



Country Report

Biomass Gasification –2010-2012 in Japan

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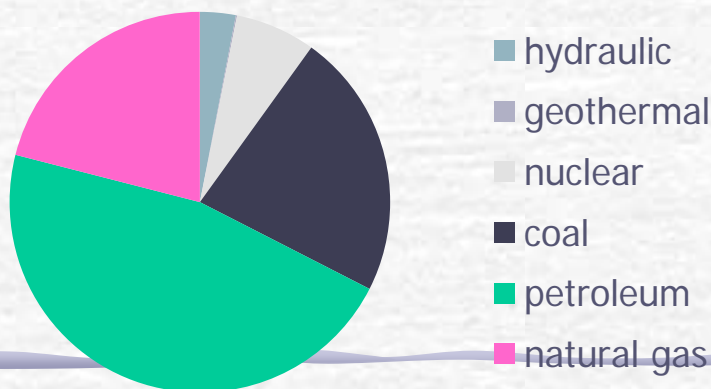
IEA Bioenergy Agreement: 2010-2012
Task 33: Thermal Gasification of Biomass
Task Meeting, 2012
Vienna, November 16 , 2012

Background:

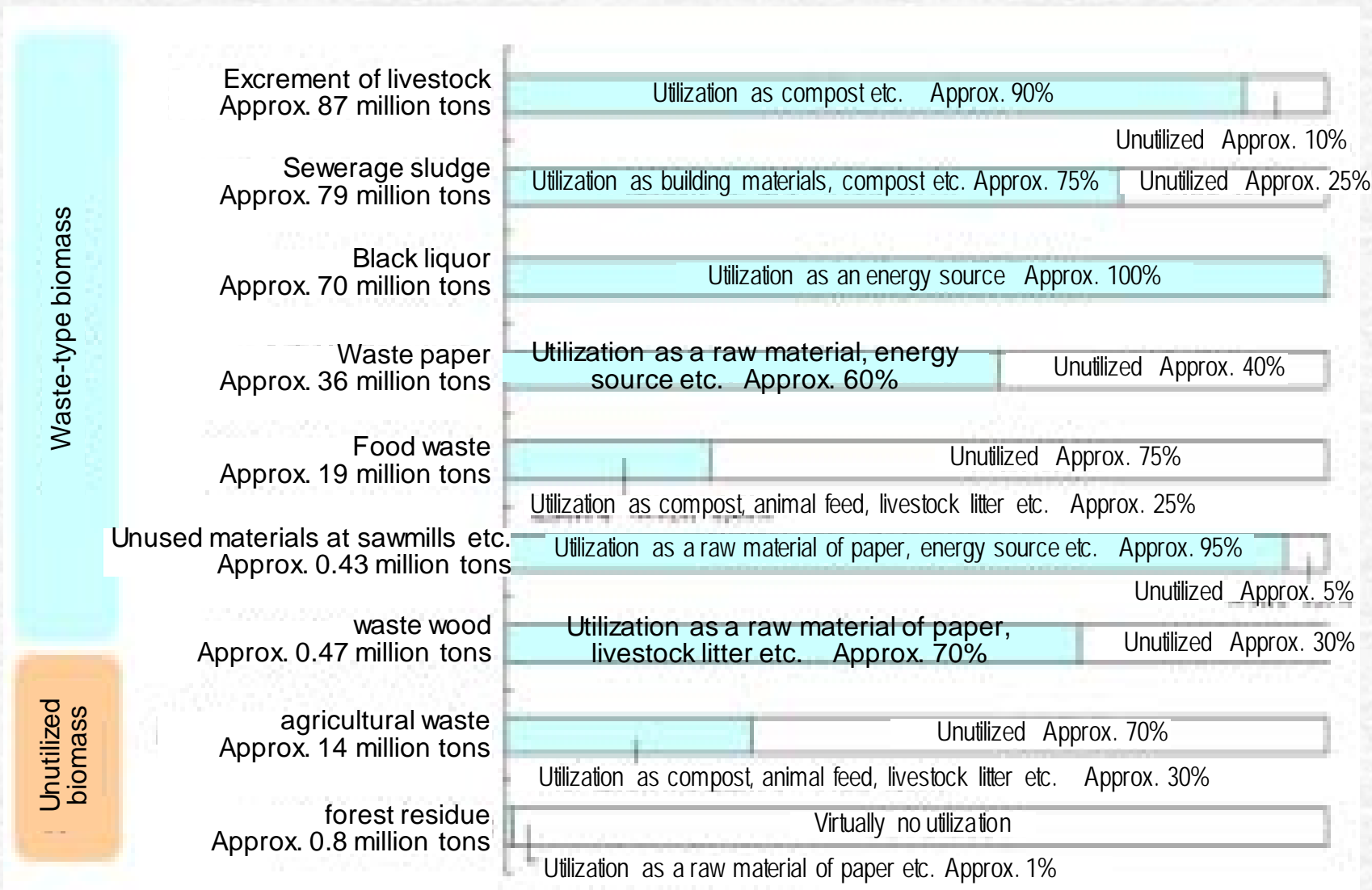
Primary Energy Sources in Japan (PJ)

	2008	2009	2010	2011	2012?
hydraulic	653	648	699	640	
geothermal	23	24	22	22	
nuclear	2 218	2 420	2 576	1436	?
coal	5 455	4 409	5 024	4765	
petroleum	11 088	9 647	9 964	9814	
natural gas	3 944	3 678	3 970	4431	
TOTAL	23 282	20 827	22 255	21107	

→ The Great East Japan Earthquake
March 11,2011



Background: Potential of Biomass in Japan





Japan's Strategies/ Policies Relating to Biomass Energy*:

- Recognition of Biomass as “Renewable energy source” in Japan and set of targets for introducing Biomass energy by government (January, 2002)
- Biomass Nippon Strategy (**Interagency proposal** for general use of biomass in Japan) (December 2002)
- Energy Conservation Technology Strategy (April 2004)
- Revision of target values (Bio-fuel was first nominated:0.5 million kl) (February 2005)
- Kyoto Protocol Target Achievement Plan (April 2005)
- Biomass Nippon Strategy (revised, March 2006)
- **New National Energy Strategy (May 2006)**
- Basic Energy Plan (March 2007)
- New (Next) Generation of Vehicles and Fuel Initiative (May 2007)
- Bio-fuel Technology Innovation Plan (March 2008)
- **Cool Earth 50 –Innovative Technologies Development Project (March 2008)**... G8 Toyako-Summit (August 2008)
- Act on Promotion of Utilization of Organic Resources Originated from Agriculture, Forestry or Fisheries as Materials for Biomass Fuels (October 2008)
- **Act of Sophisticated Methods of Energy Supply Structures (August 2009)**
- **New Growth Strategy (Basic Policy) (December 2009)**
- **Report for Establishment of Standard of Sustainable Bio-fuel in Japan (March 2010)**
- **Strategic Energy Plan (revised Basic Energy Plan) (June 2010)**
- (---- East Japan Great Earthquake, March 11, 2011----)
- **Feed-in-Tariff Scheme for Renewable Energy Act (July 2012)**

*These acts, plans, policies and strategies concerning biomass “energy” have been mainly advocated, decided and performed by METI (Ministry of Economy, Trade and Industry).

Policies:

Target for New Energy Introduction (by METI)

(Crude oil equivalent :COE thousand kl)

		Actual results (FY2000)	Actual results (FY2005)	Target Scenarios (FY2010)	Target Scenarios (FY2020)	Target Scenarios (FY2030)
Power Generation	Photovoltaic***	81	347	1,180	3,500	13,000
	Wind ***	59	442	1,340	2,000	2,690
	<u>Waste Material</u>	1,150	2,520	5,520	3,930	4,940
	<u>Biomass</u>	47		3,40		
Heat Utilization	<u>Biomass</u>	-	1,420	3,080	3,300	4,230
	<u>Waste Material</u>	45	1,490	1,860	7,630	7,160
	<u>Black Liquor and Waste, etc.*</u>	4,900	4,700	4,830		
	Solar Energy	890	610	900		
	Non Utilization Energy(Cold Heat of Ice and Snow)	45	49	50		
Total Amount of New Energy Supplied (Total Primary Energy Supply/Component Ratio)		7220 (1.2%)	11580 (2.0%)	19100 (3.2%)**	20,360	32,020

Includes
500,000 kl
Liquid fuel

*Classified as one type of Biomass

** Renewable energy (new energy + hydro-power and geo-thermal) = 8.2%

***After the Earthquake, these two energies are planned to increase largely.

Source: January, 2010,

New Energy Subcommittee of the Advisory Committee on Natural Resources and Energy (METI)



Latest Policy:

➤ Feed-In-Tariff Scheme (FITs) for Renewable Energy Act (2012.7)

The “Act on Purchase of Renewable Energy Sourced Electricity by Electric Utilities” was approved at the 177th session of the Diet.

This Act obliges electric utilities to purchase electricity generated from renewable energy sources (Solar PV, Wind power, Hydraulic power, Geothermal and **Biomass**) based on a fixed-period contract with fixed price. It will start on July 1st, 2012.

	Current				New (Purchasing Price: Under consideration)		
	~10KW	10KW ~ 500KW	500KW ~		~10KW	10KW ~ 500KW	500KW ~
Residence	42 Yen/KWh (Excess)			Residence	Excess		
Non Residence	40 Yen/KWh (Excess)			Non Residence	Full Amount		
Business Operation	Out of Scope		Business Operation				

3.11 Cataclysm: East Japan Great Earthquake



Photos just after the earthquake, the end of March, (by courtesy of LPG-GAS INDUSTRIAL NEWS JAPAN)

An earthquake of unprecedented force
A tsunami of unspeakable destructiveness
....then
A radioactive awakening



*Even now, a bus on a ruin,,,
from my friend*

Japan convulses, grieves, moves on

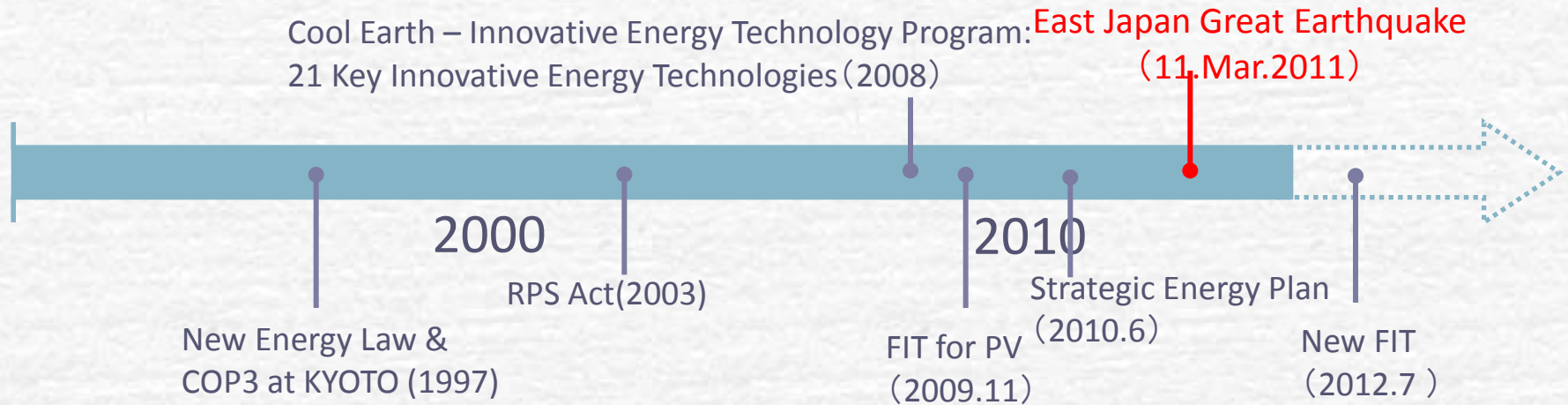
*Thank you for your helpfulness, thoughtfulness, encouragement
from all over the world!! We are fine.*

Before 3.11/ After 3.11discontinuity

Before 3.11

Review of Basic Energy Plan (June 2010) ---

**--Enforcement of introduction of Nuclear and renewable energy
Nuclear (& hydraulic, “zero emission” energy) ⇒ ~50%**



After 3.11

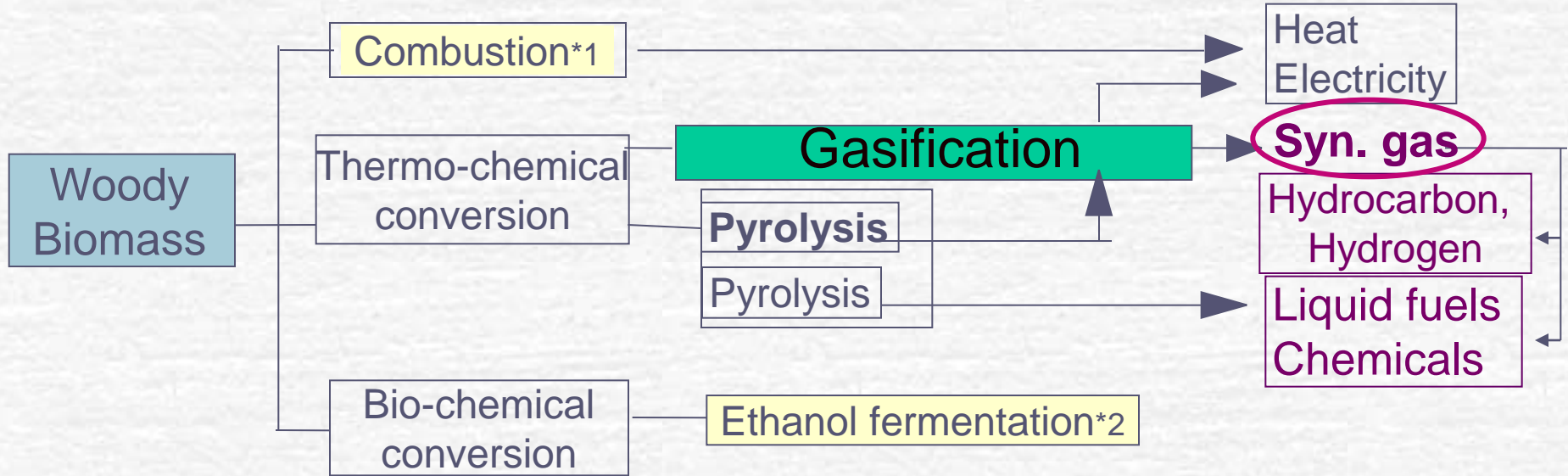
Again, Review of Basic Energy Plan ---

**--Enforcement of introduction of renewable energy,
especially solar and wind ?**

⇒ now under discussion...

Renewable energy research center in Fukushima

Woody biomass-to-energy conversion technologies



*1 Combustion:

- Co-combustion with coal for electricity, in a large scale, practical use, commercialized
- Combustion, biomass alone, pellet and/or chips, for heat in a small scale, trial to introduce, (cost?, facilities?)
- Combustion, biomass alone for electricity and heat, in a relatively large scale, partially commercialized, (a few)

*2 Ethanol fermentation:

R&D stage: many research projects (started several years ago) have been performed, but a new project has not started since 2010.

Woody biomass-to-energy conversion technologies

Gasification

Gasification now in Japan:

*Gasification-for heat, electricity (power generation)

:developed at demonstration stage in a relatively small scale

R & D projects had been performed in 2002-2012

in METI-NEDO (Ministry of Economy, Trade and Industry)

MAFF (Ministry of Agriculture, Forestry and Fisheries)

ME (Ministry of the Environment)

But now, A few plants run,

After 3.11 Earthquake,

introduction of small scale gasification-electricity (and/or CHP) system is proposed (under discussion)

*Gasification- for Liquid fuel synthesis

: developed at bench /test plant scale

R & D projects had been performed in 2002-2012

in METI-NEDO, MAFF, ME

1) Gasification-Electricity/Heat/CHP in Japan

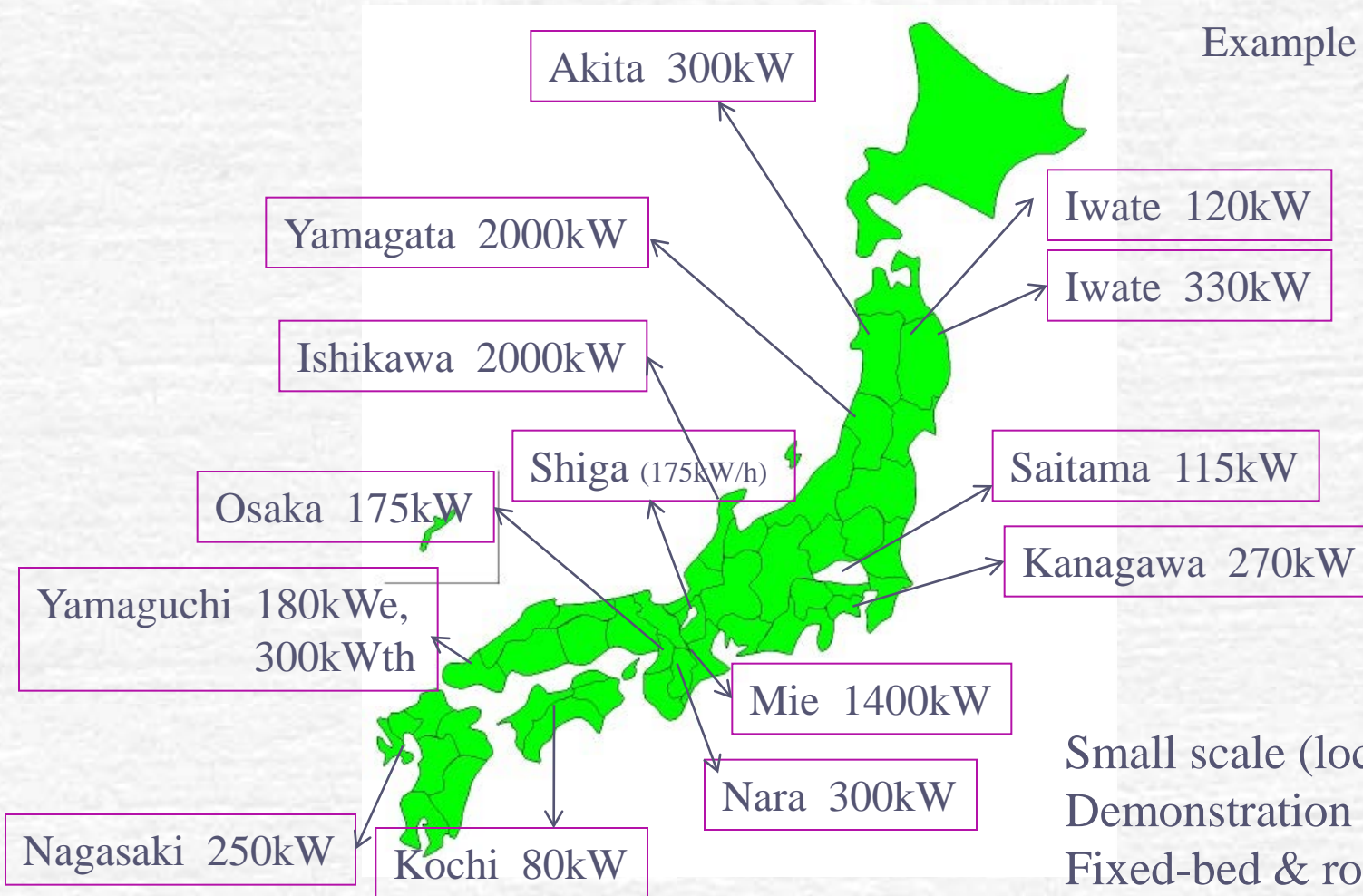
- More than 30 units have been run now in Japan.
- Most of them are demonstration stage, in a small scale (10-300kW), except a few cases of 2MW, for local distributed system.

Gasifiers are fixed bed type (Down-draft and Up-draft) and Rotary kiln type.

Electricity produced is consumed on site and/or bought by Buyback system.

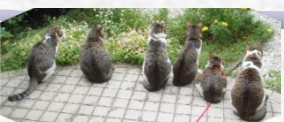


1) Gasification-electricity/heat/CHP in Japan



Example cases : > 50kW

Small scale (local, distributed)
Demonstration stage
Fixed-bed & rotary kiln type
gasifier



Biomass gasification-electricity (power generation) in Japan (1)

Company/ Organization	Type of Gasifier	Capacity	Feedstock	Introduction
Chugai Ro Co., Ltd.	Rotary kiln	100- (500?) kW	Woody/ Herbaceous	5*(latest: gasification of debris in the earthquake, 330kW, Iwate Pref. by Konoike construction CO. Ltd.,)
Tsukishima Kikai Co., Ltd	Down draft (Biomass CHP)	100-300 kW	Woody	3*(Chichibu plant: 10,000 hr run)
JFE Engineering Corporation	Up draft (Babcock &Wilcox Volund ApS)	(about)2 MW	Woody	2*(Yamagata Green Power, Ishikawa Green power) Largest in Japan now
Kawasaki Heavy Industries, Ltd.	Down draft	70-175 kW	Woody	3* (one is 175kWh/h in Shiga Pref. by Sekisui House)
	Fluidized bed	150 kW	Woody	1*

*Including test/demonstration stage plant, **Central Research Institute of Electric Power Industry



Biomass gasification-electricity (power generation) in Japan (2)

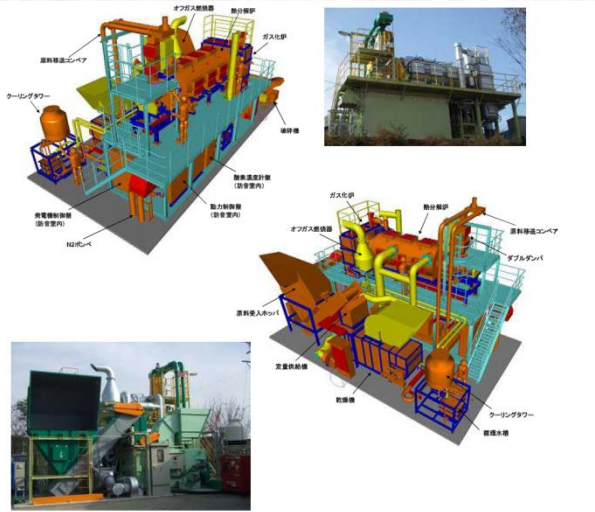
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Company/ Organization	Type of Gasifier	Capacity	Feedstock	Introduction (plant)
SATAKE Corporation	Down draft	>10 – kW (1-2 MW)	Woody/Agricul -tural residue	1* in Japan (other 4 in the world)
Shimizu Corporation	Entrained-flow (small-scale,modified, Biomass Energy Co.)	30kW	Paper, Wood (urban wastes)	1*(Next spring, commercialization)
TORISUMI Co., Ltd	Fixed bed Down draft	300 kW (150 kW x 2)	Woody (sawdust)	1*
Biomass Energy	Entrained-flow	50-300 kW	Woody	3*
CRIEPI** & Okadora Co., Ltd (The Kansai Electric Power Co., Inc.)	Carbonization -gasification	(320kW)	Woody/ Wastes	1*

*Including test/demonstration stage plant, **Central Research Institute of Electric Power Industry

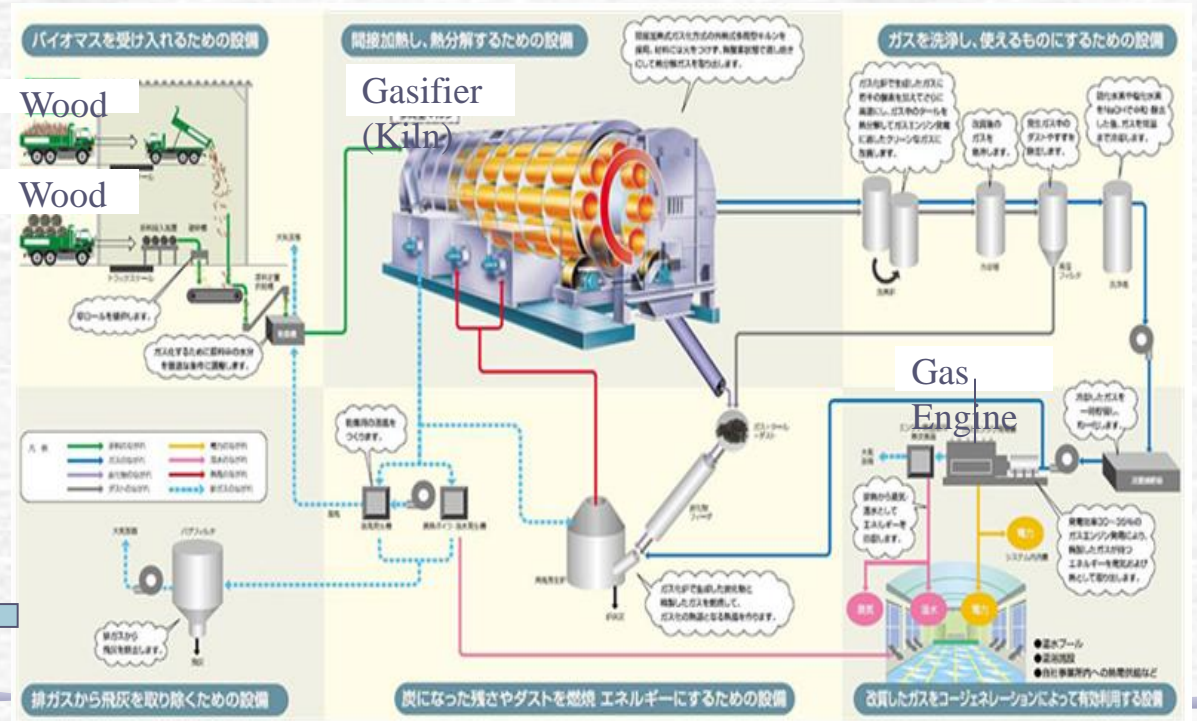


Gasification-CHP in a small scale, local area, rotary kiln type gasifier ...Chugai Ro Co. Ltd.



Woody wastes (including bark) generated in mountain district--- gasification of these wastes on site

Chugai-Ro Kogyo Ltd.
Rotary Kiln type gasifier 100-500kW



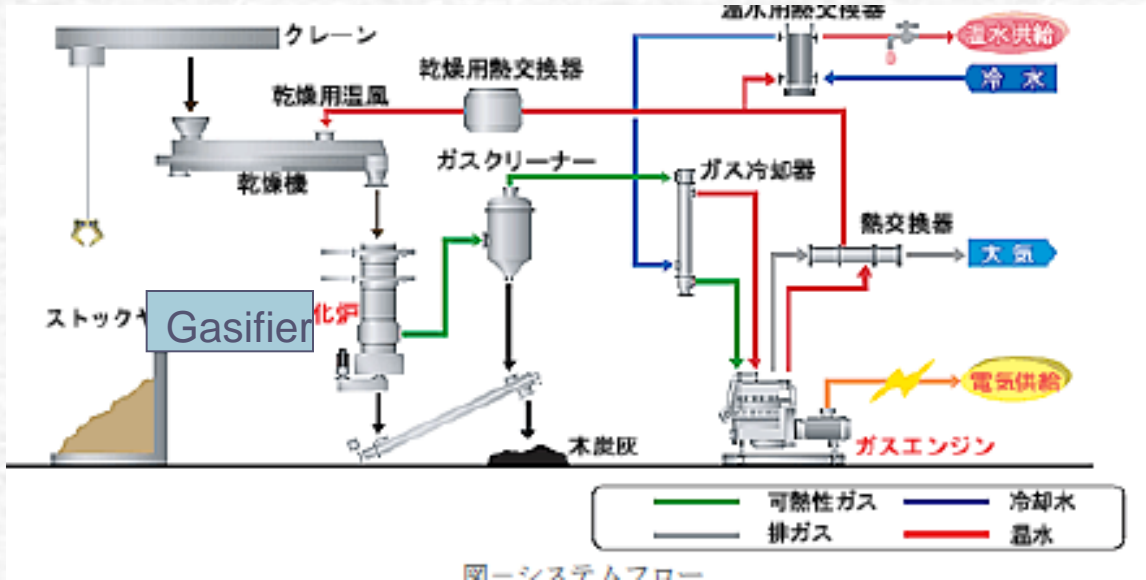
Yamaguchi Pref.
(NEDO Project)



Gasification-Power generation (&Heat) Examples



Tsukishima Kikai Co. Ltd.
Down-draft, Small scale, 100-300kW



Chichibu, Saitama Pref.
⇒ run 10,000hr



Senboku, Akita Pref.
300kW



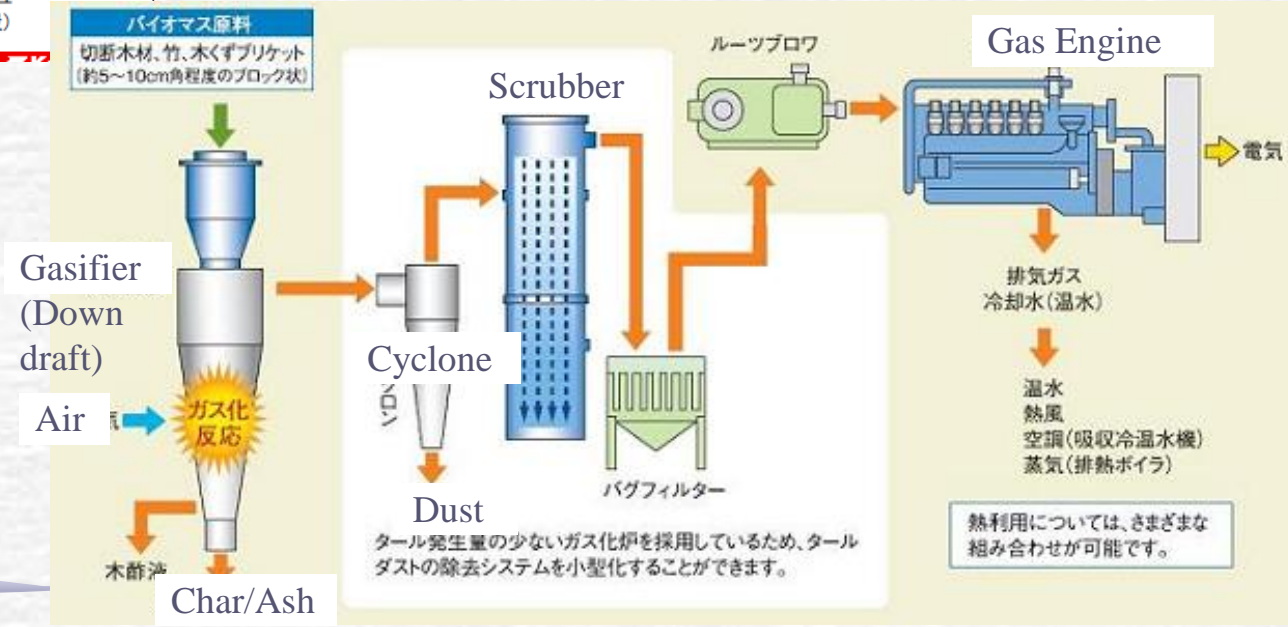
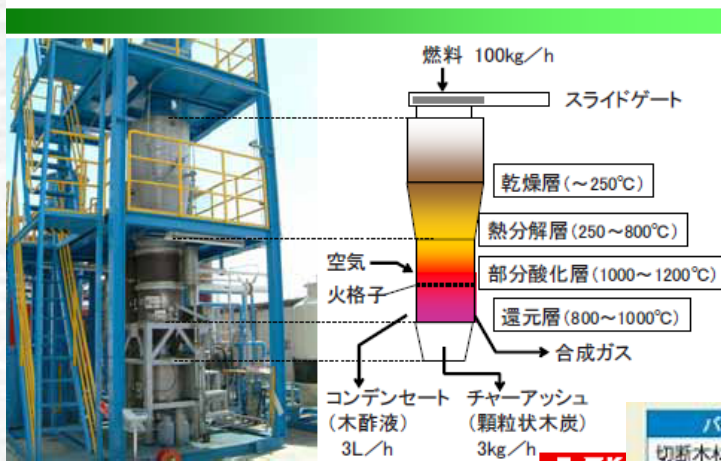
Gasifier



Gas engine

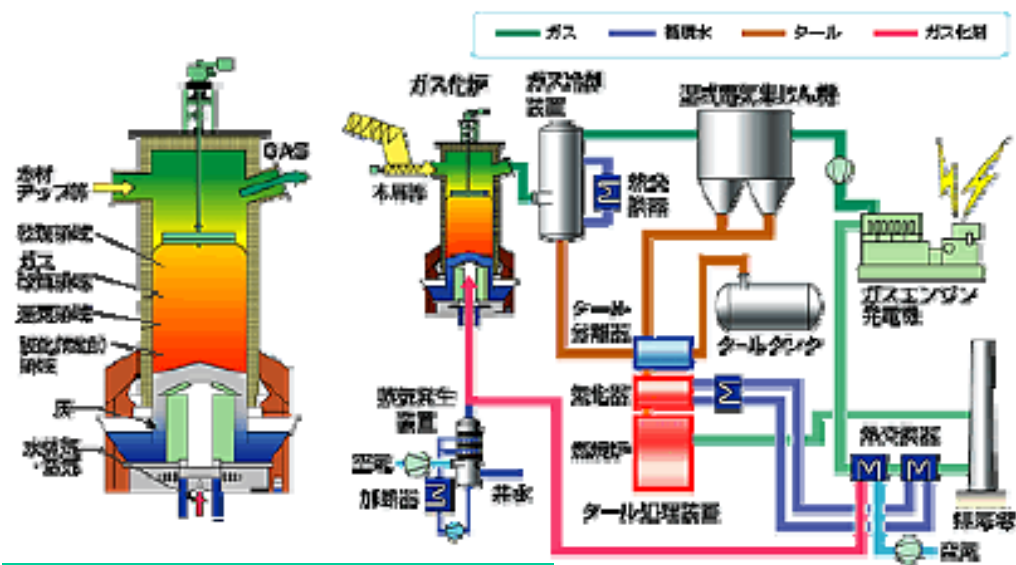
Gasification-Power generation (&Heat) Examples

Kawasaki Heavy Industries Ltd.
Down-draft, Small scale, 100-200kW



Gasification-Power generation (&Heat) Examples

JFE Steel Ltd. Licensed from Babcock and Wilcox Volund
Up-draft, 2MW



Gasifier Process flow

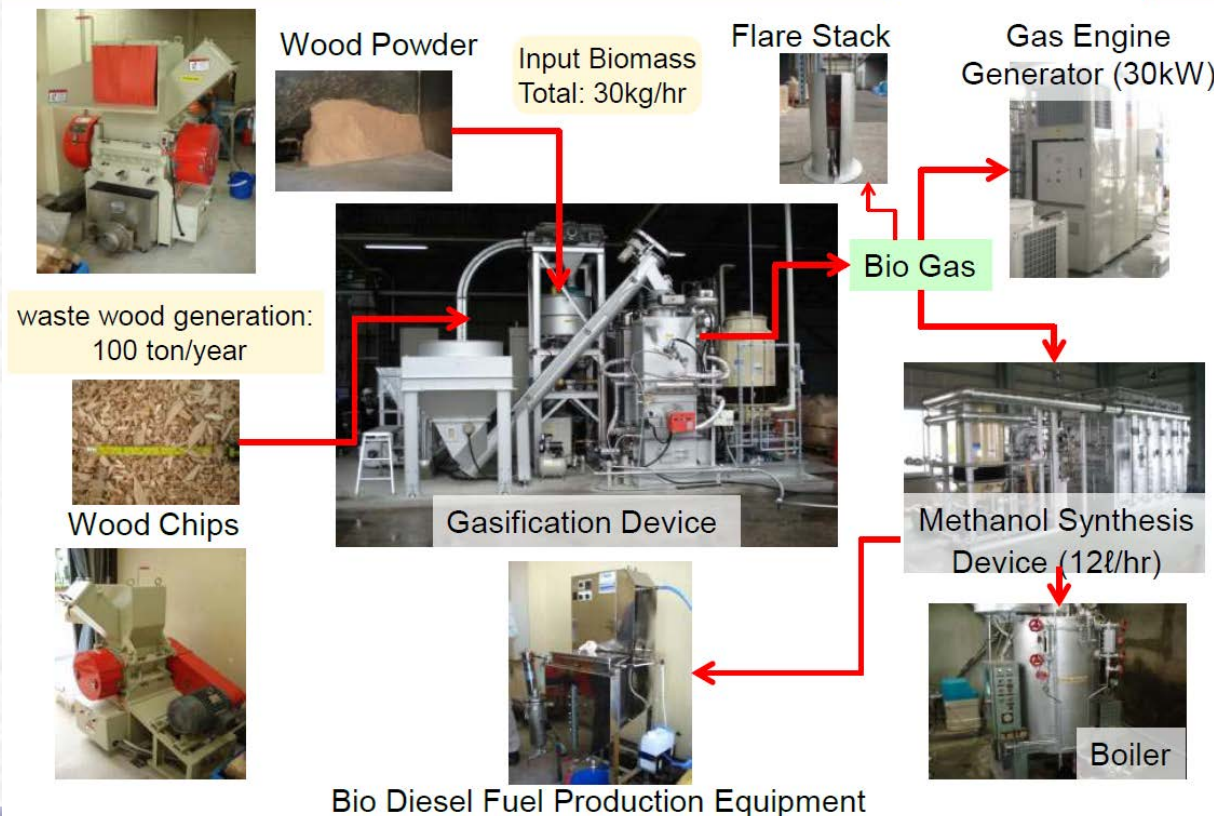
Yamagata Green Power



Gasification-CHP in a small scale, urban area, small-scale entrained-flow gasifier ... Shimizu Corporation

Shimizu Corporation: one of the largest construction company
Woody and municipal wastes (waste papers) generated
in urban (office) area --- gasification of these wastes on site

Flow Chart of "Buil. Bio-Master"



2) Gasification-Liquid fuel/Chemicals synthesis in Japan

- Only a few examples

(have a relatively large scale, have a complete system: from biomass supply-gasification-purification-catalytic synthesis) on demonstration stage

- Mitsubishi Heavy Industries Co.Ltd.,---
 - Entrained-flow gasifier,
 - Methanol (-DME) synthesis,
 - 250kg/day-scale, 2t/day-scale
- TAKUMA Co. Ltd
 - Fluidized bed gasifier
 - Electricity & Methanol



Gasification-Power generation & MeOH Syns. Examples Fluidized bed type gasifier...Takuma Co. Ltd.

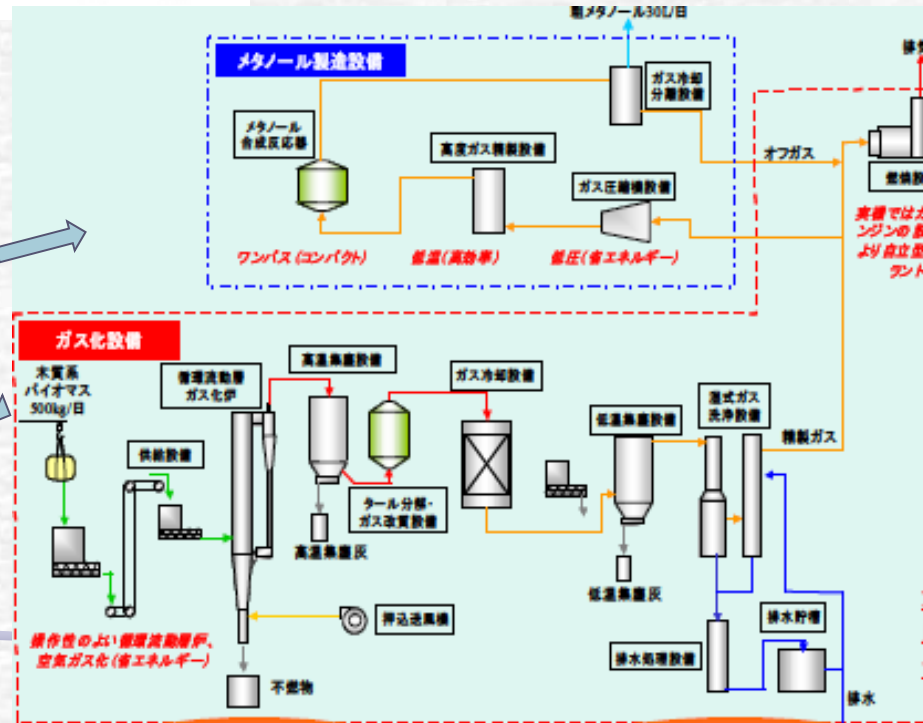
Fluidized-bed, Small scale, 150kW



Fluidized-bed, Small scale,
100-200kW, Kyoto

Methanol synthesis process

Gasification process



Gasification-Power generation & MeOH Syns. Entrained-flow gasifier ...Mitsubishi Heavy Industries Ltd.



A Bench-scale plant



Overview of 2t /day test plant

Gasifier : Entrained-flow type:

Capacity: 240 kg-biomass/day (left),

2t biomass/day (right),

gasification agents: oxygen and steam

normal pressure at 750-1000 °C,

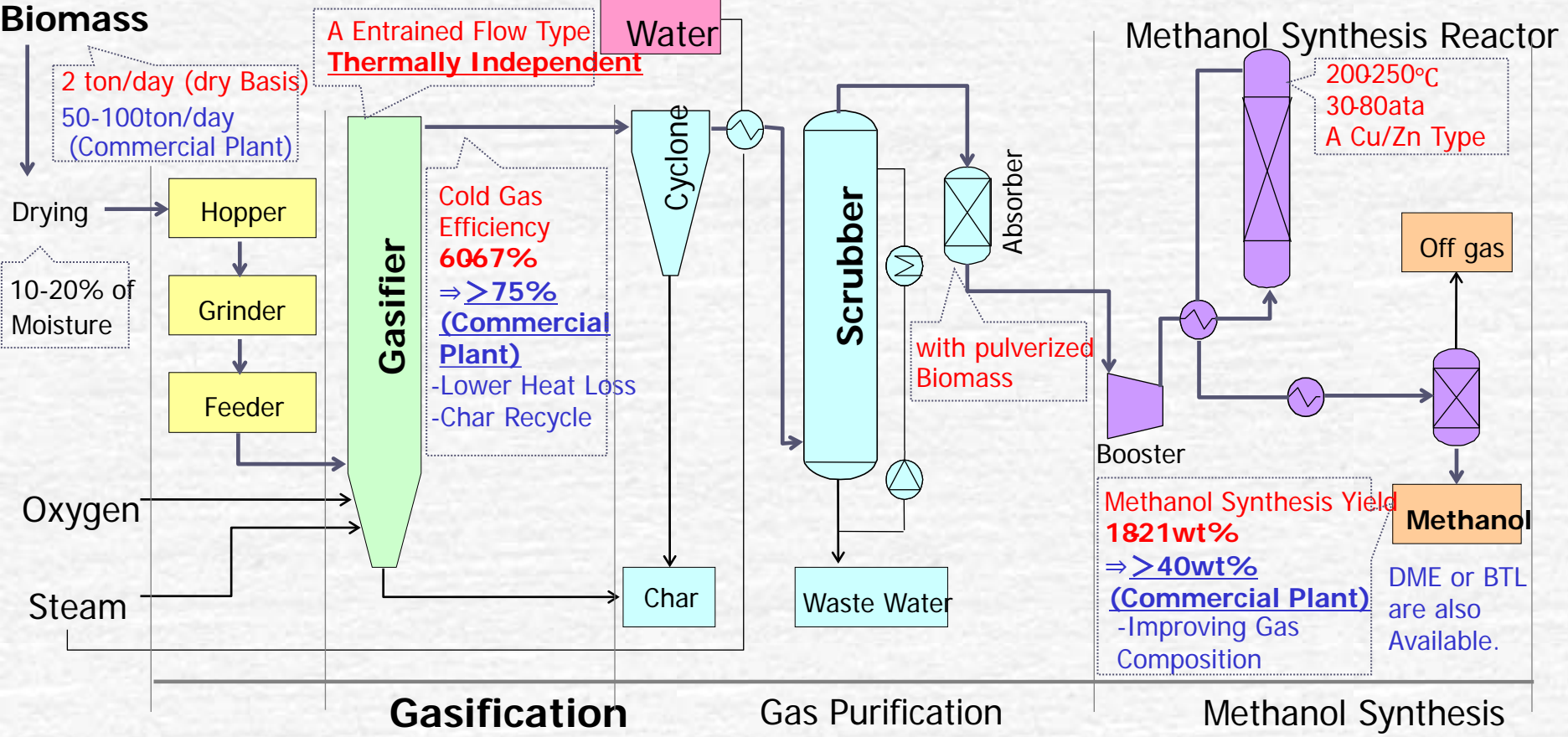
240 kg-biomass/day: heated by electric furnace

2t biomass/day: self-heating (partial combustion)

Methanol synthesis devise: Capacity: equiv. 20kg-biomass/day

Cu-Zn catalyst, 30kg/cm² at 180 - 250 °C

Schematic diagram of biomass gasification-methanol synthesis system



Feedstock biomass preparation:

Grinding
(pretreatment)

Pulverization at Plant

feeding & injection



Feedstock



Japanese Cedar



Mixture of hardwood



Thinned wood



Driftwood



Scrap wood



Hopper

Injector

NEDO's Biomass R&D Projects (now)

* Development of an Innovative and Comprehensive Production System for Cellulosic Bioethanol (FY2009-2013):

1.2 billion yen (11 million EUR, 1EUR= 105 yen)

- To establish comprehensive production system from cultivating grass and wood biomass to producing bioethanol.

* Development of Technologies for High-efficiency Conversion of Biomass and other Energy (FY2007-2012):

1.9 billion yen (18 million EUR, 1EUR= 105 yen)

- Strive to innovate technology for 2nd generation biofuels which derive from cellulosic materials.

➤ * Strategic Development of Next Generation Bioenergy Utilization Technologies (FY2010-2016):

2.0 billion yen (19 million EUR, 1EUR= 105 yen)

NEDO's Biomass R&D Projects (now, new)

➤ Strategic Development of Next Generation Bioenergy Utilization Technologies (FY2010-2016):

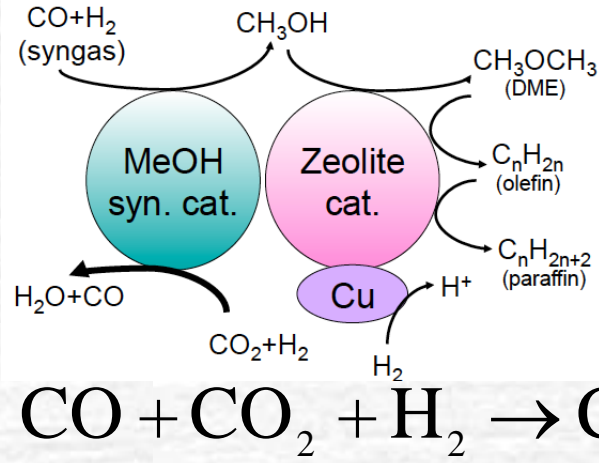
2.0 billion yen (19 million EUR, 1EUR= 105 yen)

- This project carries out R&D in two phases; the next-generation technology development and the practical application development
- To develop next generation biofuel production technology such as BTL and microalgae biofuel.
 - BTL Synthesis--- gasification + catalytic synthesis
 - Bio-LPG synthesis (entrained-flow gasifier in labo. scale)
 - FT synthesis
 - Bio-jet fuel(entrained-flow gasifier in bench. scale)
- The development of application technology supports technological developments for practical applications within 5 years after the project (ex. fermentation, the development of mills for co-incineration, etc)

NSG (natural synthetic gas): also Bio-SNG project* has started in 2012

*SNG Production from Woody Biomass using Gasification Process.
(dual fluidized bed gasification-catalytic synthesis)

Synthesis of LPG from Biomass-Derived Syngas (FY2010-2013)



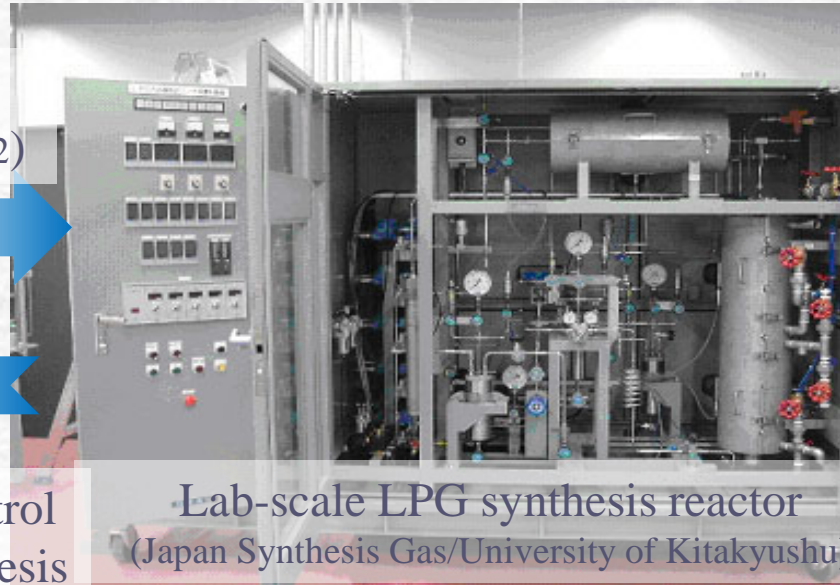
direct LPG synthesis
hybrid catalyst



Lab-scale
gasifier(AIST)

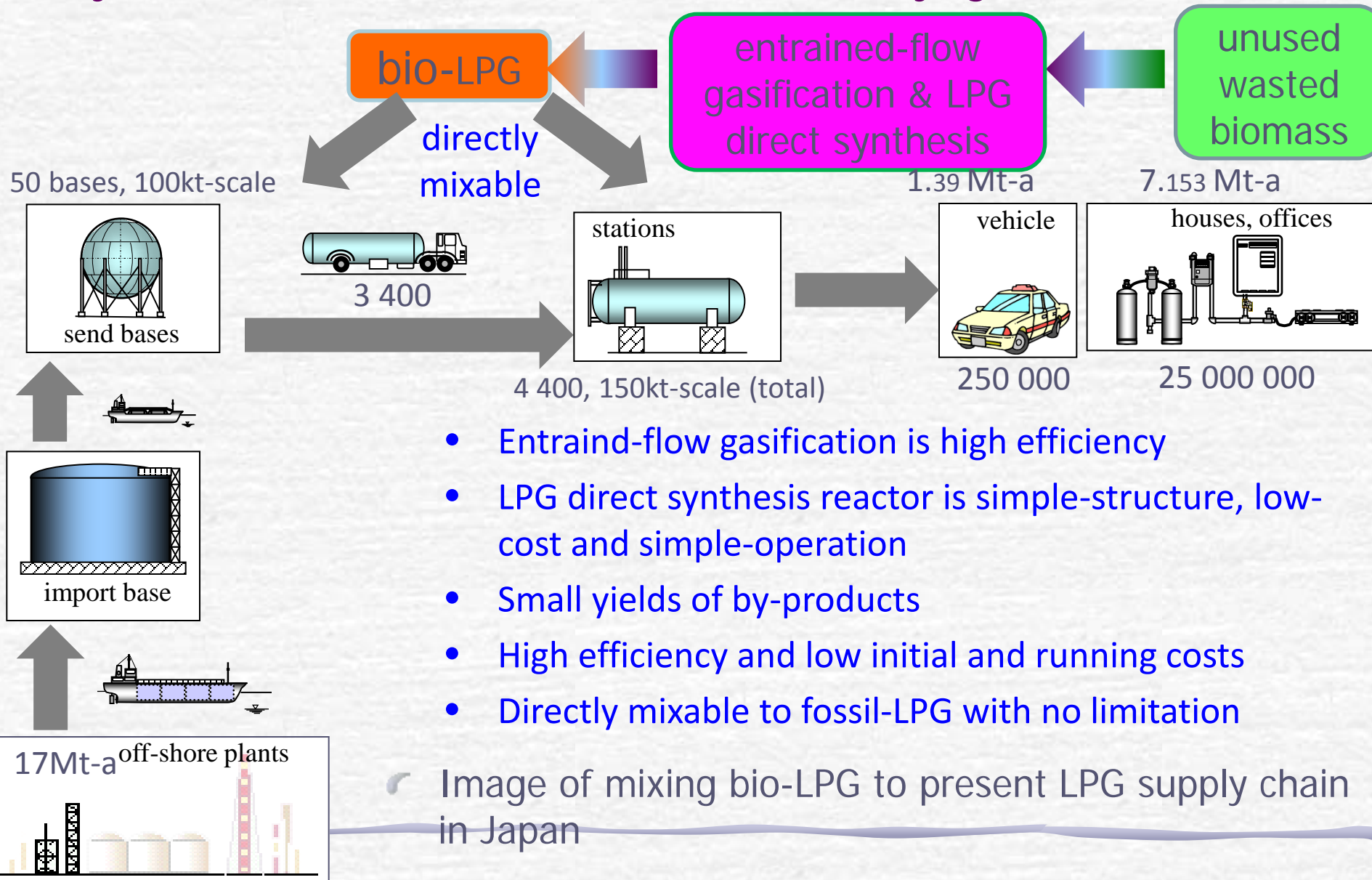
bio-Syngas
(CO, CO₂, H₂)

Composition control
for catalytic synthesis



Lab-scale LPG synthesis reactor
(Japan Synthesis Gas/University of Kitakyushu)

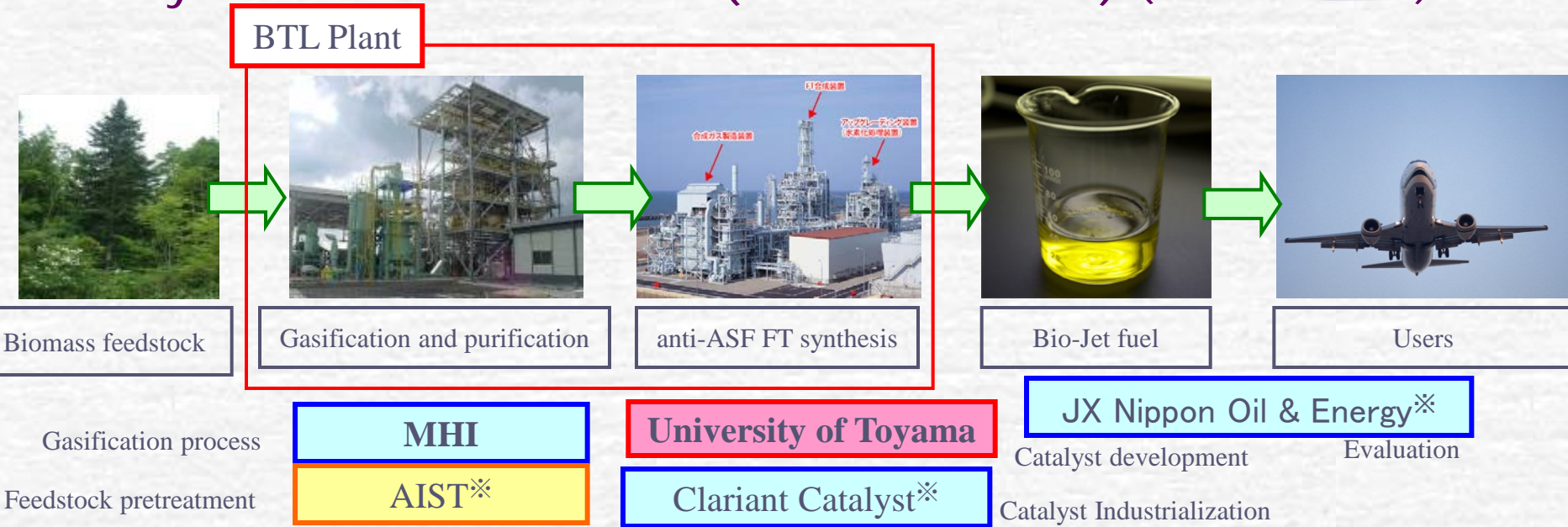
Synthesis of LPG from Biomass-Derived Syngas (FY2010-2013)



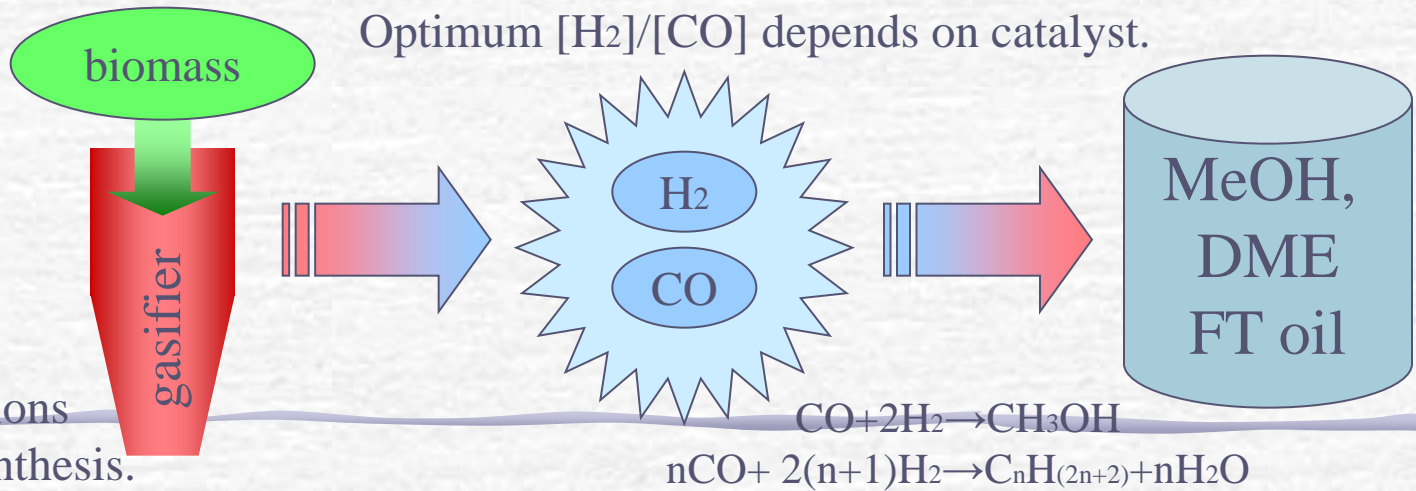
- Entrained-flow gasification is high efficiency
- LPG direct synthesis reactor is simple-structure, low-cost and simple-operation
- Small yields of by-products
- High efficiency and low initial and running costs
- Directly mixable to fossil-LPG with no limitation

Image of mixing bio-LPG to present LPG supply chain in Japan

Synthesis of Bio-Jet fuel (a tentative title) (FY2012-2013)



Ordinal BTL (MeOH, DME, FT oil) process



Present Status of Biomass Gasification in Japan

- Gasification for heat and/or power generation (electricity) has been partially in practical application or demonstrated, but in a small scale (10-300 kW) in most cases.
- Gasification for liquid fuels(bio-fuel)/chemicals synthesis had been developed at bench/test plant scale. (R &D stage)
A few test plants having a complete system (including biomass feeding-gasification-purification-bio fuel synthesis processes) had run, but now none.....
R&D projects for gasification from basic research to demonstration stages are in progress.

Some kinds of Tariff, incentives, subsidies are under consideration.

After 3.11 earthquake, basic energy plan has been reviewed, (including renewable energy, biomass energy).





Thank you for your
kind attention!!

