Co-firing and Biomass Utilization of Japan's Coal Power Plants

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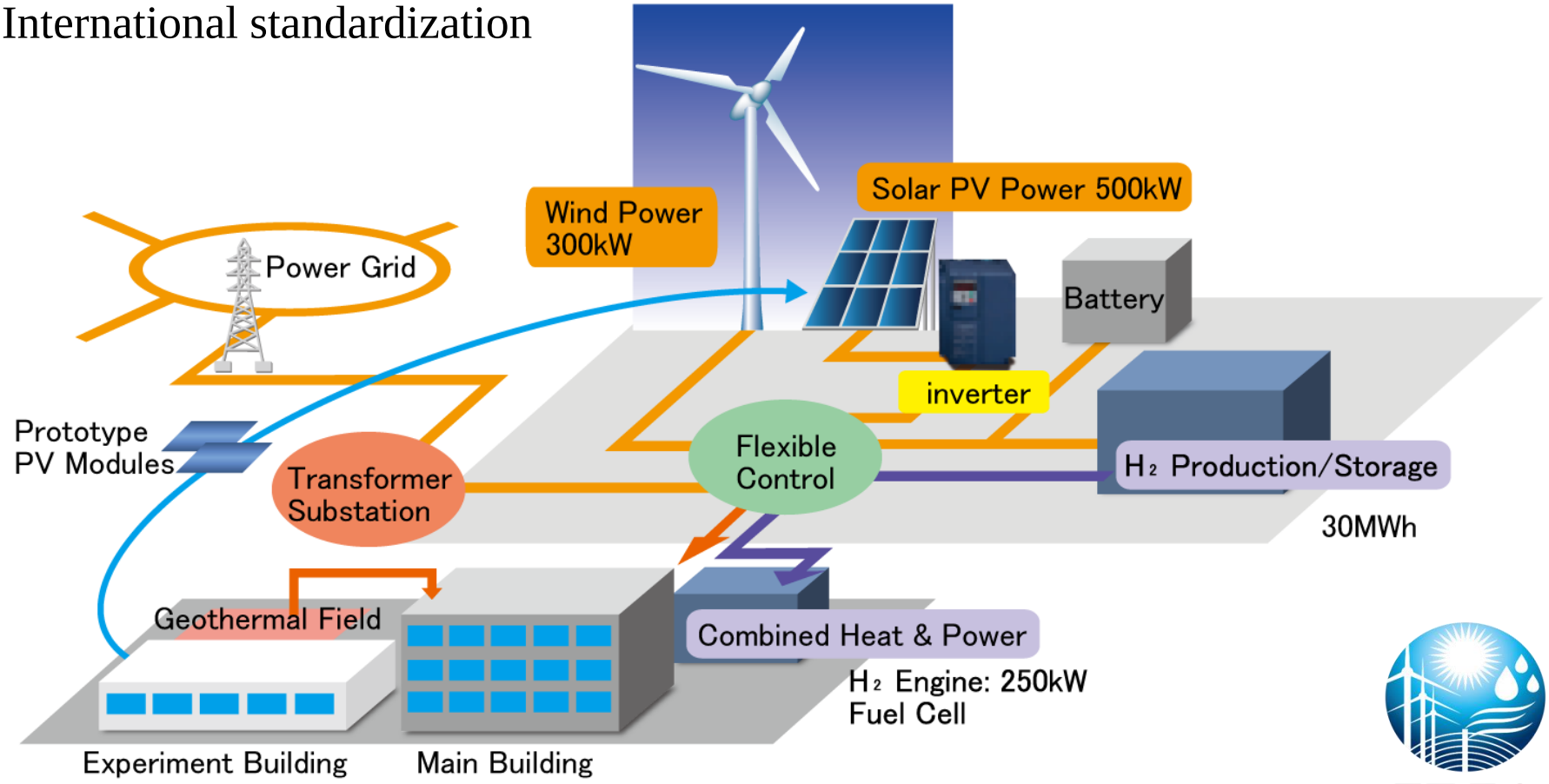
Renewable Energy Network at FREA(April, 2014)

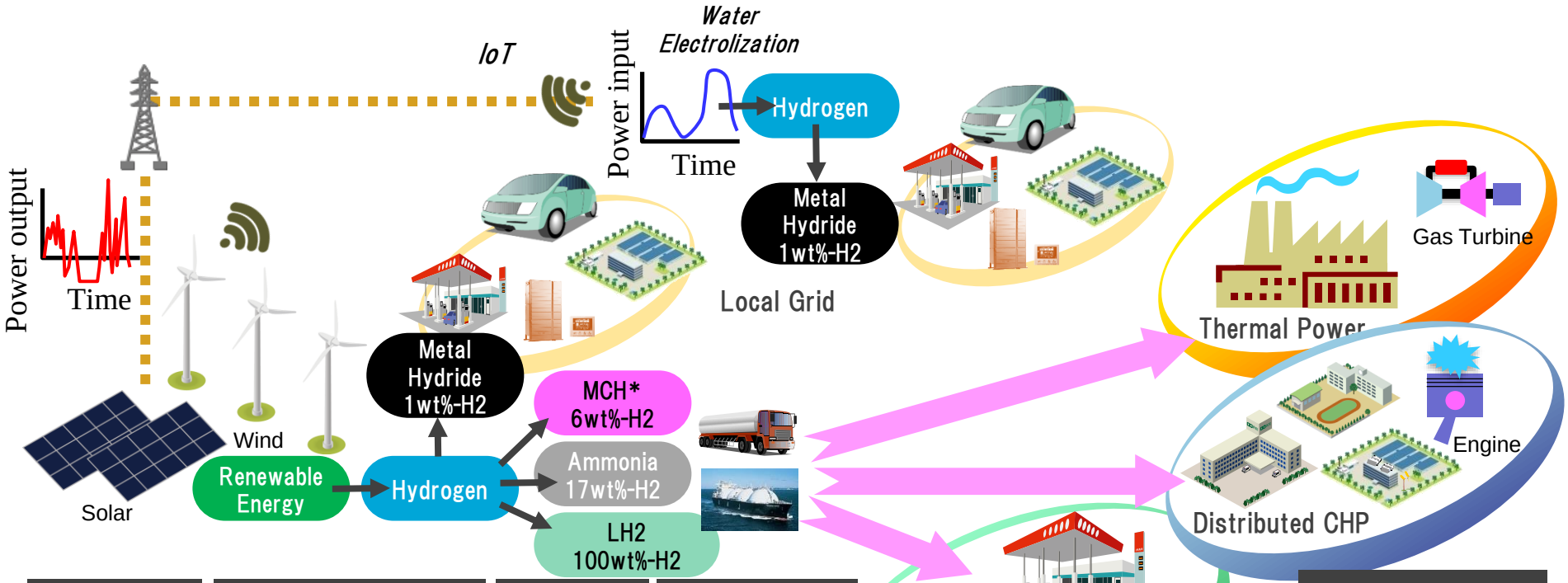
System R&D for renewable energies mass introduction

- MW PV, wind power integration with storage (batteries, hydrogen)
- ICT network for power generation forecast and system control
- Test bed for new technology (power electronics etc.), demonstration
- International standardization



Sustainable Society with Renewable Energy and Hydrogen

"How to store and transport renewable Hydrogen "



Power	Energy Conversion	Storage	Transportation
Fluctuating Intermittent	Water Electrolization Energy Carrier	Abundant Safe	Long & short Distance

Total System Technology

Utilization
Thermal Power Distribute CHP Mobility

* MCH: MethylCycloHexane

Major Developments of Biomass Policy in Japan

Ministry of Economy, Trade and Industry
Agency of Natural Resourcesand Energy

■After **the Great East Japan Earthquake and subsequent nuclear accident** happened, the biomass industrialization strategy was drawn as principle to create regional green industry and fortify an independent and distributed energy supply system.

Year	Policies
2002	Biomass Nippon Strategy
2005	Kyoto Protocol – Target Achievement Plan
2009	Basic Act for the Promotion of Biomass Utilization
2010	Basic Energy Plan（Revised)
2010	National Plan for the Promotion of Biomass Utilization

2011.3.11 Great East Japan Earthquake and Accident of Fukushima 1st Nuclear Power Plant

2012	Biomass Industrialization Strategy <Feed-in Tariff started>
2014	Basic Energy Plan (Revised） ⇒ 2015 and 2017; Revised FIT for Biomass Power Generation ⇒ 2016; Electricity Deregulation started from April ⇒ 2017; Gas Deregulation started from April

Source: Ministry of Agriculture,Forestry and Fisheries

Target of biomass utilization by type (2020)

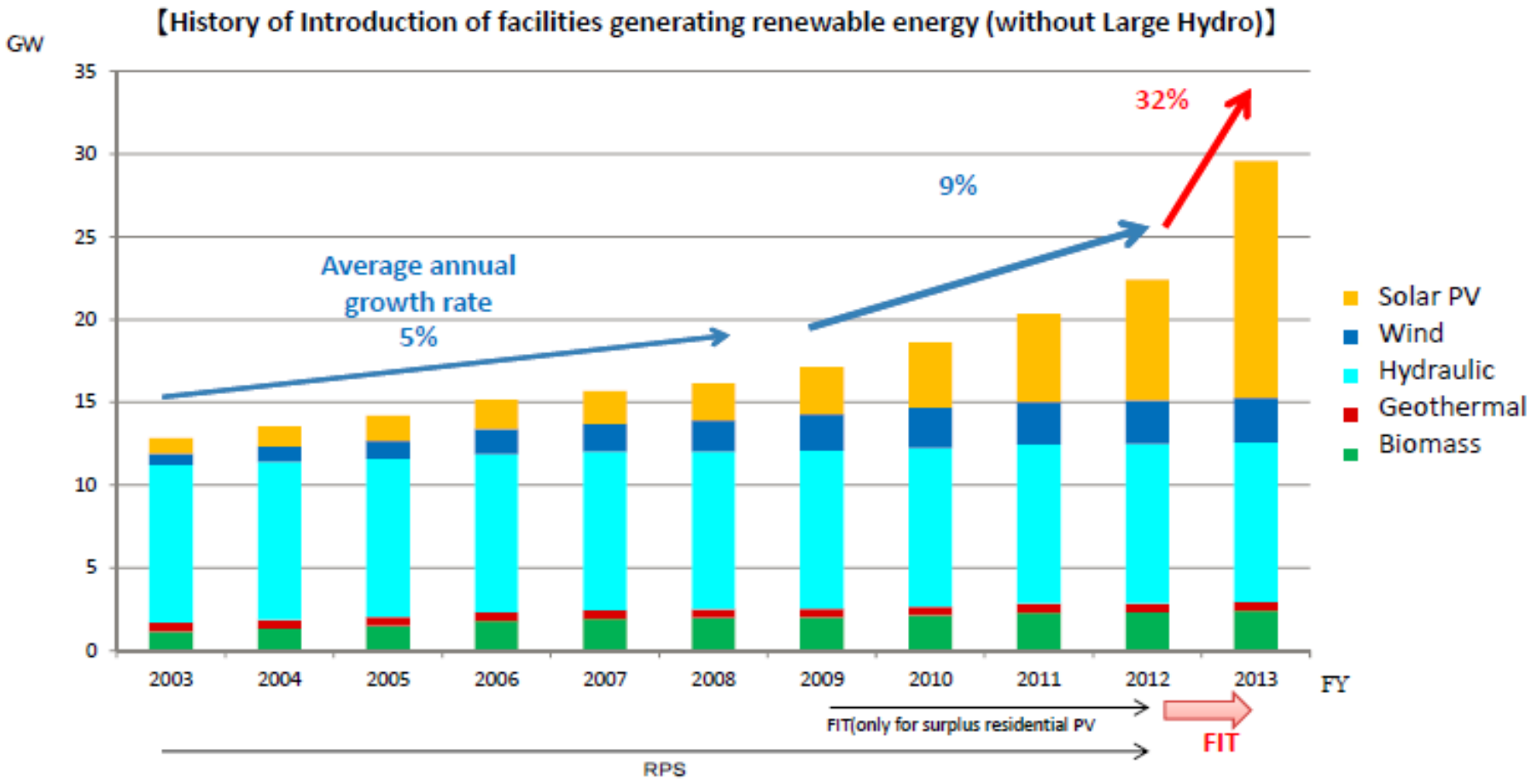
Ministry of Economy, Trade and Industry
Agency of Natural Resources and Energy

National target of average utilization ratio is set for each type of biomass to promote high utilization biomass based on their types and to clarify the necessary measures to be taken on the national level.

Type of biomass	Amount generated annually (2009)	Present and target utilization ratio 2009→2020
1 Animal waste 	Approx. **88 million tones**	90% → **90%**
2 Sewage sludge 	Approx. **78 million tones**	77% → **85%**
3 Black liquor 	Approx. **14 million tones**	100% → **100%**
4 Waste paper 	Approx. **27 million tones**	80% → **85%**
5 Food waste 	Approx. **19million tones**	27% → **40%**
6 Sawmill wood residue 	Approx. **3.4 million tones**	95% → **95%**
7 Wood waste from construction 	Approx. **4.1 million tones**	90% → **95%**
8 Non-edible parts of food crops 	Approx. **14 million tones**	85% → **90%**
9 Forest off-cuts 	Approx. **8 million tones**	0% → **30%**

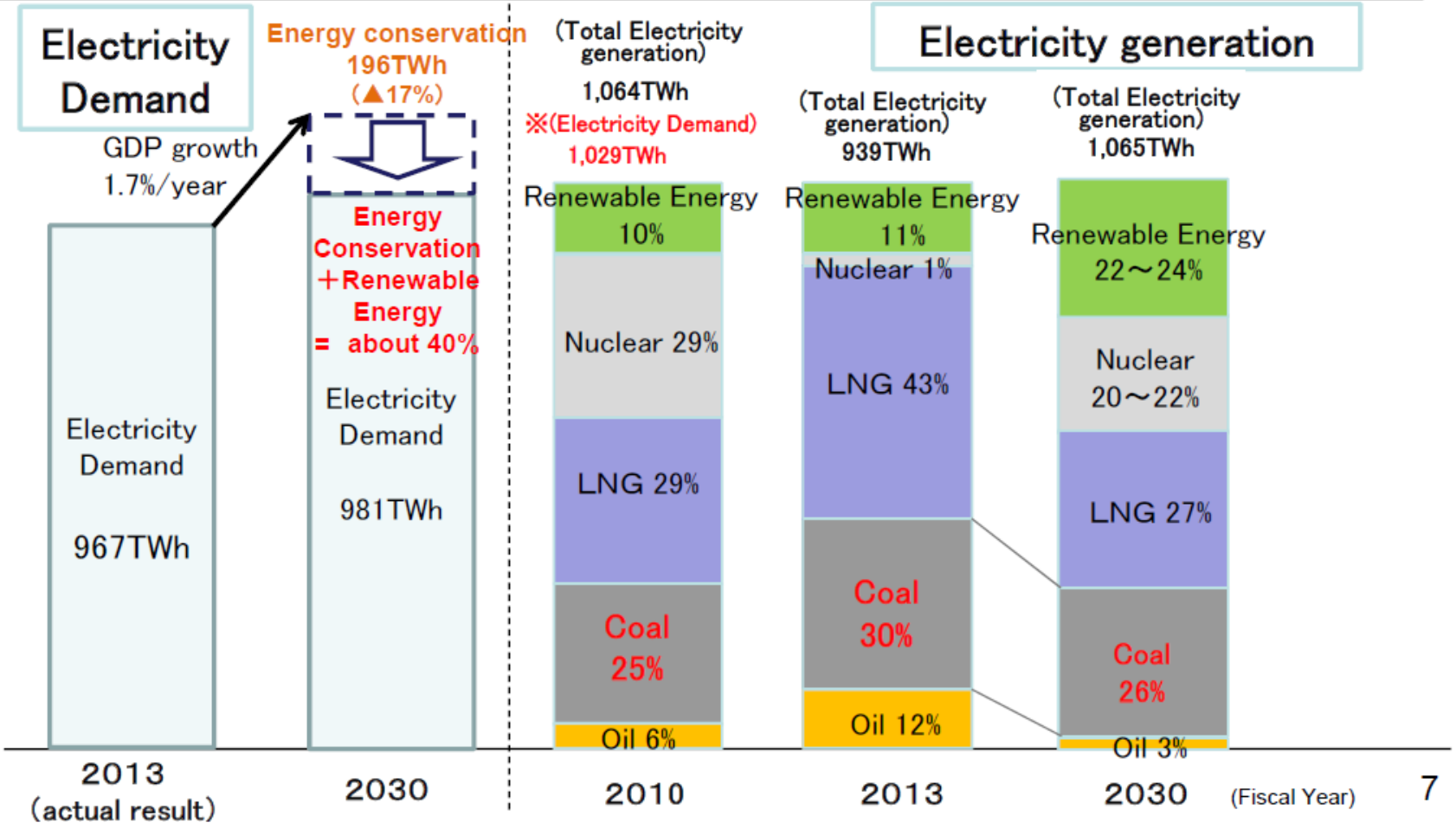
Note: 1 Black liquor, saw mill wood residue, forest off-cuts are dry-weight, all others are wet weight.
2 Target for energy crops is 400,000 carbon tones produced by 2020.

Source: Ministry of Agriculture,Forestry and Fisheries


【History of Introduction of facilities generating renewable energy (without Large Hydro)】
GW
35
30
25
20
15
10
5
0
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
FY
32%
9%
Average annual growth rate 5%
Solar PV
Wind
Hydraulic
Geothermal
Biomass
FIT(only for surplus residential PV
FIT
RPS

Japan's latest policy for new energy mix

【Target Level 】
- Electricity Demand in 2030 will be consistent with the level of 2013 with energy conservation.
- The dependency of nuclear power generation , which was around 30 % share in 2010, will reduce to 20～22% in 2030.
- The dependency of renewable energy such as solar and wind will rose from 22% to 24%, and the one of coal will reduce from 30 % to 26 %.

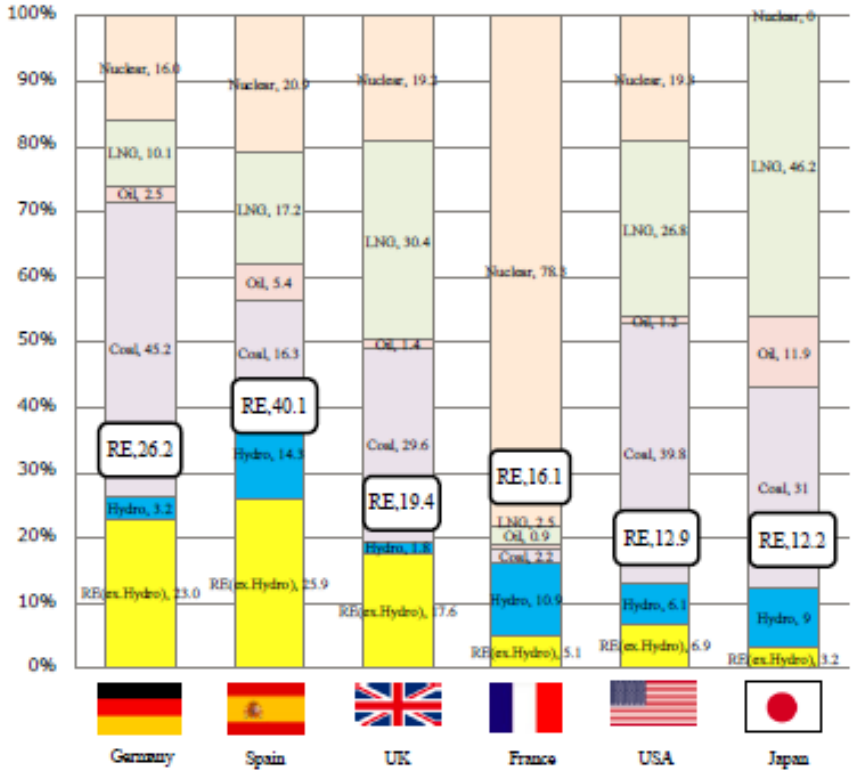


Current State of Renewable Energy in Japan

Ministry of Economy, Trade and Industry
Agency of Natural Resources and Energy

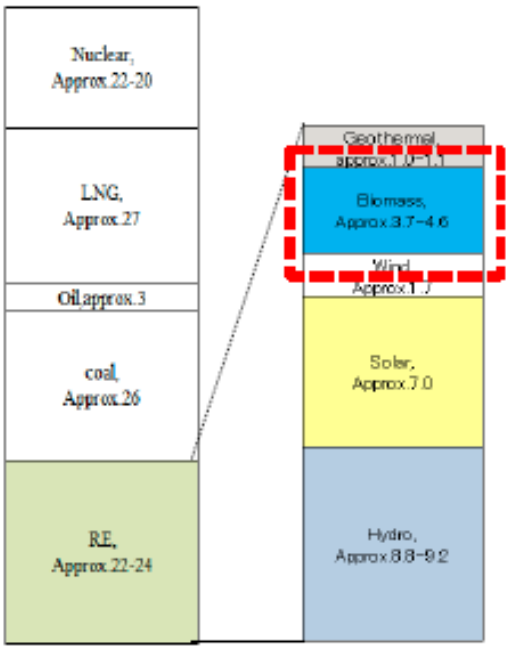
Renewable energy（RE）accounted for approximately 12.2% of power generation in 2014.
More specifically, hydroelectric power generated by large-scale dams, etc., accounted for 9.0%, with solar PV, wind, geothermal and **biomass** power accounting for 3.2%.

Composition of power generation by energy source(2014)



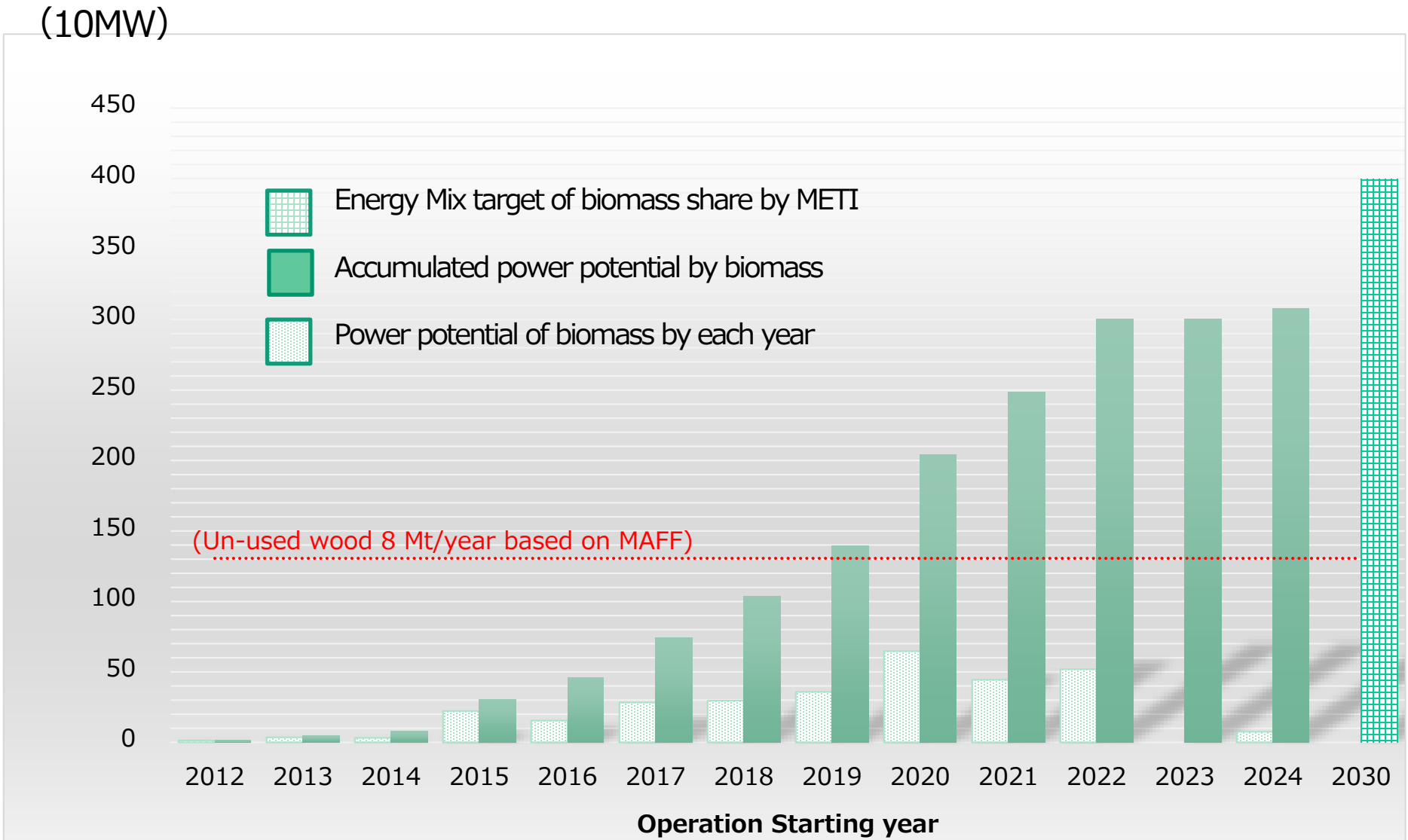
出典：日本/電源開発の概要」より作成（2014年度実績値）。
日本以外/2014年推計値データ、IEA Energy Balance of OECD Countries (2015 edition)

Composition of power generation by energy source in Japan(2030)



FY2030

Source:Ministry of Economy,Trade and Industry



Potential of Power Plant by Woody Biomass in Japan (GW)

(estimated by JCOAL) ＝＞ *Not enough domestic biomass, so requires importing biomass for achieving the target by 2030.*

Classification of Co-firing Biomass Power Plants in Japan

1) **About 20 co-firing plants are operating and planning, most of them are relatively small scale plant below 112 MW.**
2) **Co-firing ratio is expected up to 50 %.**
3) **Less than 10% biomass is co-fired at large-scale power plant around 1 GW.**
4) **Feedstock: Domestic wood chip/pellet, and imported pellet and PKS**

Advantages of Biomass for Co-firing with Coal

1) **Biomass Energy as aid for baseload power source**
2) **Reduction of CO_2 emission**
3) **Utilization of non-utilized biomass**
4) **Cleaner exhaust gas with less SOx, PM and heavy metals**
5) **Combination of BECCS can be applied.**
6) **Combined use of biomass for IGCC/IGFC is expected for higher efficiency.**

Design of Co-firing upto 50% Biomass

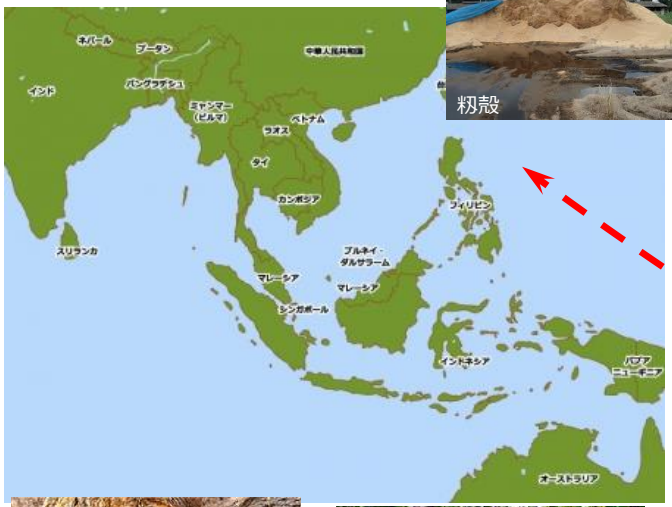
JCOAL Japan Coal Energy Center

Targets;
- Possibility of JCM
- Further reduction of CO_2
- Utilization of non-used biomass resources
- Utilization of ash from co-firing

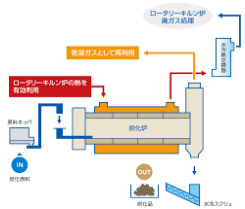
Challenges;
- Sustainability
- Feasibility

On-site

Stable supply of biomass



Torrefaction



Pelletization

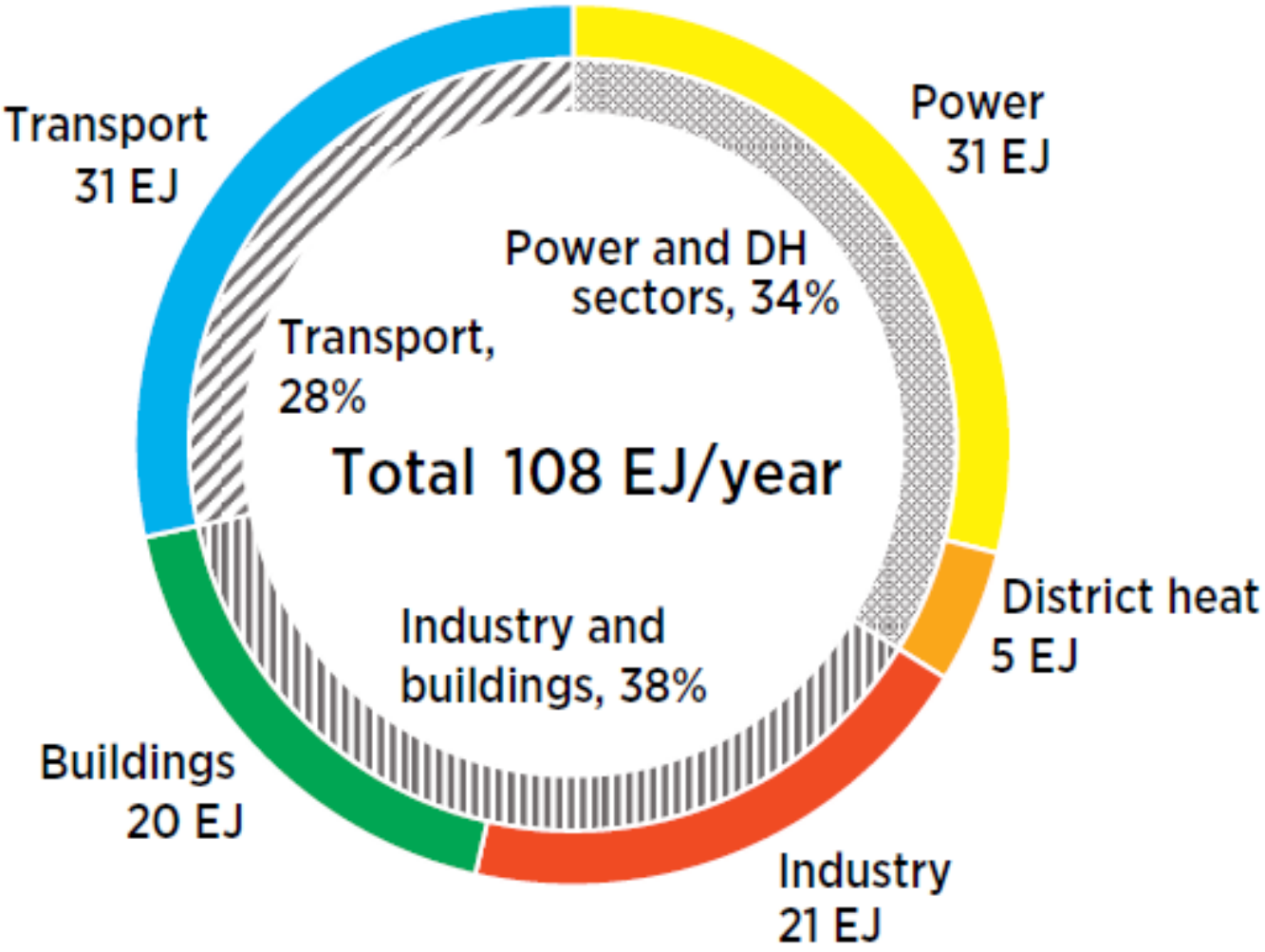
Conversion
to hydrogen
carriers

transportation

Utilization

Challenges
- Upgrading of energy density
- Improvement of stability and grindability
- Utilization of by-products
- Co-gasification feedstock

Figure 14. Global biomass demand by sector in REmap 2030 (in primary energy terms)



Biomass is versatile and can be used to provide power, transport and heat.

IRENA
International Renewable Energy Agency

Biofuel Potential in Southeast Asia:

Raising food yields, reducing food waste and utilising residues

Table S-2 **Residue potential for 2050 (PJ/year) – 50% collection of harvest residue**

Country	Harvest Residue	Process Residue	Total Residue	Residue for Feed	Residue for Fuel (Primary Biomass)	40% to Biofuel (Energy Content)	Share of Liquid Fuel Use in 2012
Indonesia	2 158	653	2 811	306	2 505	1 002	55%
Malaysia	208	59	267	87	179	72	12%
Philippines	785	288	1 073	303	770	308	91%
Thailand	1 282	578	1 861	226	1 635	654	84%
Viet Nam	1 015	353	1 368	426	942	377	79%
WORLD	98 555	29 730	128 285	32 877	95 409	38 163	39%

IRENA analysis (Appendix I)

Future Needs for Alternative Transportation Fuel

National Institute of Advanced Industrial Science and Technology AIST

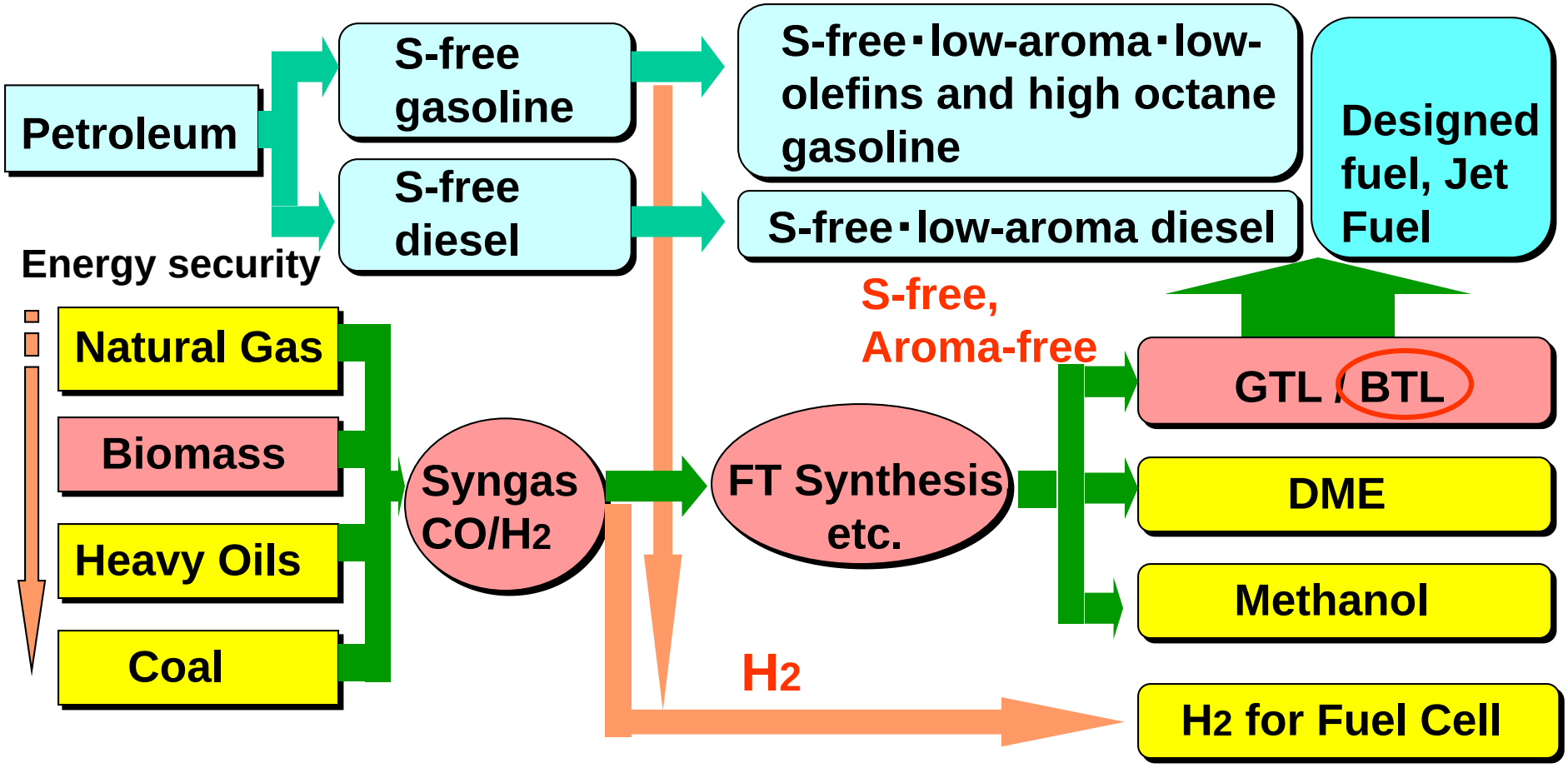
2000-2010
Fuel technologies for urban environment

2010-2020
Fuel technologies for mini-minimizing fuel consumption

2020-

*PM,NOx reduction
*Advanced end-of-pipe technologies

*CO_2 reduction
*New engine system/new fuel



Effective Utilization of Biomass with Asian Partners

Technology Transfer
Investment

CDM
JCM

CO_2 Reduction

Credit

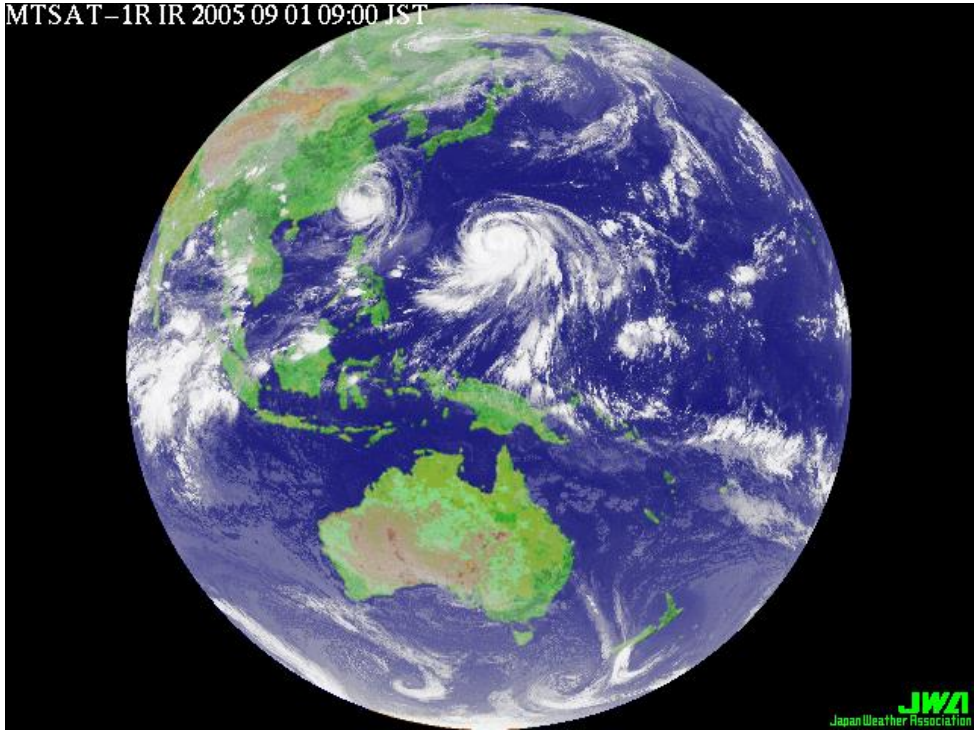
Solid&Liquid Fuels

Bulk Chemicals

Local Energy Supply
Forest Restoration

Conclusions

1) *Importance of energy self-sufficiency in Japan*
2) *Importance of sustainable supply of biomass feedstock in Asian countries*
3) *Design of highly efficient co-gasified plant for IGCC and IGFC is expected for power and fuels.*
4) *Combined use of biomass and other renewable energy for further reduction of fossil fuels, contributing to 80% GHG reduction in Japan until 2050 !*



"Green Biomass for Cool Earth"

Thank you very much for your kind attention !

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