Organic waste & Biomass to Energy Technologies

2014.10

Dohwa Engineering Co., Ltd.

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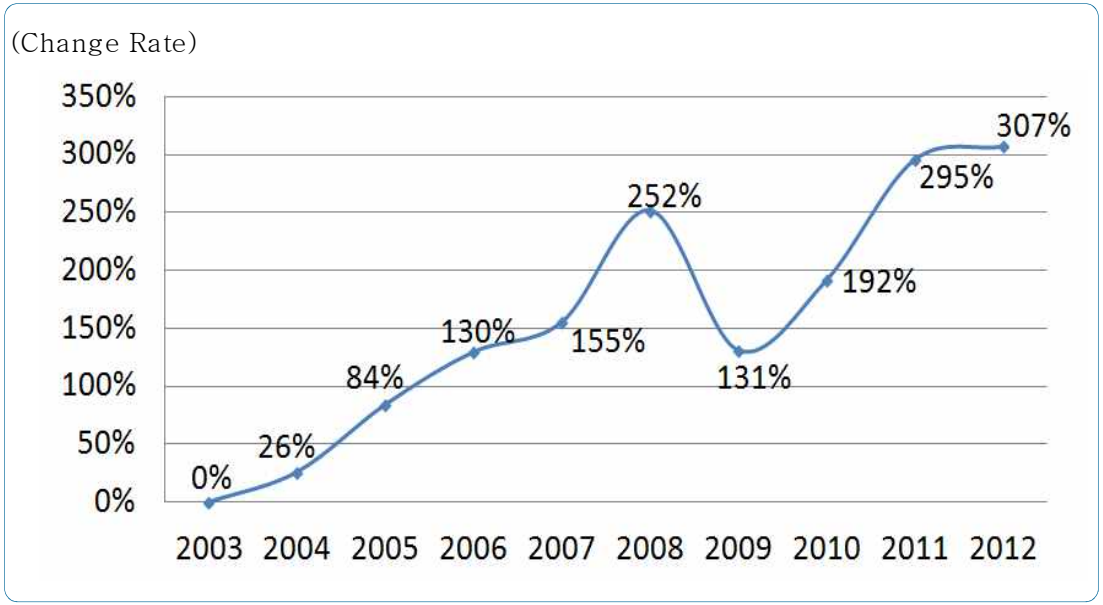
Contents

Background of Renewable Energy

Annual change in oil prices



International oil price rapidly increase recently 4 years

Year	Cost ($/bbl)
2003	26.80
2004	33.77
2005	49.37
2006	61.55
2007	68.43
2008	94.29
2009	61.92
2010	78.13
2011	105.98
2012	109.03
2013	105.25

- International oil price is 105.39 $/bbl(2014. 08)
- 10th largest energy consumer of the world ⇨ relies on imports for 97%

1. Policy and Trend of Renewable Energy

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EU	The goal of renewable energy supply in 2020 is 20 % of total energy 34 % of generation , 10 % of transportation fuel
Japan	The goal of renewable energy supply in 2020 is 20 % of total energy (MOE, ' 10.1) (Reopen to give solar energy subsidy(' 09.1) Mandatory for purchase remain solar energy (' 09.11)
USA	Provide renewable energy which is 25% of electric power in 2025 (Announcement of Obama Government)
China	The goal of renewable energy supply in 2020 is 15% of Primary Energy (300GW of Water, 30GW of Wind, 1.8GW of Solar, 30GW of Biomass) Develop and supply plan of Wind, solar, water etc.
Germany	The gold of renewable energy supply in 2020 is 18% of Final Energy (30% of generation amount)

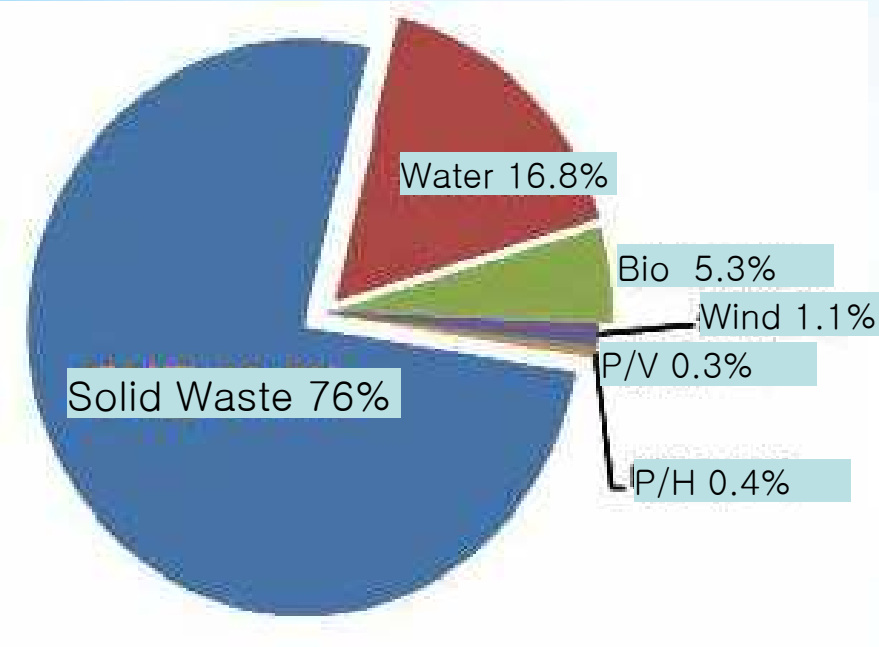
Div.	USA	Japan	Germany	Denmark	UK	Korea
Supply rate('07)	5.0%	3.4%	8.6%	18.1%	2.4%	2.4%
Goal	10.9%('30)	20%('20)	18%('20)	30%('20)	15%('20)	11%('30)

Data : Energy Balance of OECD Countries('09), IEA

Set the goal of renewable energy supply and under continuous efforts

Policy of Renewable Energy in Domestic

<Composition of Renewable Energy>



- Renewable energy using Bio is 5.3% of total energy
- Plan to increase rate of bio-energy up to 30% by 2030
- Production cost of bio energy among national renewable energy is similar with 10% of solar and 70% of wind

(단위 : Won/kwh)

Div.	Solar	Wind	Water	Waste	Bio
Unit cost of production	716	107	70	71	75

Establish goal plan in supply structure of Bio-Energy among renewable energy

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Alternative Clean Energy in Domestic

- To address global warming, the development of alternative clean energy source like biomass must accelerate to reduce our dependence on fossil fuel.
- Korean power demand ranked third place of electricity consumption rate among global top 8 major countries (International Energy Agency(IEA))
- A steep increase of power demand especially on specific time (summer and winter) can lead to electricity crisis like Blackout

(unit : 1,000TOE)

Remark		2020	2030	2050
Primary Energy Demand Forecast		287,976	300,417	373,872
	Long-term goal of renewable energy supply	5.6%(16,241)	11.0%(33,027)	20.0%(74,774)
	Goal of waste resources and biomass energy supply	4.7%(13,383)	7.0%(21,000)	10.0%(37,387)

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Domestic Policy for Alternative Clean Energy

- Government needed alternative clean energy and introduced the "Renewable energy Portfolio Standard(RPS)" to satisfy power demand and reduce greenhouse gas emissions and opened the new RECs(Renewable Energy Certificates) market
  - -RPS duty supply: 2.0% by 2012, 2.5% by 2013, 3.0% by 2014, 10% after 2022 of total electricity generated
  - -2012year result: KEPCO subsidiaries(6 companies) are carrying out 64% (3,808 GWh out of total 5,911 GWh)
- REC Performance in 2012Unit(GWh)

Generator	Total amount of duty (photavoltaic)	Performance result		Implementation delay	Penalty (0.1 billion won)
		Self-supply	Outside purchase		
Kosep(남동)	834(43)	62(18)	302(23)	470(2)	105
Komipo(중부)	738(43)	89(6)	303(36)	346(1)	59
Kowepo(서부)	761(43)	72(6)	366(33)	323(4)	45
Kospo(남부)	834(43)	115(13)	451(29)	268(1)	8
EWP(동서)	734(43)	72(13)	351(30)	311(0)	44
KHNP(한수원)	2,010(43)	1,291(2)	333(37)	386(4)	0
Total	5,911(258)	1,702(58)	2,106(188)	2,103(12)	261

Increased buying biomass fuel and RECs for the effective implementation of the RPS to avoid penalty

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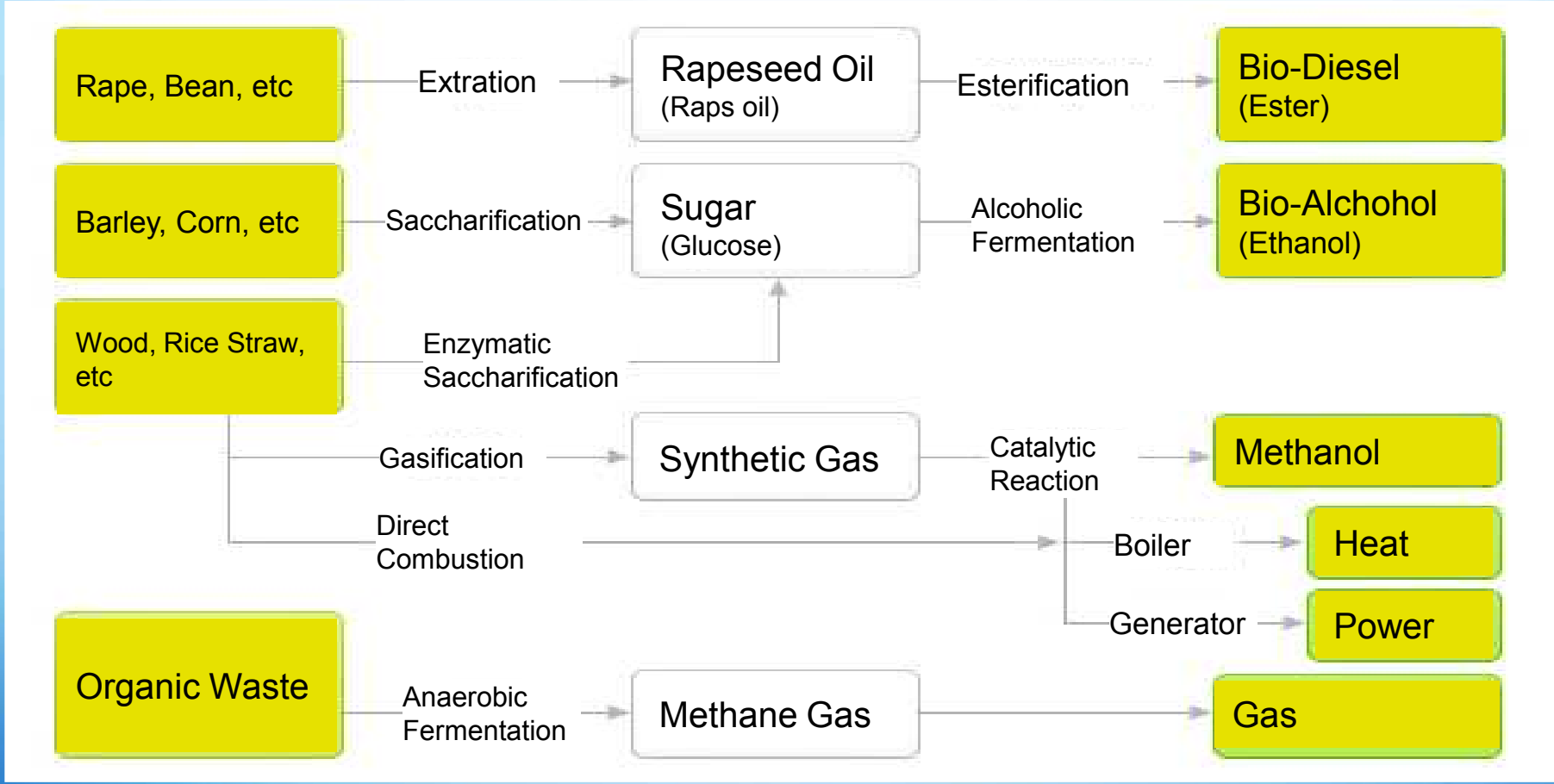
What is Biomass?

- Biomass is derived from sources of various types, such as agricultural, forestry, fishery, stockbreeding, and Organic waste resources, and the technologies to use those various types also vary widely.

Biomass as a Renewable Energy Source

- Biomass can either be used directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel such as biodiesel, bioethanol and biogas.



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Treatment Technology of Food Waste in Domestic

Feeds	Installation cost is cheap but expensive production cost , odor from dehydration process and difficult to look for source of fodder demand
Compost	Many facilities are already installed because of easy access, but low additional value of by-product and need a wide area
Combine to sewage treatment	Low installation cost because of using the existing sewage plant, but low operation result and need high-level treatment process

"Waste to Energy"
National policy change

Anaerobic Energization	Low odor and possible to be energization by manufacturing bio- gas Low operation cost , preparing for climate changes and suitable for low carbons policy

Change into Anaerobic energization is coincide with government policy

4. Characteristic of Organic Waste

Characteristic of Food Waste in Domestic

Food waste

Div.	Moisture (%)	TS (%)	VS (%)	VS/TS (%)
K city	82.35	17.65	14.33	81.19
D city	83.49	16.51	14.29	86.55
I city	76.26	23.77	17.45	73.41
Literature	74 ~ 85	15 ~ 26	13 ~ 19	73 ~ 86

Food waste leachate

Div.	BOD (mg/L)	COD (mg/L)	SS (mg/L)	T-N (mg/L)	T-P (mg/L)
K city	97,856	138,417	68,042	8,289	672
I city	83,617	141,393	42,653	3,246	498
Literature	61,097 ~ 82,501	136,570 ~ 160,146	16,385 ~ 50,984	2,527 ~ 2,835	226 ~ 656

Data : K city, D city, I city, basic design report,
literature : feasibility study of biogas development using organic waste, 2008, SLC

Moisture and VS rate is high, High concentration leachate is generated

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Characterization of Food Waste in Domestic

Moisture

- Eating habit, High moisture
- Odor generation because high moisture content

Organic matter

- Fast hydrolysis and acidification of organic matter
- High biodegradability (removal rate of VS : over 80%)

Appropriate Treatment of food waste!!

Physical composition

- High load by deviation per days and months
- Need to pretreatment facility by foreign material

Salt concentration

- Consistant amount of salinity
- Low Influence to process

Need high efficiency energization facility

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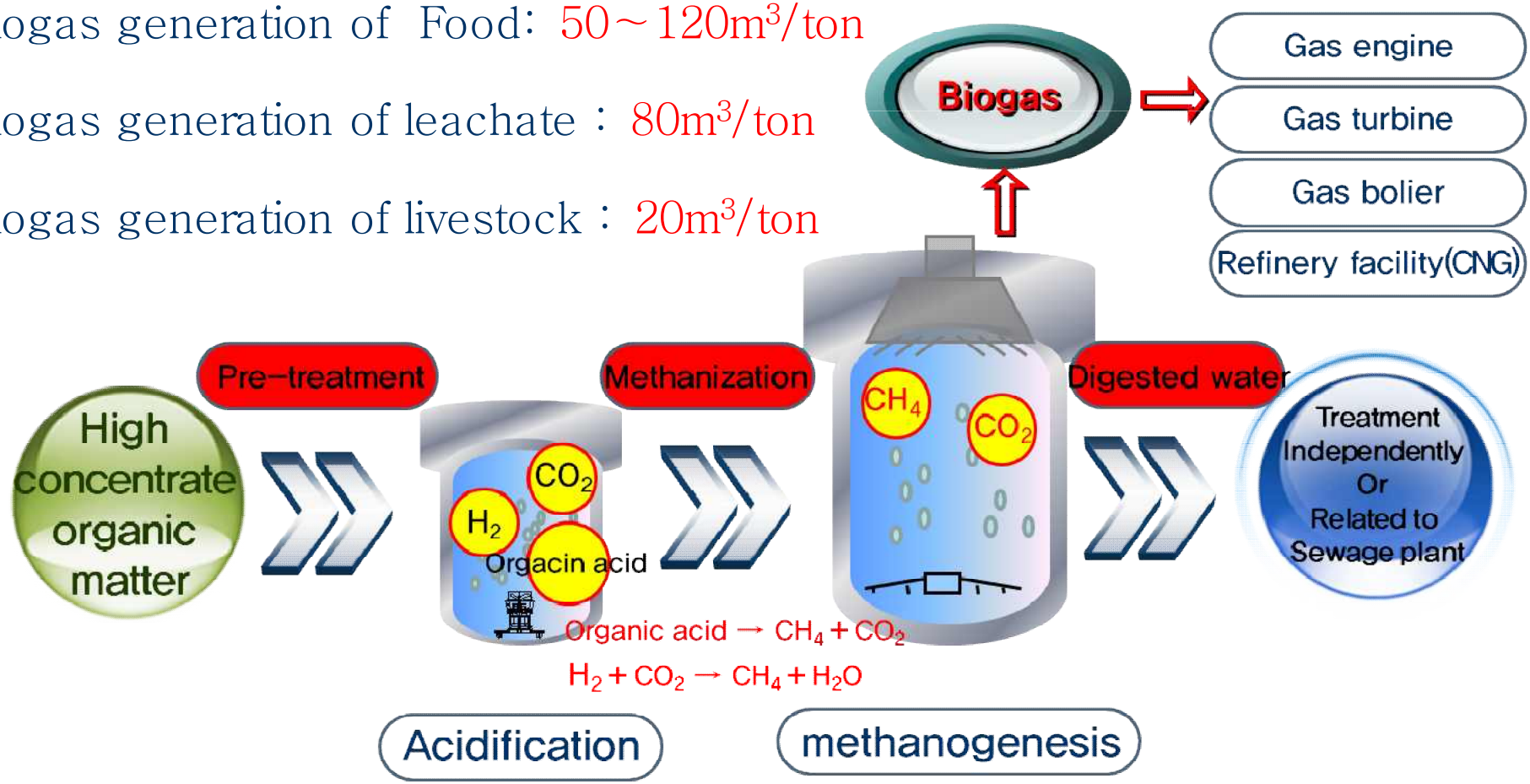
Concept of anaerobic digestion technology

- Biogas generation of Food: 50~120m³/ton
- Biogas generation of leachate : 80m³/ton
- Biogas generation of livestock : 20m³/ton



Biogas is generated by anaerobic digestion process

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Input & Pre-Treatment Process

Food waste input

Food waste storage

Crushing, Seperating

Hydration(wet)

Dehydration(dry)

Anaerobic digestor

Process for micro-organism to be easy to use

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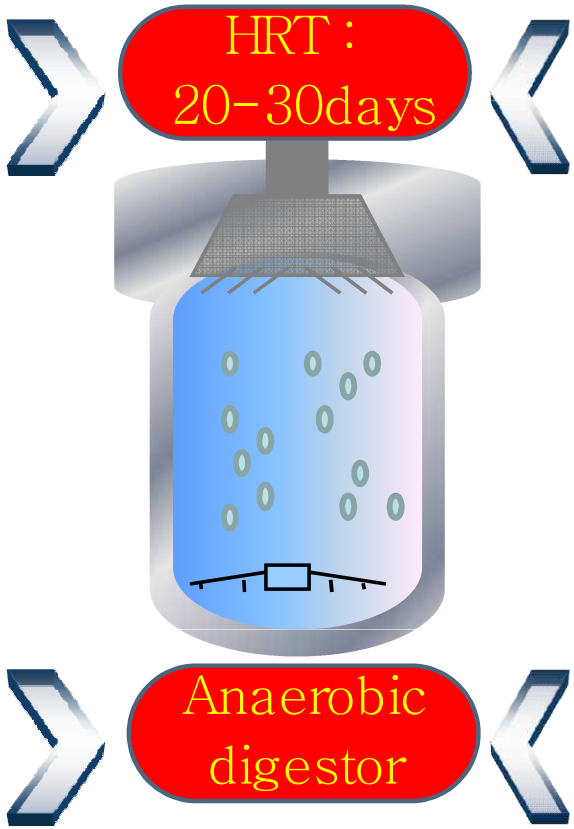
Anaerobic Digestion Process Types

Input method

- SBR (sequencing batch reactor)
- CFR (continuous flow reactor)

Digestion

- Single Tank
- Double Tank



SS(mg/l)

- Wet digestion : less than 10%
- Dry digestion: more than 20%

Temp. in tank

- Middle : 35℃
- High : 55℃

Select Anaerobic digestion process according to operation condition

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Operating Condition of Anaerobic Digestor

Div.	Condition	Remarks
Temp.	middle: 30~40℃ high: 50~60℃	Additional heating cost of reactor when temperature increases
HRT	15~30 days	CSTR process
pH	Near 7.0	Optimal condition of methanogen
ORP	Less than -300 mV	Organic carbon's reduction condition
Removal rate of VS	70~85%	Differences depend on characteristics of food waste
Removal rate of COD	40~95%	Big differences depend on characteristics of food waste

Basic conditions to maintain high activity of Anaerobic micro-organism

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Biogas Utilization Process

Desulfurization

Dehumidification

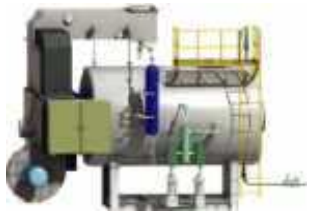
Gas storage tank

Refine

Remove siloxane

Fuel of Vehicle

Gas boiler



Generation of gas turbine

Generated biogas can be utilized to various energy sources

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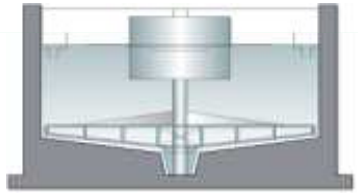
Waste water treatment process

Storage tank

Flocculation tank



Physical treatment
(floatation,precipitation)

Dehydration of sludge

Combine sewage treat.

Discharge

Digested waste water are treated independently or ties to sewage plant

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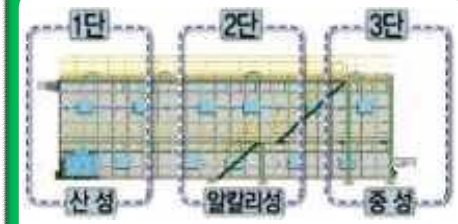
Odor Treatment Process

High Concentration (Input area)

Burnning

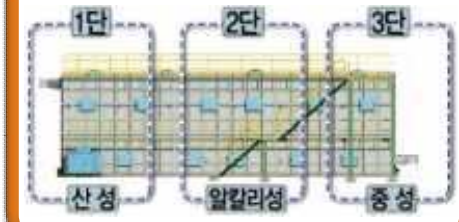
Chemical treatment



Low Concentration (Rooms)

Bio fillter

Chemical treatment



Removal odor by separating high and low concentration

6. Example of Organic waste to energy in domestic

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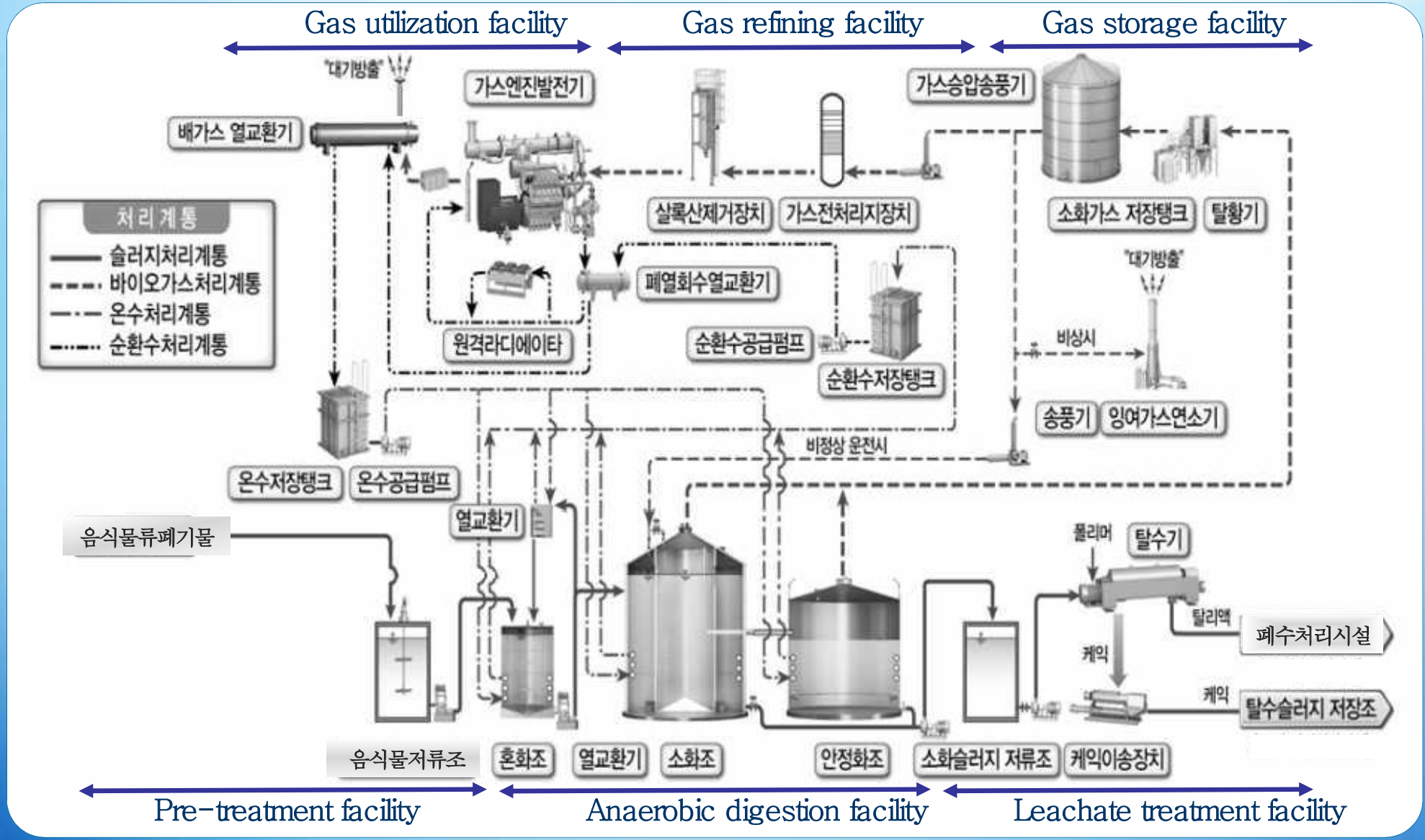
Process diagram



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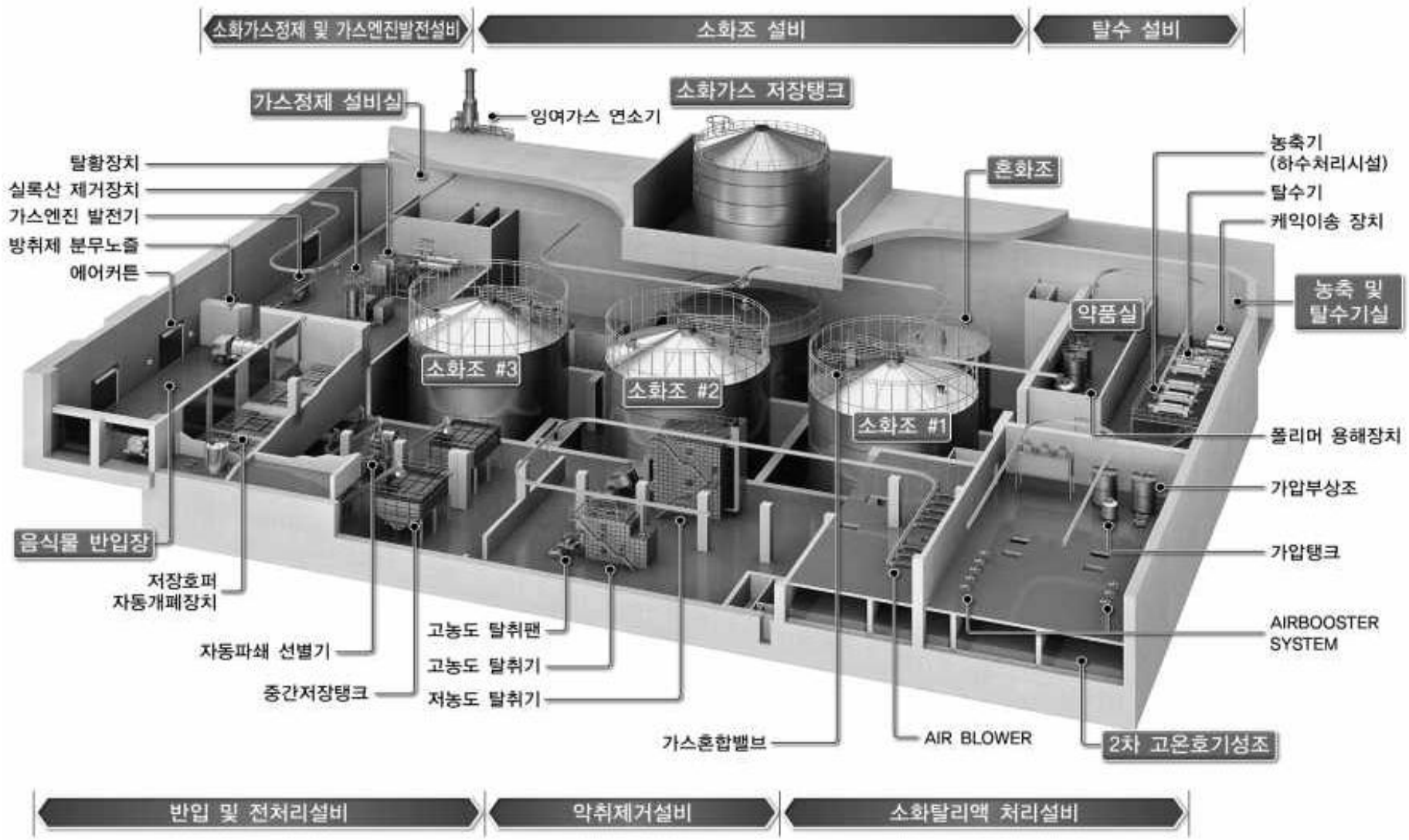
Case of underground(P city-Private investment business)



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Introduction Techniques of Domestic

Div.		Dae-woo	Seo-hee	Hallasanup	Ecoday
Technology		Own technology	OWS(Belgium)	OWS(Belgium)	Own technology
Name		DASB	Dranco Process	Double wet middle temp. digestor	E.PFR-2 SYSTM
Waste		Leachate, livestock waste water	Food waste	Food waste, livestock waste water	Food waste, Leachate
	Process	Double wet	Single dry	Double wet	Double wet
	Temp.	middle(35~40℃)	high(55± 2℃)/ middle(35± 2℃)	middle(within 35℃)	middle(within 35℃)
	Time	25 ~ 30 days	Within 30 days	(1st 3 ~ 5days, 2nd 15 ~ 20days)	Within 15 days
	CH_4	Within 60%	60 ~ 70%	60 ~ 75%	Within 75%
Character of process		No-power stirring by gas pressure	No hydrolysis process	pH control by returned discharge water	High load, Fast treatment
Result		•Nambu waste treatment 1,700㎥(leachate) •Asan(100 ton/day)	•Busan(200 ton/day) •Dongdaemun(98 ton/d)	•Paju(30 ton/day) •milyang(20 ton/day) •Sokcho(20 ton/day)	•Paju(30 ton/day)

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Introduction Techniques of Overseas

Div.		ARROWBIO	BTA	OWS	HESE
Technology		Own technology	Own technology	Own technology	Own technology
Name		Double wet anaerobic	Single and double wet anaerobic	DRANCO Process	Double wet anaerobic digestion
Waste		Food Waste	Food waste, livestock waste, sludge	Food waste	Food waste, livestock waste
	Method	Double wet	Single dry, double wet	Single dry, double wet	Double wet
	Temp.	middle(35~40℃)	middle(35~40℃)	high(50~65℃)	middle(within 35℃)
	Time	HRT : 1 ~ 3days SRT : 80 ~ 90days	Single : 14 ~ 16days Double : 5 ~ 7days	15 ~ 30days	19days
	CH_4	81%	65 ~ 75%	50 ~ 60%	Within 60%
Characteristic of process		UASB	No-power stirring by gas pressure	Directly supply steam to reactor	Maintain Aerobic at hydrolysis
Performance		•Tel Aviv, Israel(100 Ton/day)	•Kirchstockach, Germany(20,000 Ton/yr) etc.	•Rome, Italy (40,000Ton/yr) •Leonberg, Germany (30,000 Ton/yr) etc.	•Leicestershire, UK (40,000 Ton/yr) etc.

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Cases of Organic Waste to Biogas in Domestic

Div.	Gwangju	SLC	Dongdaemun gu
Picture			
Capacity (Ton/day)	150	500	98
Completion	2007. 02	2013. 08	2010. 10
Treatment	Leachate	Food waste leachate	Food waste
Utilization of biogas	Heat reactor	Heat reactor and air conditioning and heating	Electronic and steam generation for onsite
Anaerobic Process	Wet high temp.	Wet double phase	Dry single phase
Remarks	Anaerobic digestion of food waste leachate	Largest in national of anaerobic digestor	Undergrounding and Making park

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Project Plan of Food Waste to Biogas

Local Government	Treatment	Period (year)	Capacity (T/d)	Case of underground
Sokcho	Food waste	09-10	40	-
Daegu	Food waste	09-12	300	Treatment facility(underground), Park(ground)
Goyang	Food waste	09-12	260	Treatment facility(underground), Park(ground)
Kimhae	Leachate	09-12	100	-
Jinju	Leachate	10-11	150	-
Unpyoung	Food waste	10-12	100	Treatment facility(underground), Park(ground)
Gwangju	Leachate	10-12	300	Treatment facility(underground), Park(ground)
Ulsan	Leachate, Livestock	10-12	150	-
Chungju	Leachate	10-12	200	-

6. Example of Organic waste to energy in domestic

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Case of Changing Facility into Park (K city-300 Ton/day, Detail design)

Possible to make the park being designed with efficiency and environment friendly

6. Example of Organic waste to energy in domestic

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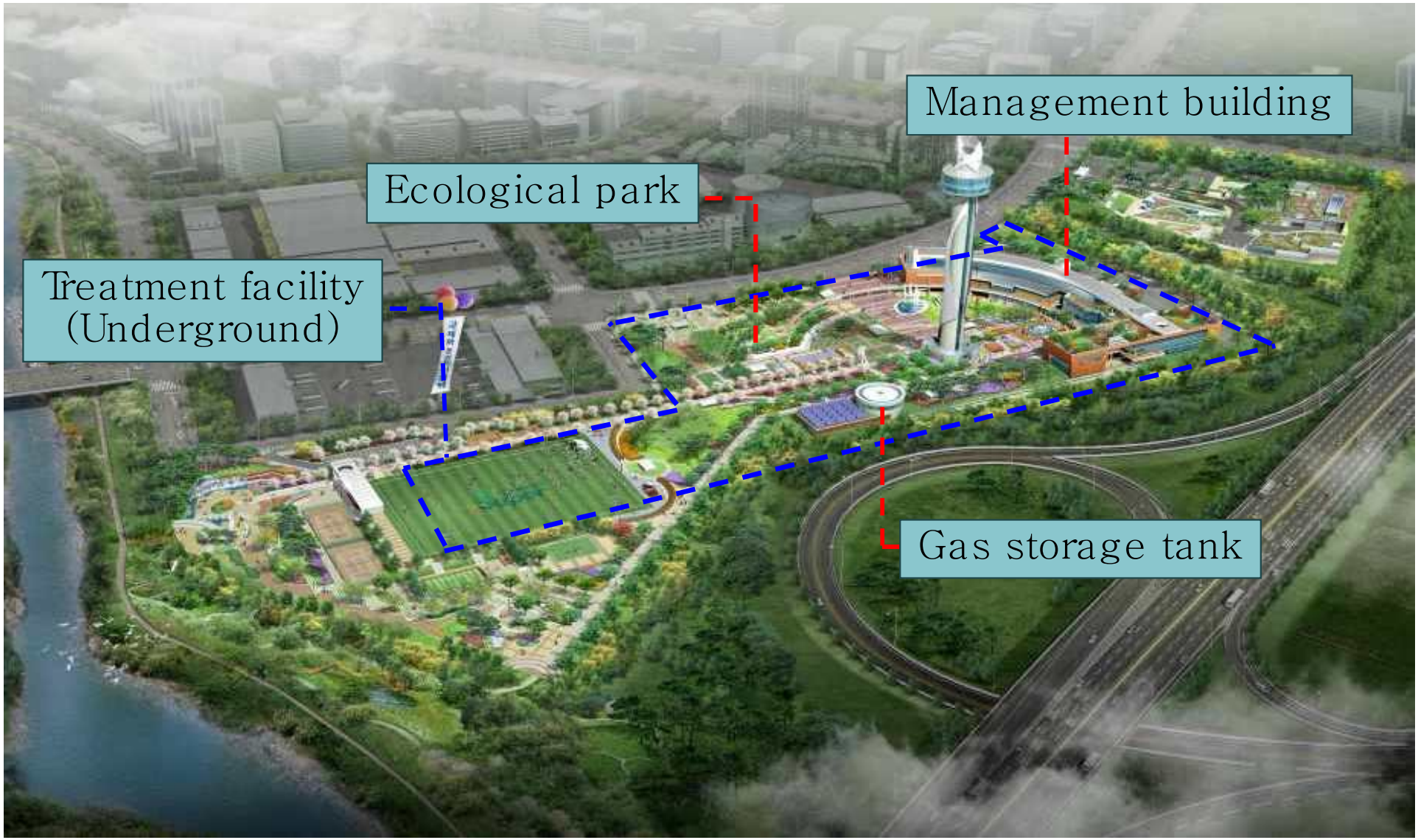
Case of Changing Facility into Park
(P city-200 ton/day, on going private investment business)



Quiz

1. What is the RPS ?

   And please explain about relations between RPS and Bio-energy.

2. You are assumed to be an engineer of organic waste to energy facility. What are most items can be considered for normal operation?

3. Please calculate the yield of Methane gas production(m3/hr) and power generation(MW) for 100 t/d Food waste.

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Thank you