen Waste

Receiver

Separation, sand removal, pyrolysis device

Pretreatment of Kitchen Waste

Bag-breaking and separation

Coarse material

Light material

Pulping

D ≤10mm

Sand removal

Cyclone Sand Remover

Oil & Fat Separator for biodiesel

120℃~170℃ steam

60~85℃ pulp

Three phase separator

Left to right:
oil, solid, organic wastewater

Clean Discharging of Fecal Sludge

Safe Discharging of Fecal Sludge

Uploading of Fecal Sludge

Solid-liquid separation

Flocculent dewatering

Left to right: solid, supernatant and liquid FS before dewatering

Anaerobic Digestion

- CSTR
- Mesophilic
- Biogas boiler for producing steam, excess biogas is burned in torch
- Digestate goes to solid-liquid separation
- Liquid supernatant goes to WWTP

Biogas torch

Composting

- Aerobic composting
- One period: ca. 15 d
- Solid: applied in gardening / municipal greening

WWTP

AOM: Anaerobic +Oxic+ MBR

	COD	BOD	SS	NH_4^+-N	pH
	≤500 mg/L	≤350 mg/L	≤400 mg/L	≤45 mg/L	6.5-9.5

Odor control from in-housed composting

Online and real-time monitoring

Lessons learnt

- Co-treatment with kitchen waste
- Located inside of WWTP, final wastewater goes to WWTP
- Output: Composting + biodiesel + biogas
- EPC (Engineering Procurement Construction) model

National Urban Fecal Sludge and Kitchen Waste Treatment Industry Technology Innovation Strategic Alliance

- **Foundation: 2014**
- **Governing Body: Ministry of Science and Technology, China (MoST)**
- **President Unit: Beijing Century Green Environmental Engineering & Technology Ltd. (in short: CGEET)**

Case 3- Canfit

Key facts

- 300-400t/d FS from public toilets in Xicheng district and Haidian District
- 50tons/d separated kitchen waste (KW)
- Treatment fee of 229 CNY/t KW.
- Liquid fecal sludge 56 CNY/t
- Capacity of one truck – 5 tons (most trucks)

Output- byproducts

1. Biogas, and a part of this up-graded to bio-methane (93% methane content) (water pressure scrubbing, compressed and bottled (17 bar) for own consumption)
2. Bio-ethanol (experimental stage)
3. Biofuel (biodiesel from floating fat, gutter oil, grease trap fat and used restaurant oil)
4. Biochar (carbonization of solid digestate biogas in barrels)
5. Compost
6. Struvite (MAP experimental)

5 ton Kitchen Waste truck

Discharge of Kitchen Waste

Biochar production

Biochar and compost

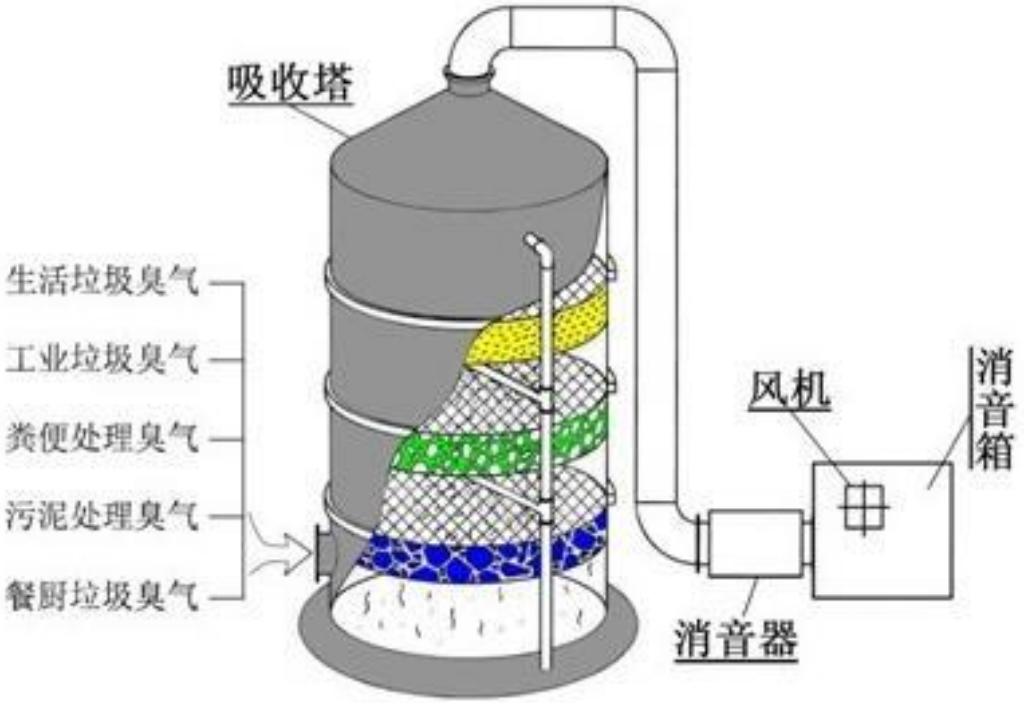
- ✓ **Compost can be sold for 600-800 CNY/t and biochar for 2000-3000 CNY/t.**
- ✓ **The compost NPK value is >7%. Average standard for sales need to be around 5%.**

UASB

1200m³ volume, biogas 1000-3000m³/d. HRT is 40h.

Post-treatment of wastewater

Odor control



- Bio-filter
- Natural plant extracts

Odor concentration	H_2S (mg/m^3)	NH_3 (mg/m^3)
2000	0.33	4.9

Odor control

Smell removal facility

15m high

Samples

Laboratory for process control

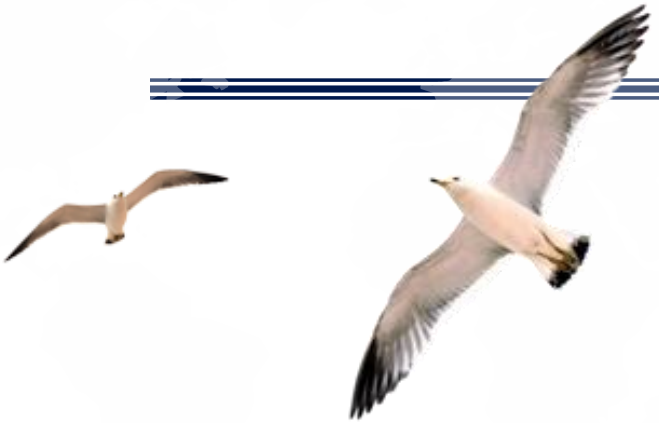
Workshop for experiments

Lessons learnt

- Own laboratory for experiments and process control
- R & D model: biogas to bio-methane, struvite, bio-ethanol, biochar, etc.
- Research model – many by-products, many problems need to be handled.

Highlights

- Case 1 – agricultural model, FS treatment for hygiene and bio-slurry reuse
- Case 2 – EPC model, FS and kitchen waste treatment for composting, biogas, biodiesel.
- Case 3 – R & D model, FS and kitchen waste treatment for by-products: bio-methane, struvite, bio-ethanol, biochar, compost, etc.



THANK YOU VERY MUCH FOR YOUR ATTENTION!

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