The Biogas Technology Center

Chiang Mai University

Since 1988 (Formerly Biogas Advisory Unit)

Background

1988 : Thai-German Biogas Program (TG-BP) by Chiang Mai University + Dept of Agricultural Extension under support of GTZ initiated

1991 : Biogas Advisory Unit (BAU) established under the Science and Technology Research and Development Centre CMU

2003 : Biogas Advisory Unit transformed to Biogas Technology Center (BTC) directly under Chiang Mai University Council

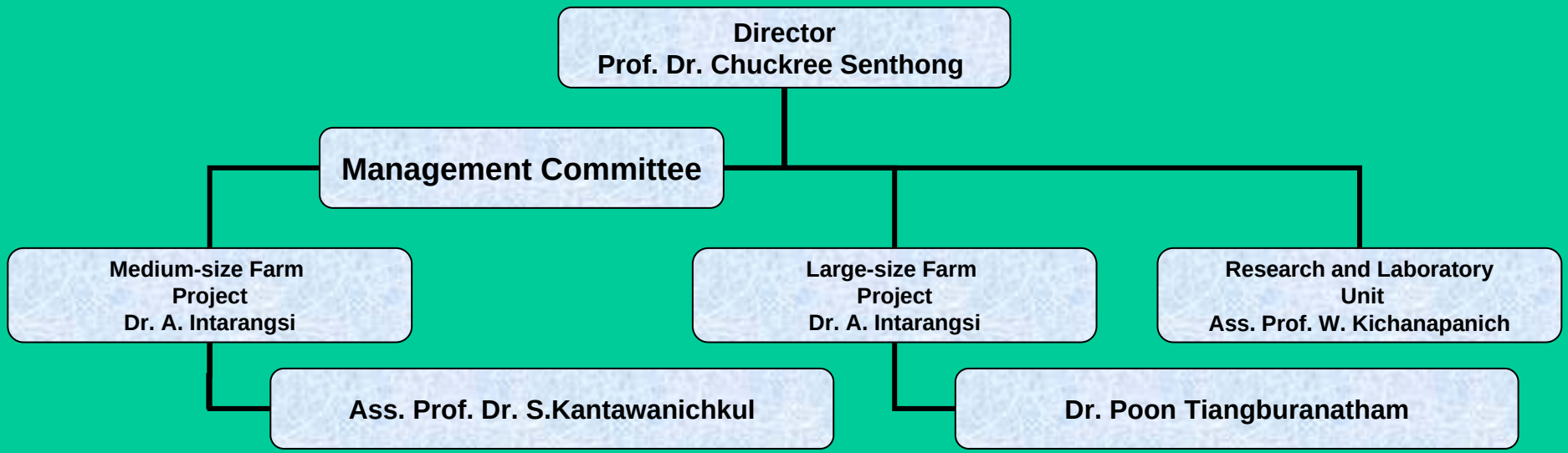
OBJECTIVES

1. Research on And Development of Technologies for Wastewater Management for the Conservation of Energy and environment

2. Dissemination and Implementation of the technologies

3. Teaching and Training of students, professional engineers, technicians and operators on the systems

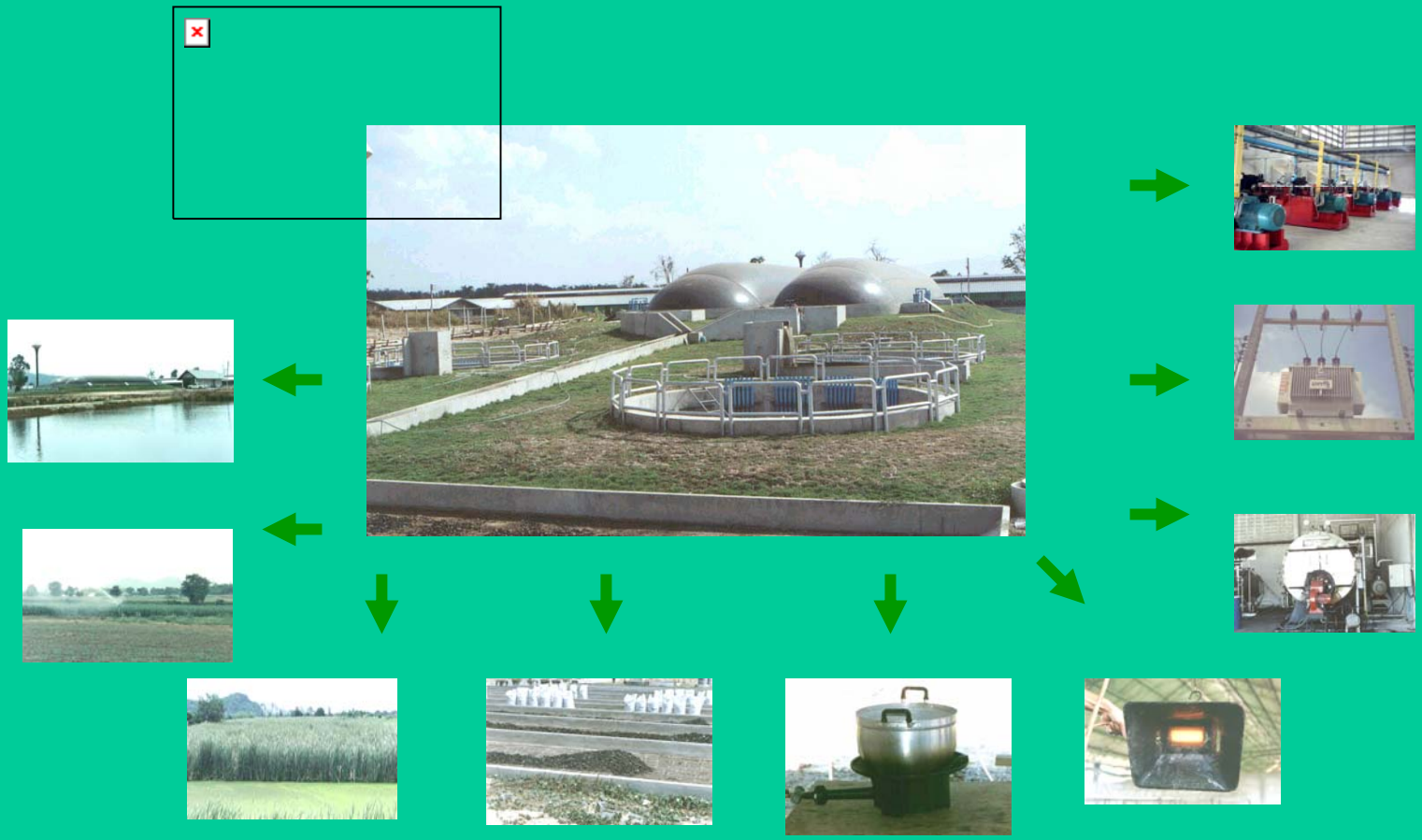
Organization Chart



Organizational Strength

6	Senior Administrators
7	Academic Advisors
16	Engineers
1	Scientist
9	Technicians
6	Laboratory staff
12	Administrative staff

The Promotion Programme for Biogas Production in Small and Medium-sized Livestock Farms



Supported by : The Energy Conservation Promotion Fund (ECPF)
Energy Policy and Planning Office (EPPO) , The Ministry of Energy

The Promotion Programme for Biogas Production in Small and Medium-sized Livestock Farms

Phase I	1995-1998	Completed
Phase II	1997-2003	Completed
Phase III	2002-2009	In progress

- Medium-sized Farms
- Large-sized Farms

The Promotion Programme on Biogas Technology Production in Livestock Farms

(Phase I and Phase II) 1996-2002

Item	Phase 1	Phase 2
• Total Number of Pig farms	6	14
• Total Digester volume	10,000	46,000
• Biogas Production (1 x 10^6 m^3/year) - Equivalent of LPG (1 x 10^6 kg/year) - Equivalent of Electricity (1 x 10^6 kW-hr/year) - Equivalent of Heavy oil (10^6 litre/year)	1.6 0.7 1.9 0.9	10 4.6 12 5.5
• Bio-Fertilizer (10^6 kg/year)	4	12.8
• COD removal (10^6 kg/year)	9	60
• Reduction of Methane emissions (10^6 kg/year)	0.7	4.4

First Demonstration Biogas Plant (V.1)

in Maehia (200 m^3) - 1992

Anaerobic Digestion and Biogas Production Technology

as used in The Promotion Programme on Biogas Production in Livestock Farms (Phase II) (1998-2002)

CD + UASB

Biogas Generation Process

Hydrolysis

↓

Acidogenesis

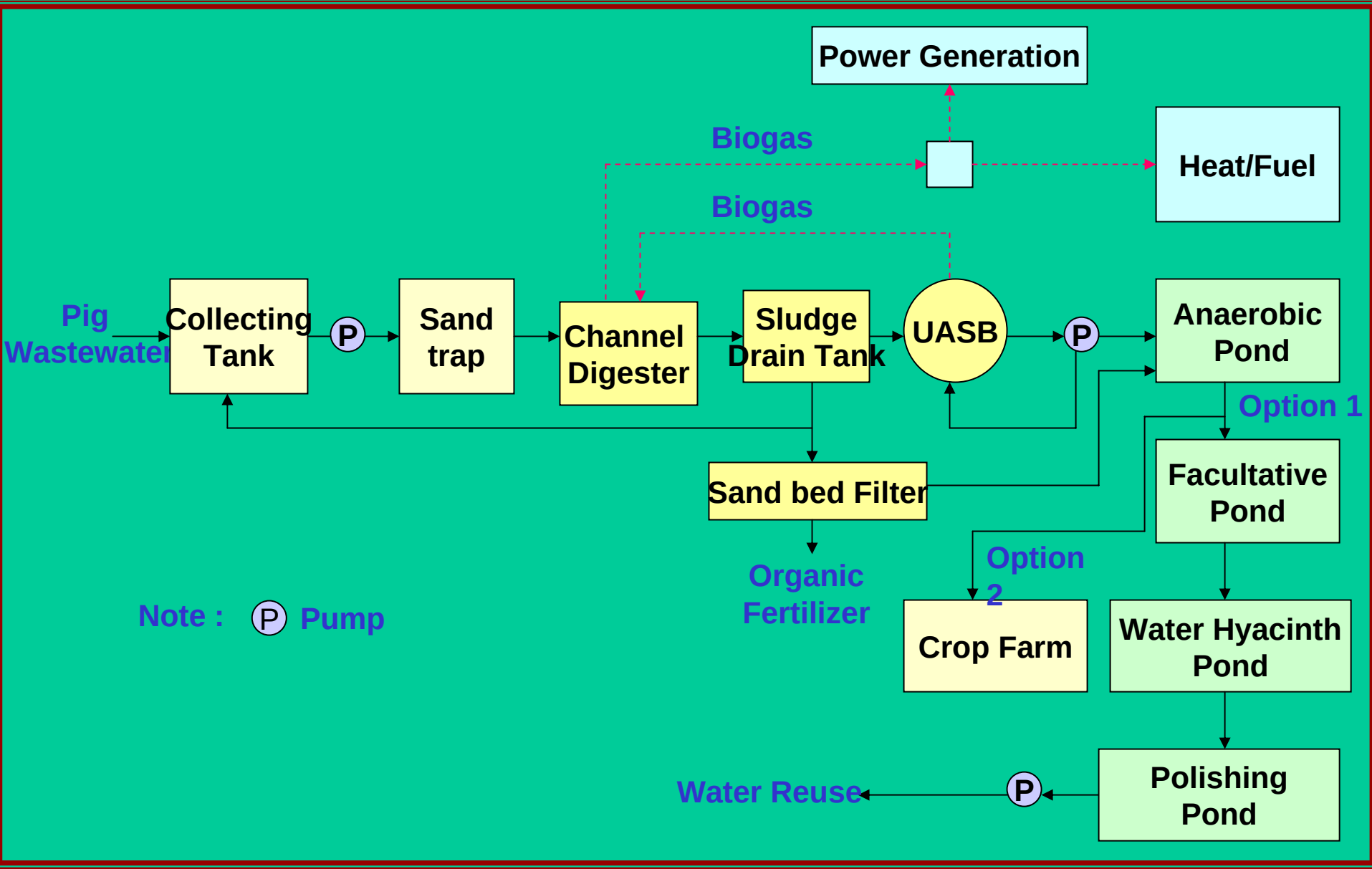
↓

Acetogenesis

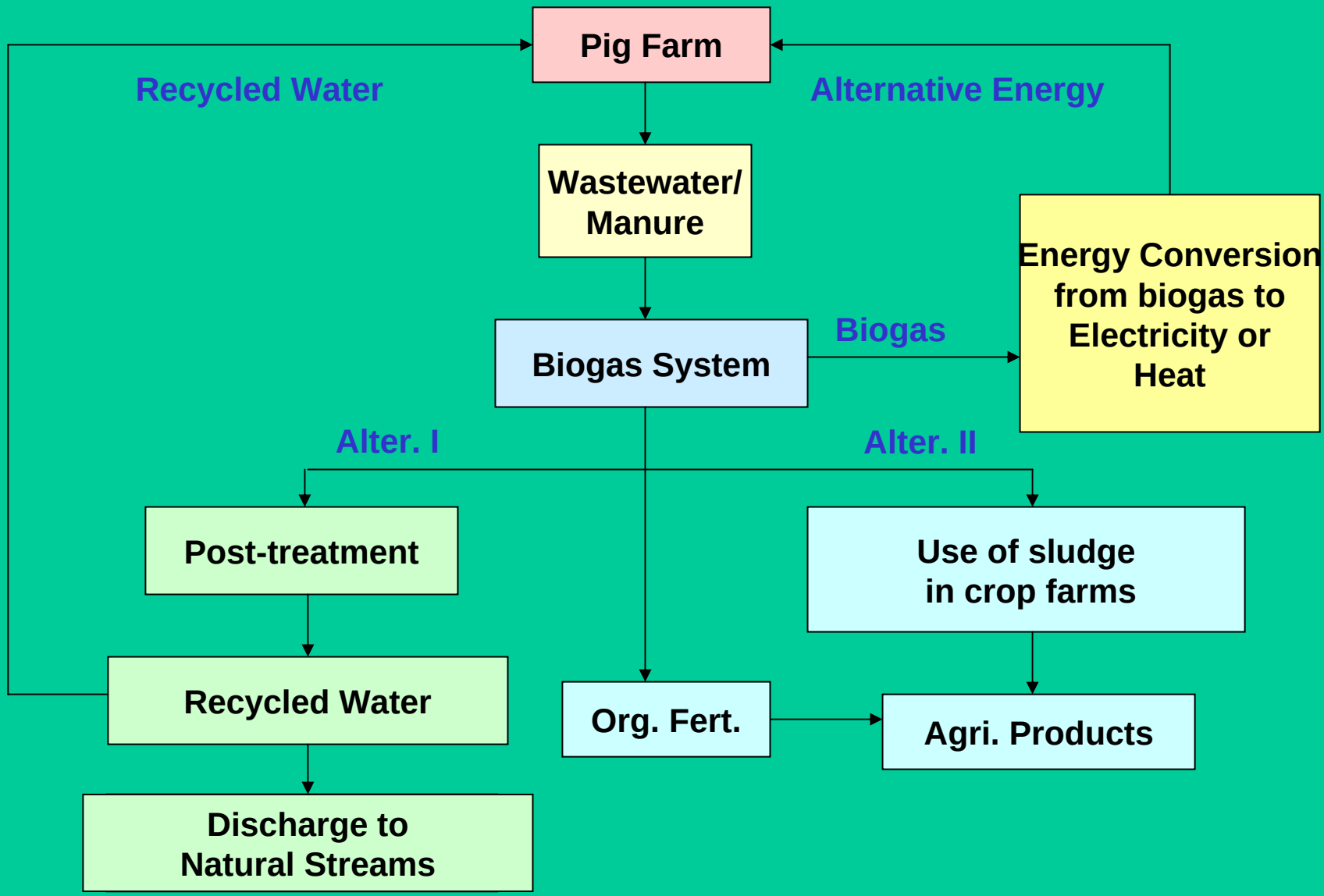
↓

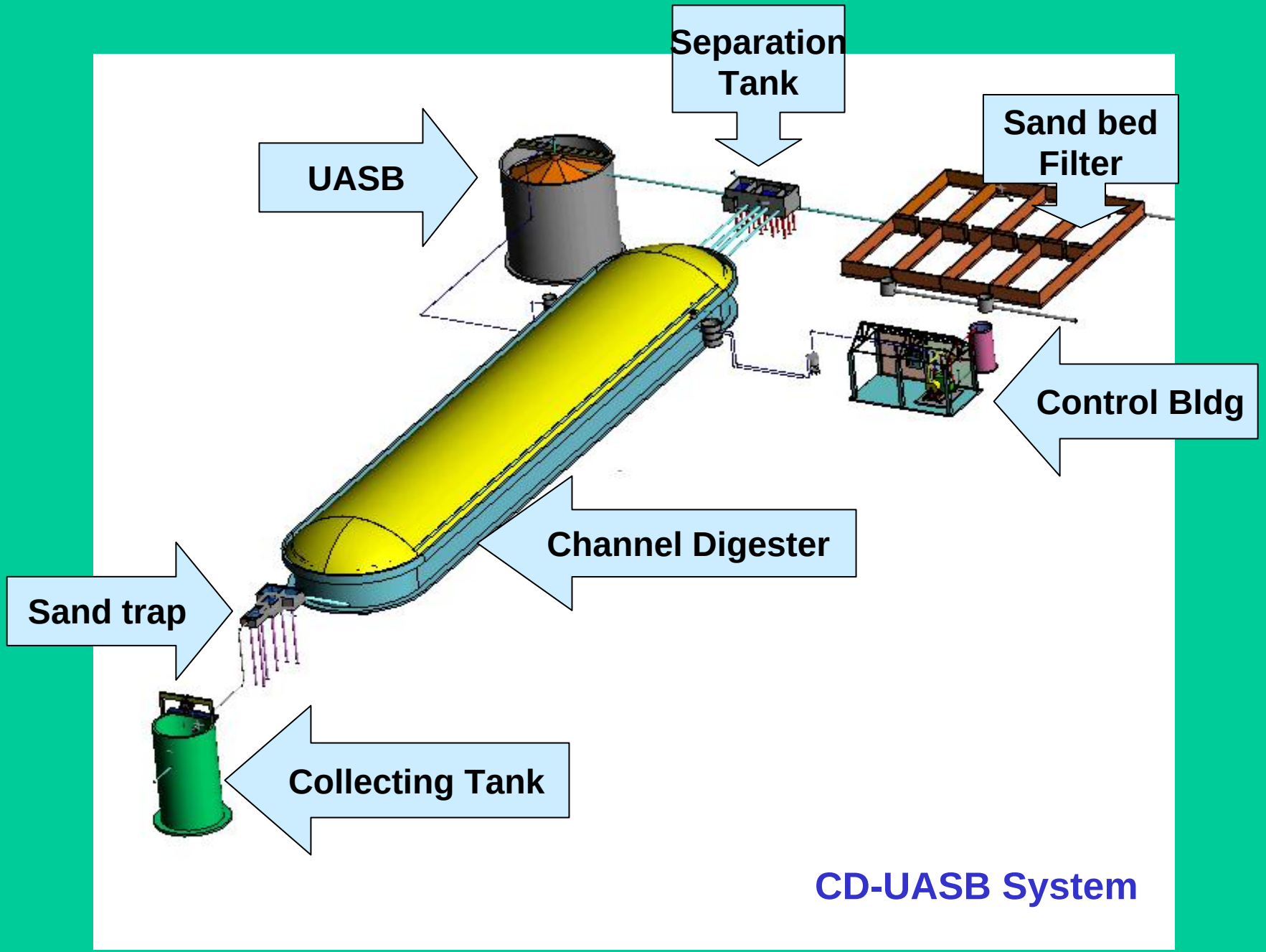
Methanogenesis

Anaerobic Digestion and Biogas Production Process in Livestock Farms

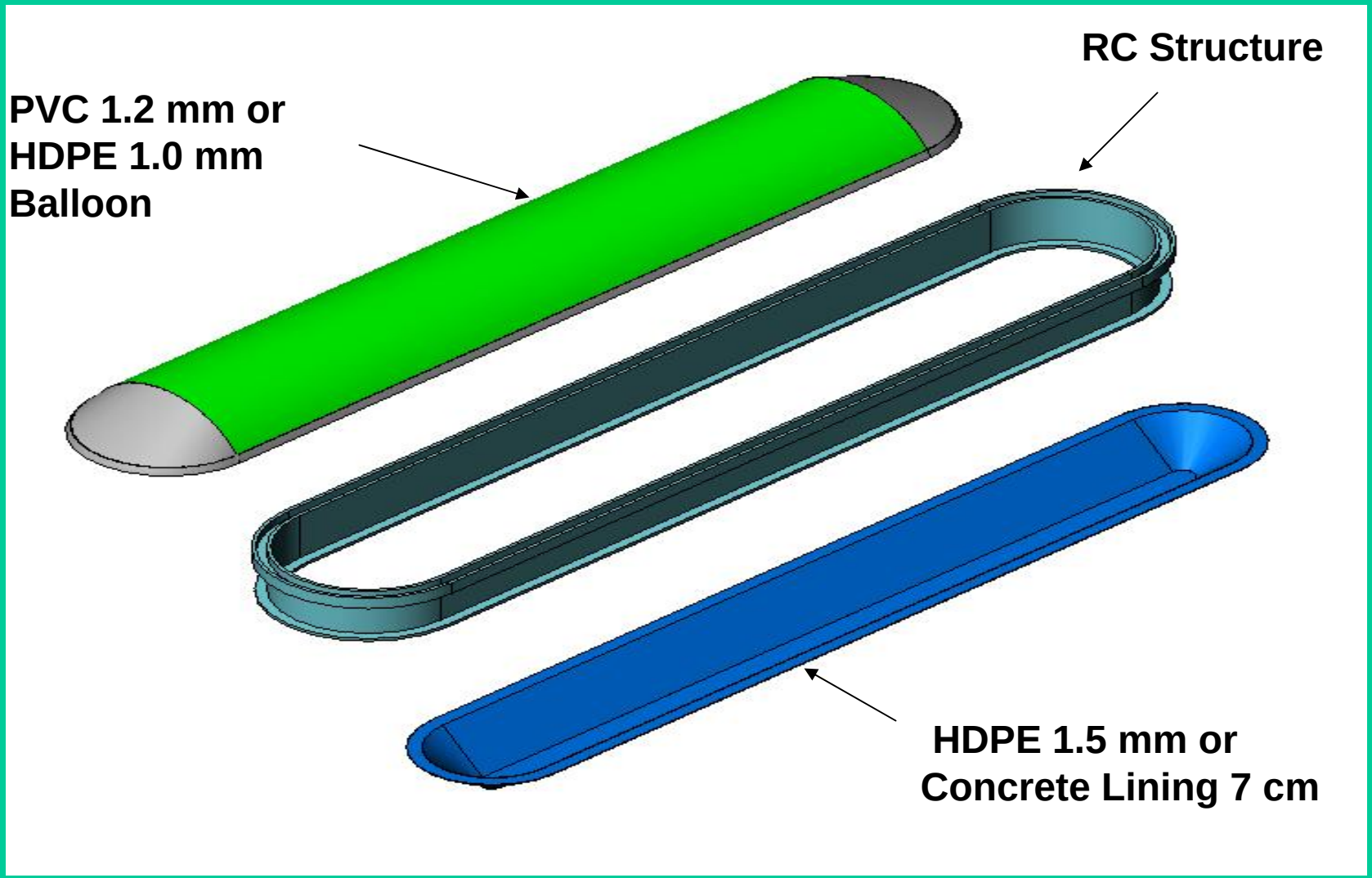


Waste Management in Farms with Biogas System

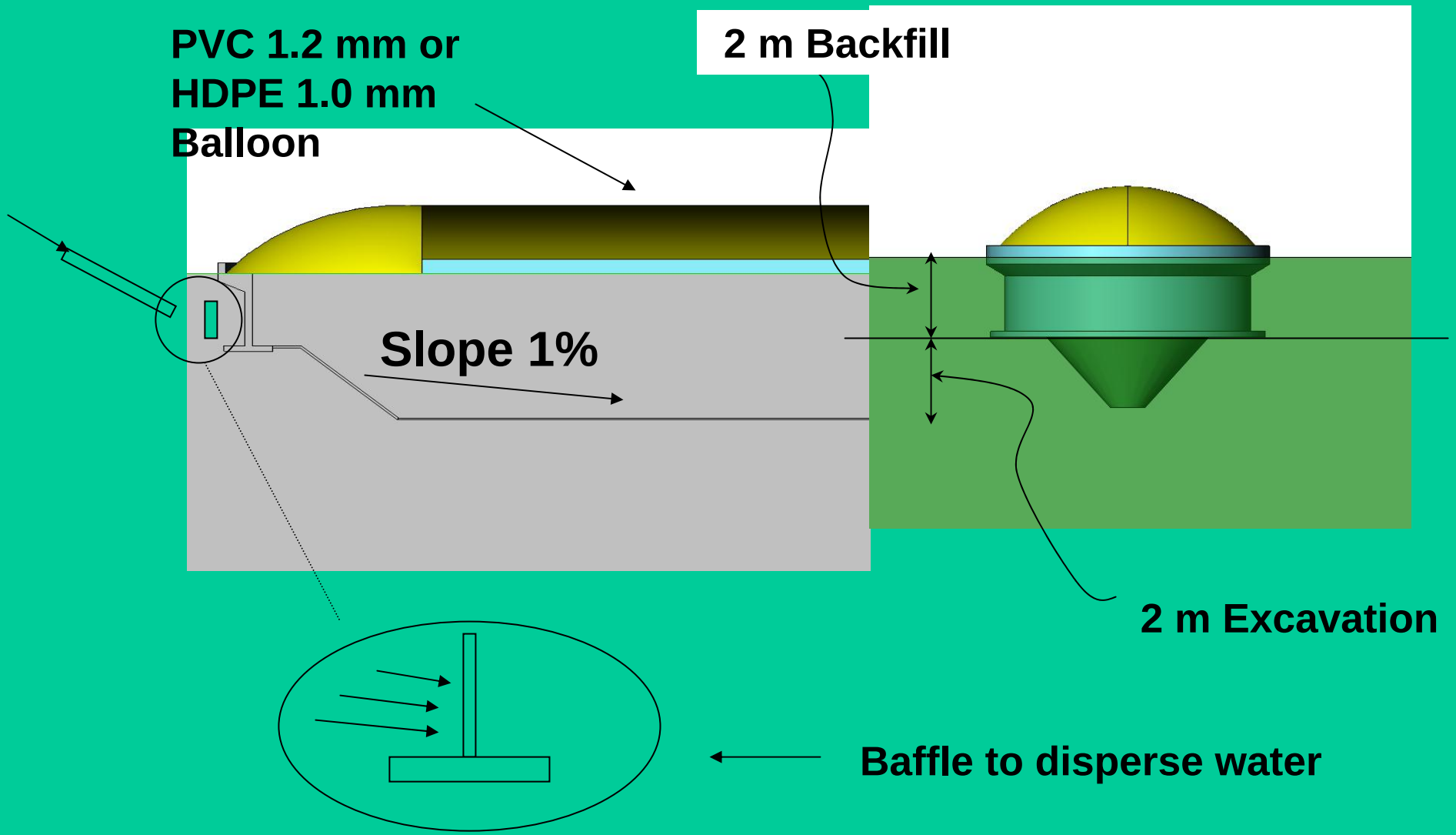



Separation Tank
UASB
Sand bed Filter
Control Bldg
Channel Digester
Sand trap
Collecting Tank
CD-UASB System

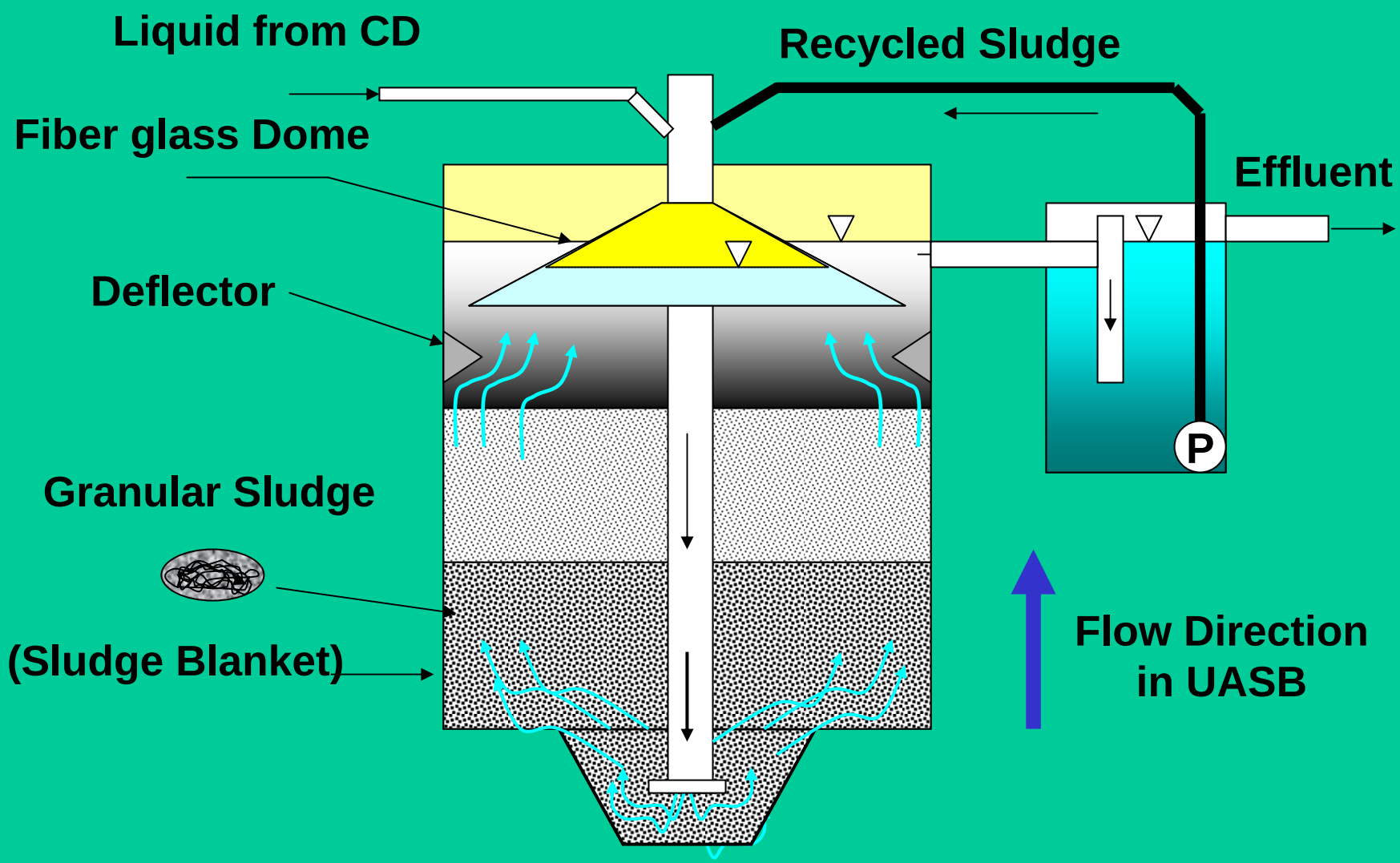
Channel Digester Tank, (CD)



Channel Digester Tank, (CD)



UASB (Up-flow Anaerobic Sludge Blanket) Tank

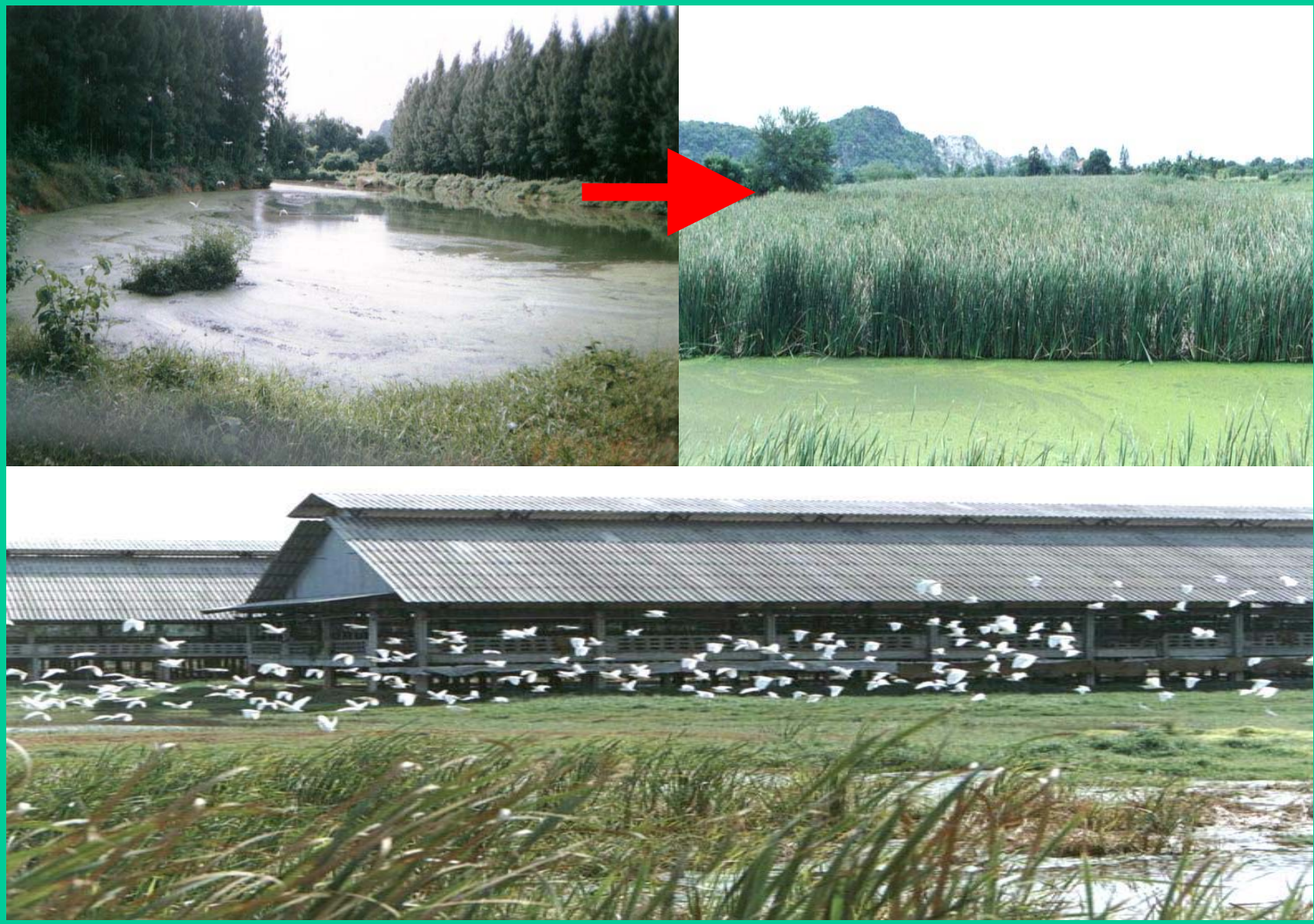


Organic Fertilizer from Sand Bed Filter

Drying Time : 4 days

Dried Sludge

Post Treatment



Environmental Benefits

Quality of H-UASB Effluent

pH	8.13
COD	700 mg/l
BOD	220 mg/l
SS	460 mg/l
TKN	447 mg/l
% COD Removal	86%
Reduced Odor and Housefly	> 90 %

Environmental Benefit

Water Quality after Post-Treatment

Item		STD.	Unit
pH	7.8	5.5-9.0	
COD	200	300	mg/l
BOD	40	60	mg/l
SS	90	150	mg/l
TKN	120	120	mg/l

Sample Projects

Phase II

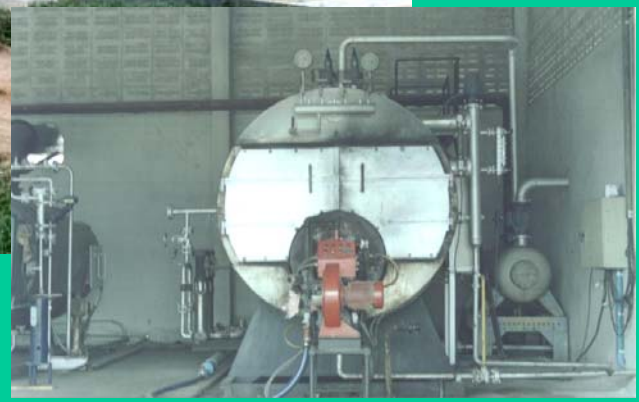
CD + UASB

(BG V.2)

Kanahybrid Farm , Nakornratchasima (4,000 m^3)

K.P.K. Farm (2) , Ratchaburi (4,000 m^3)

S.P.F Farm (2) , Prachinburi (2,000 m^3)



S.P.M. Farm (2) , Ratchaburi (5,000 m^3)

S.P.M. Farm (3) , Ratchaburi (4,000 m^3)

Kittiwat Farm , Chiangmai (1,000 m^3)

Jirasak Farm , Ubonratchatanee (2,000 m^3)

Tharnkasem Farm , Saraburi (3,000 m^3)

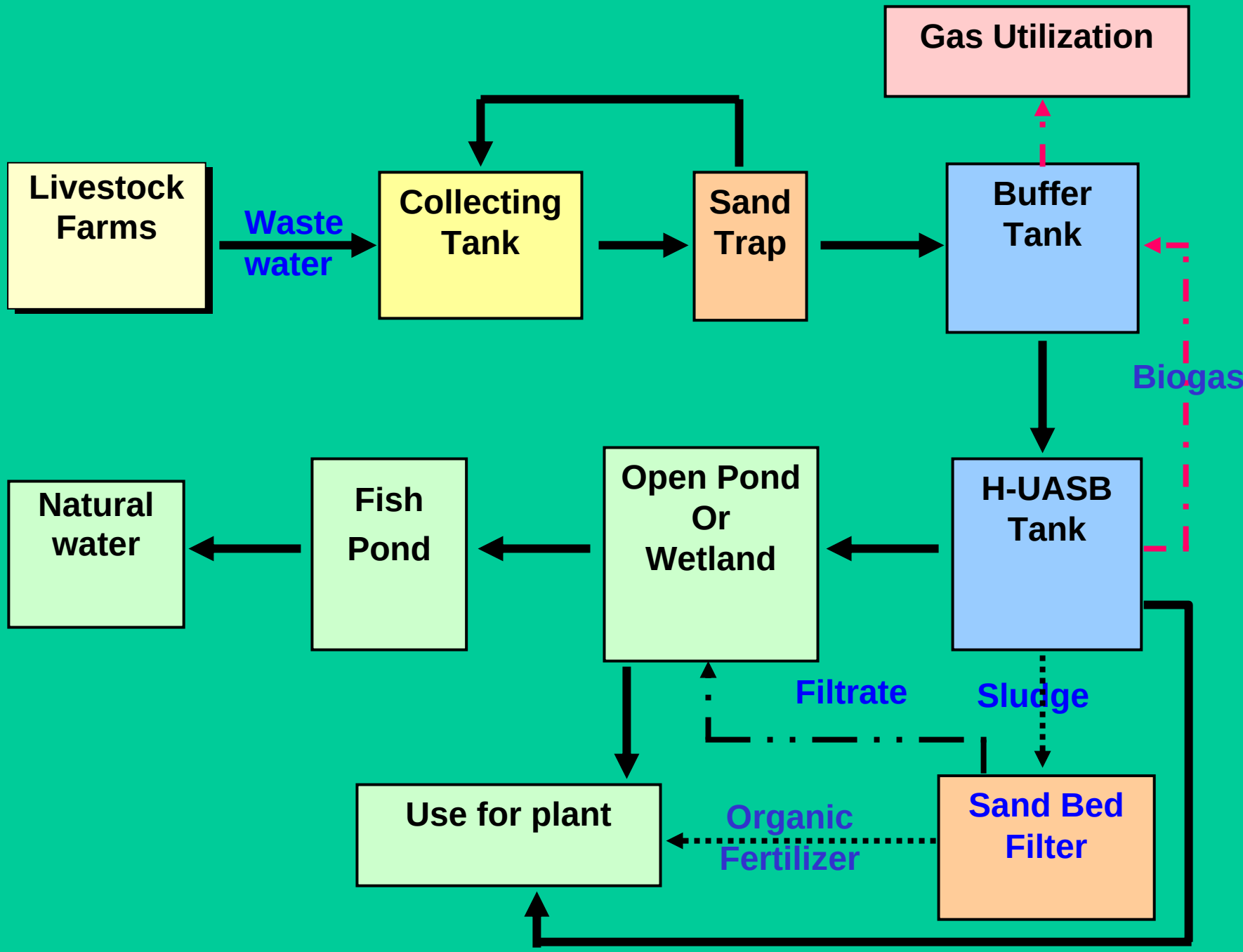
Raisomsukit Farm , Ratchaburi (2,000 m^3)

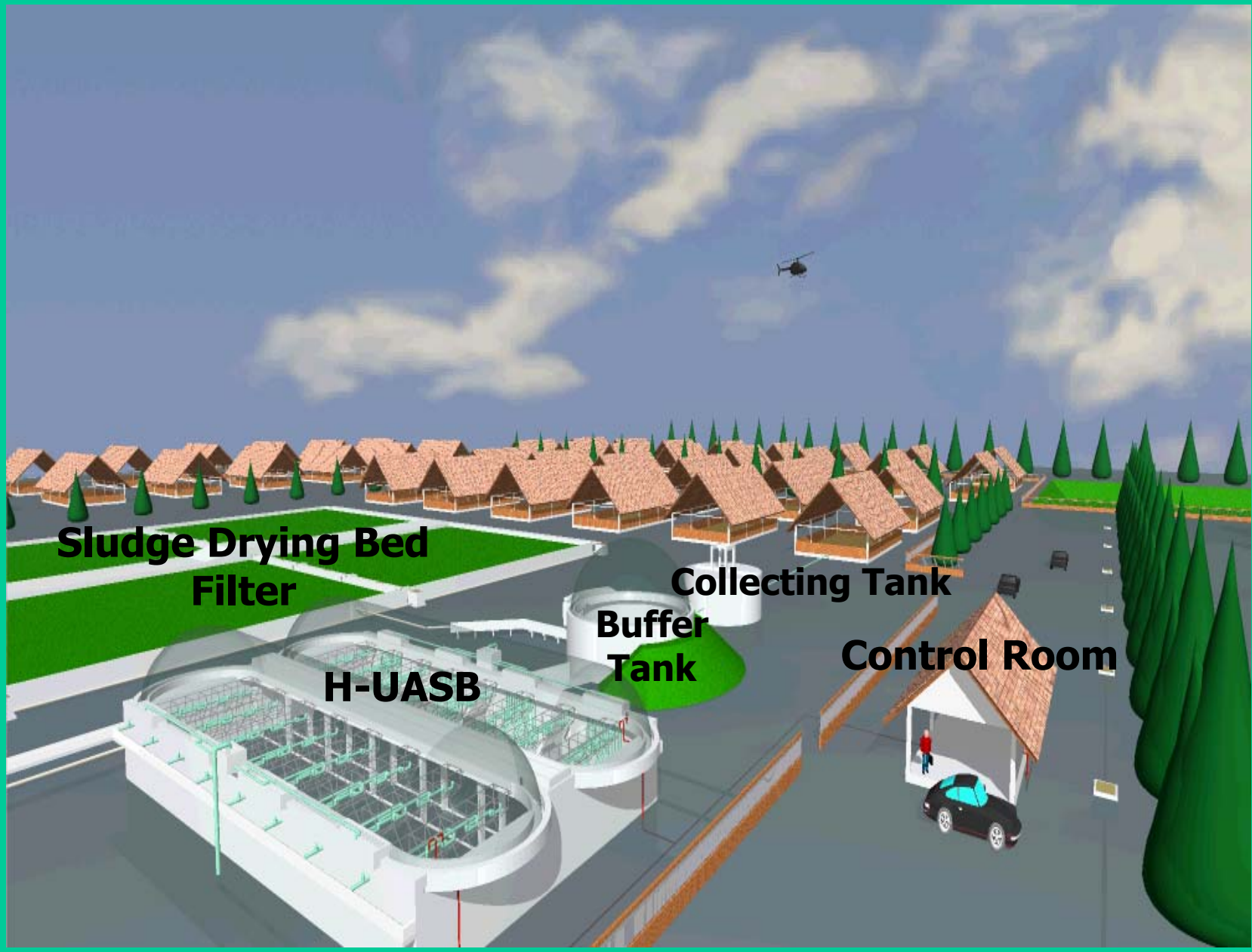
Anaerobic Digestion and Biogas Production Technology

as used in

The Promotion Programme on Biogas Production in Livestock Farms (Phase III) (2002-2009)

BT + H-UASB


Gas Utilization
Livestock Farms
Waste water
Collecting Tank
Sand Trap
Buffer Tank
Biogas
Natural water
Fish Pond
Open Pond Or Wetland
H-UASB Tank
Filtrate
Sludge
Use for plant
Organic Fertilizer
Sand Bed Filter

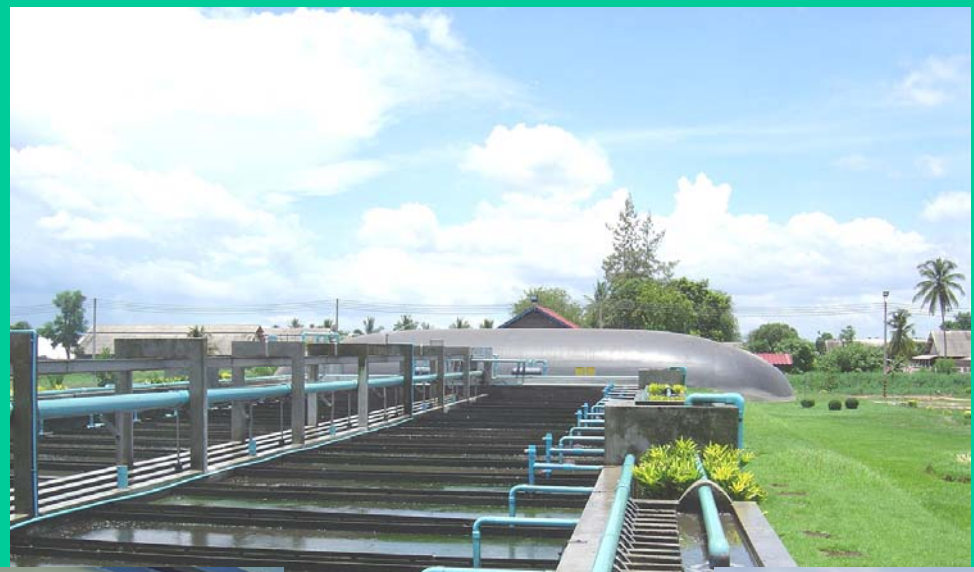

Sludge Drying Bed
Filter
H-UASB
Buffer
Tank
Collecting Tank
Control Room

Sample Projects

Phase III

H-UASB

(BG V.3)



CP Kampaegphet (2,000 m^3)

Weerachai Farm , Ratchaburi (12,000 m^3)

Boonmee Farm (2) , Ratchaburi (4,000 m^3)

Investment Cost and Biogas Production in Livestock Farms under Biogas Promotion Programme Phase III

Item	Unit	Value
1. Construction volume	m^3	280,000
2. Number of pigs under programme per year	Fattening pig	$1.8\text{-}2.0 \times 10^6$
3. Biogas production per 15 years	m^3	1.14×10^9
4. Total Investment	million baht	2,437.24
4.1 Supported by ECPF	million baht	853.08
4.2 Supported by farms	million baht	1,584.16

Benefits from Biogas System

- Production Cost Reduction from replacement of conventional fuels with Biogas. Investment return period 3-8 years
- Effluent from system passes the discharge standard set by the Pollution Control Dept
- Reduce groundwater and surface water contamination and allow recycling of wastewater
- Reduce pollution problems in farm surroundings (Odor and Flies)
- Alleviate resistance from local community

Biogas Utilization

Properties of Biogas (At 0 °C , 1 Atm. Pressure)

- CH_4 Content	:	65-70	%
- CO_2 Content	:	30-35	%
- H_2S Content	:	1,000	ppm
- Heat value	:	24.48	MJ/m^3
- Flame speed	:	25	cm/s
- A/F Ratio (Theoretical)	:	6.19	m^3a/m^3g
- Combustion Temp	:	650	^oC
- Ignition Temp CH_4	:	600	^oC
- Specific Heat (*Cp*)	:	1.6	$kJ/m^3\text{-}^oC$
- Density (*p*)	:	1.15	kg/m^3

1 Cu.m. Biogas Heat Replacement Value

LPG	0.46	Kilogram
Gasoline	0.67	Litre
Diesel	0.60	Litre
Heating Oil	0.55	Litre
Firewood	1.50	Kilogram
Electricity	1.20	KW-h

Types of Biogas Utilization

- Used as fuel for direct heat
- Used to generate mechanical/electrical power
- Co-generation System

Percentage of Energy replaced by Biogas

Size of farm	Percentage of Energy replaced by Biogas (%)		
	Electricity	LPG	Heavy oil
Medium farm	60	40	0
Large farm	80	10	10
Everage	70	25	5
Replaced value	9.57×10^8 kW-hr	1.31×10^8 kg	3.1×10^7 litre

Average Investment Costs for Fuel Replacement by Biogas

Fuel or Energy	Investment Costs		
	ECPF	Farms	Total
1. Biogas (Baht/m^3)	0.75	1.39	2.14
2. Electricity(Baht/kW-h	0.62	1.16	1.78
3. LPG (Baht/kg)	1.63	3.02	4.65
4. Heavy Oil (Baht/litre)	1.36	2.52	3.88

Research Directions

1. Anaerobic Digestion Technology and Digester Design

2. Post-treatment of the Effluence from Anaerobic Digesters

3. Treatment of Inert Solids from Anaerobic Digesters

4. Utilization of Biogas

R & D PROJECTS

1. Digester Design

Treatment of various wastes with anaerobic digesters

R & D PROJECTS (CONT.)

2. Purification of biogas

Bio Filter for removal of Hydrogen Sulfide before utilization

R & D PROJECT (Cont.)

3. Utilization of Biogas as Alternative Energy Source

Modification of carburator in internal combustion engine

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