BECCS in integrated assessment models - road to the negative emissions based on Japanese experiences -

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Biomass Energy
CO_2 capture and storage (CCS)
BECCS in integrated assessment models
Summaries

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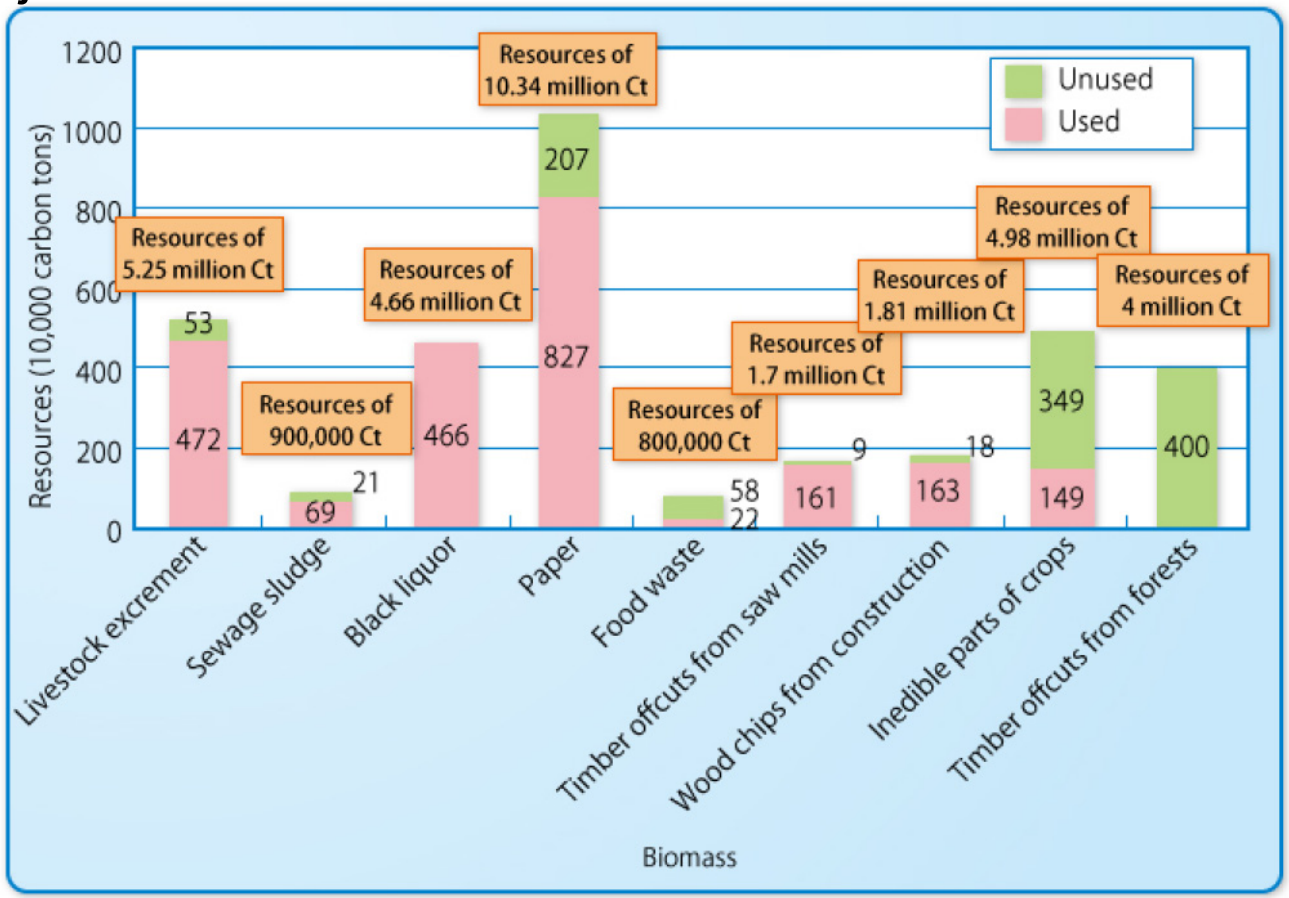
Biomass resources in Japan

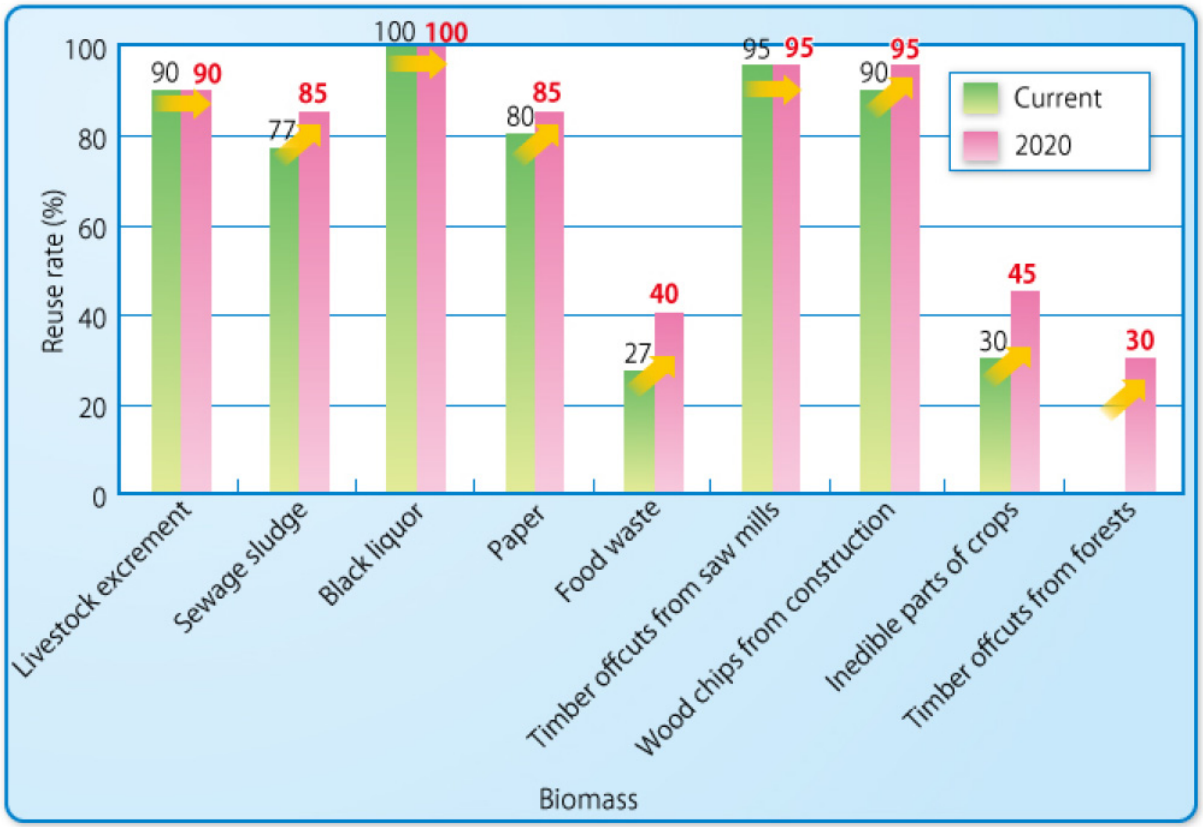
- Currently, paper (incl. black liquor) and livestock excrement are the two major area of biomass resource used.



Source: Asia biomass web page, strategy for commercialization of biomass
http://www.asiabiomass.jp/english/topics/1209_03.html

Targets of resource utilization rate in 2020

- Most of the biomass resource are already used (excluding timber offcuts from forests).



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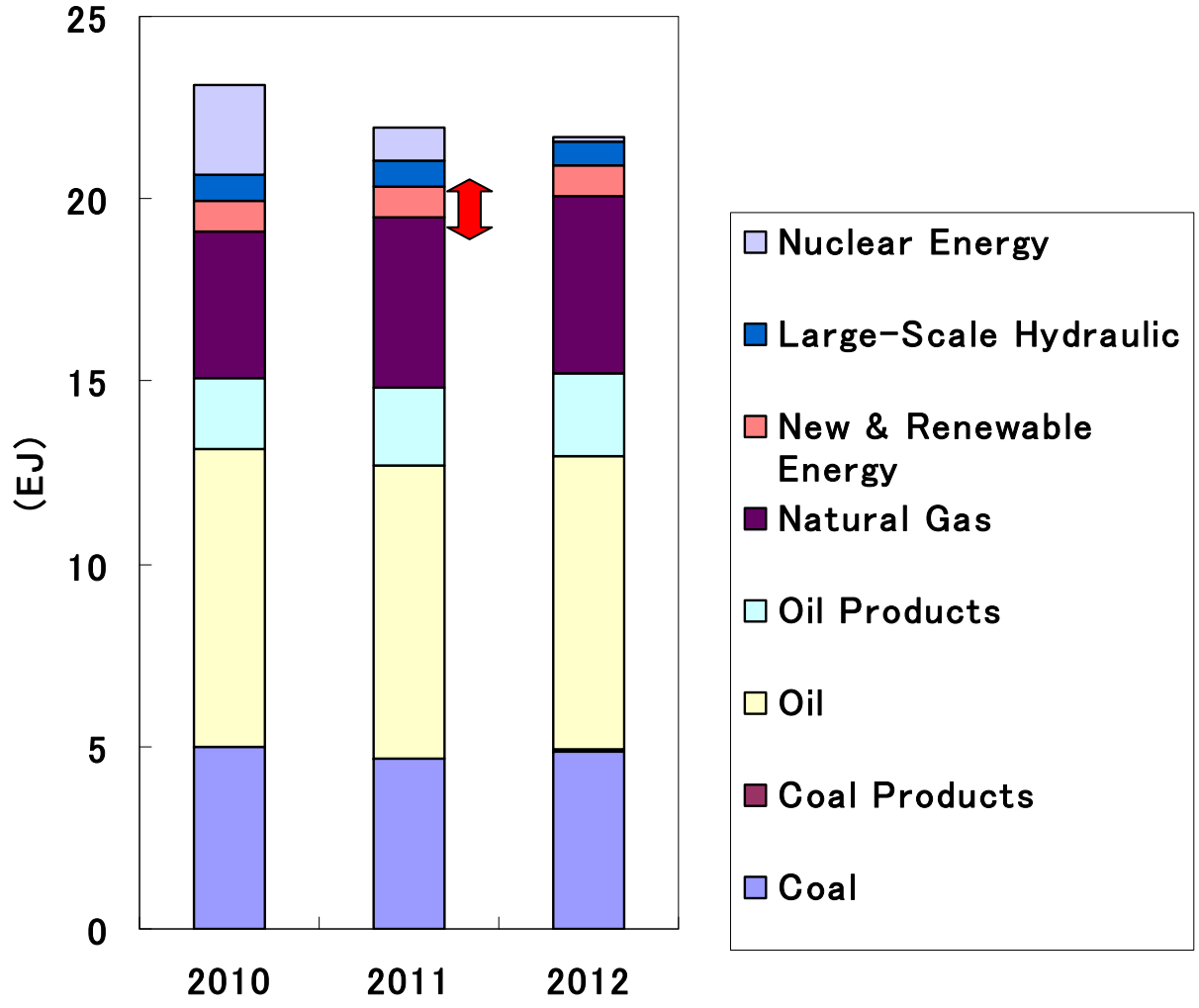
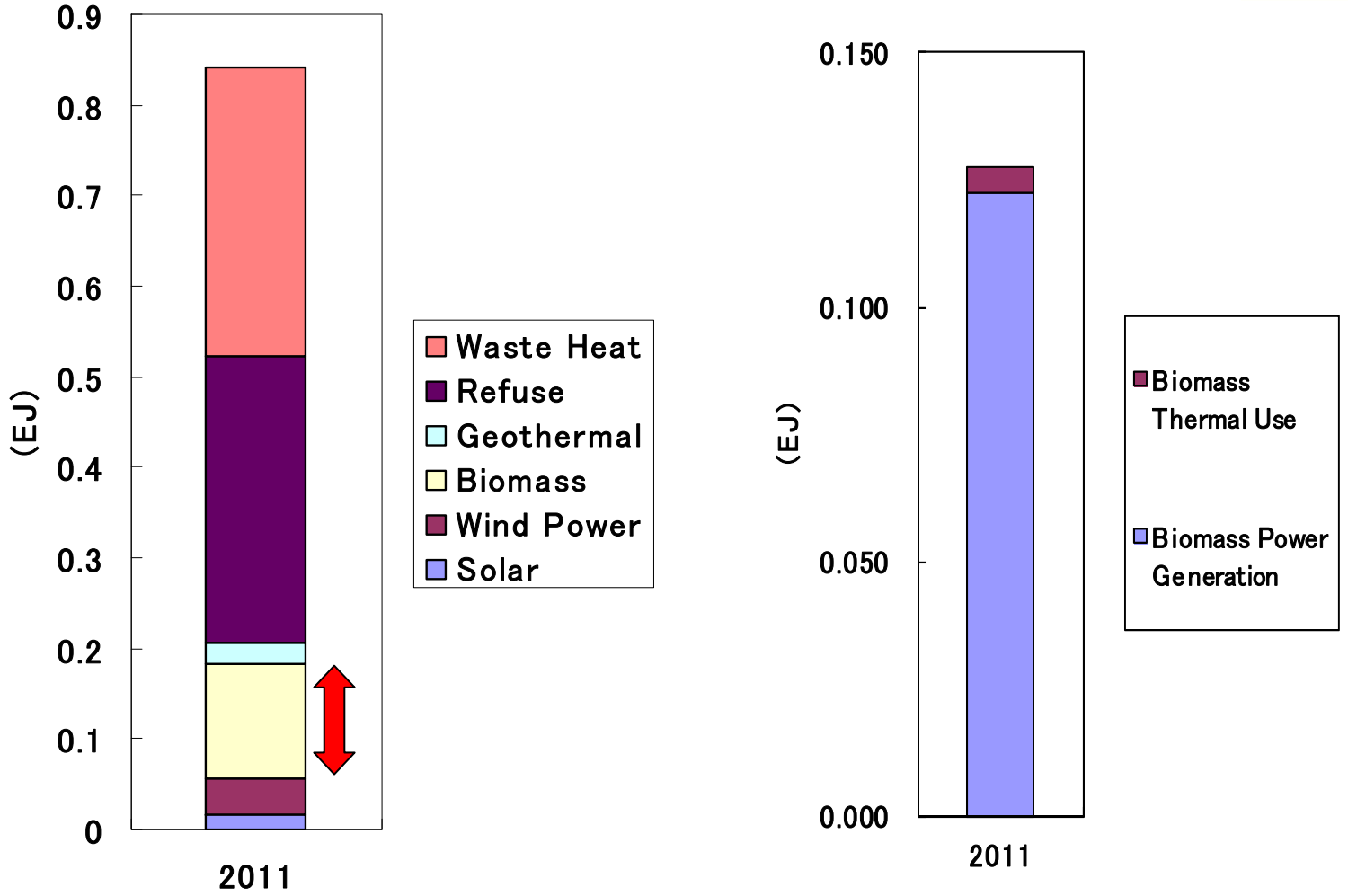
Primary Energy Supply of Japan (1)



Source: Energy balance table, ANRE/METI

Primary Energy Supply of Japan (2)



Source: Energy balance table, ANRE/METI

Major Policy Milestones in Recent Years (1)

- 2002 Biomass Nippon Strategy
  - Sustainable society by fully utilizing biomass
  - Create 300 biomass towns to promote the sustainable utilization
- 2005 Kyoto Protocol Target Achievement Plan
  - Promote widespread use of biofuels including fuel for transportation (500,000 kL by 2010)
  - Biomass towns and develop biomass energy conversion technologies
- 2007 Next-generation Vehicle and Fuel Initiative (METI)
  - An importance of the development of cellulosic biomass is mentioned for spreading biofuel and less using fossil fuel.
- 2008 Biofuel Technology Innovation Plan (METI and MAFF)
  - Cost target for cellulosic ethanol is 40 yen per liter in 2015
- 2009 Basic Act for the Promotion of Biomass Utilization
  - Draw up the 'national plan for the promotion of biomass utilization
  - Set up the 'national biomass policy council'

Source: MAFF and METI

Major Policy Milestones in Recent Years (2)

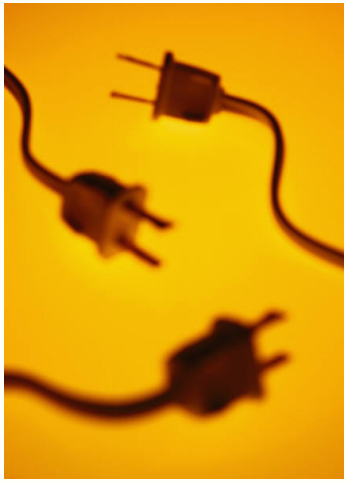
- 2010 Basin Energy Plan
  - Introduce renewable energy in 10% of primary energy supply by 2020
  - Increase biofuel at a volume equivalent to 3% cut of gasoline demand by 2020
- 2010 Act on Sophistication of Energy Supply Structures
  - An obligation to use a certain amount of biofuel is imposed on oil refineries.
  - The development of next-generation biofuel technology, whose GHG emission reduction is more than 50% compared to fossil fuel, shall be promoted and introduced in the oil refining industry.
  - Biofuel target 500,000kL (oil equivalent) by 2017, achievable by imported fuel
- 2010 National plan for promotion of biomass utilization
  - Set the targets for 2020
  - Set the basic policies on the development of technologies for effective biomass utilization

Source: MAFF and METI

Strategy for the Commercialization of Biomass (2012)

- Collaboration of seven ministries
  Cabinet Office, Ministry of Education, Culture, Sports, Science and Technology (MEXT), Ministry of Agriculture, Forestry and Fisheries (MAFF), Ministry of Economy, Trade and Industry (METI), Ministry of Land, Infrastructure and Transport (MLIT), Ministry of the Environment (MOE)
- Currently, Japan's resources of biomass is 255.5 million tons (when converted to carbon, 34.44 million tons of carbon), with its reuse rate for all of its biomass being 74.8%. The objectives listed in the Basic Plan for the Promotion of Biomass Utilization by the year 2020 are:
  - Use biomass equivalent to approximately 26 million tons of carbon (raise the reuse rate to 88.5%)
  - Create new industries
  - Formulate plans to promote the utilization of biomass in 600 municipalities
- If these objectives were to be achieved then 13 billion kWh of power generation from biomass and energy from 11.8 million kL of fuel usage (crude oil equivalent) could be obtained, which would constitute a reduction in the amount of CO_2 emitted of 40.7 million tons (3.2% of the amount of CO_2 emitted by Japan).
- Research collaborations are going on with foreign countries, especially in Asia

Source: Asia biomass web page



Feed-in tariff

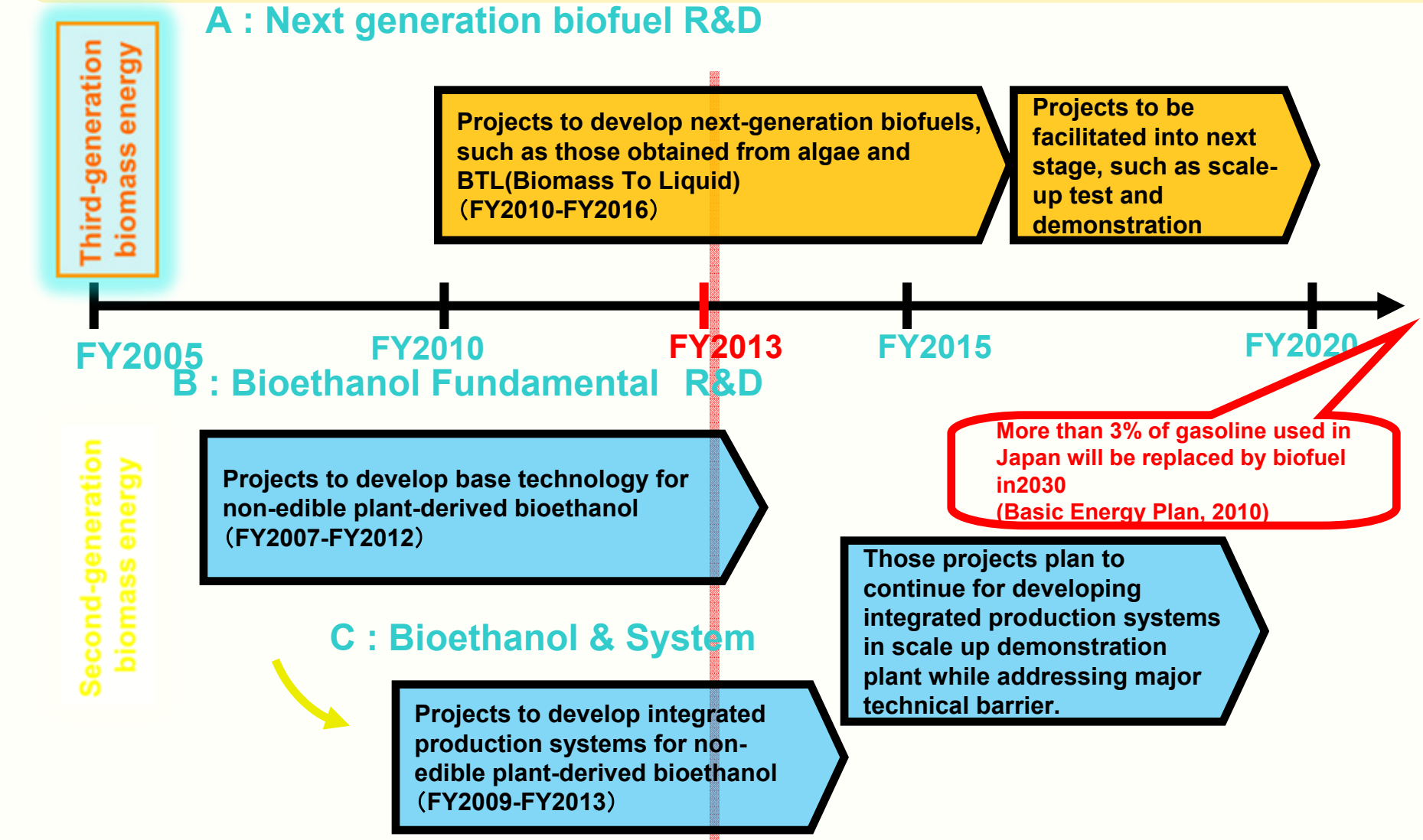
- Solar PV
- Small- and medium scale hydroelectric generation
- Wind power
- Biomass
- Geothermal power

Energy source	Biomass				
Type	Biogas	Wood fired power plant (Timber from forest thinning)	Wood fired power plant (Other woody materials)	Waste fired power plant (excluding woody waste)	Wood fired power plant (Recycled wood)
Tariff (tax inclusive)	40.95 yen	33.6 yen	25.2 yen	17.85 yen	13.65 yen
Duration	20 years				

Source: MAFF and METI

METI : Biofuels Technology Development Schedule

- Improve the efficiency of cellulosic ethanol production and reduce the production cost
- Introduce and promote next-generation bio-fuels that do not compete with food supplies



Source: METI

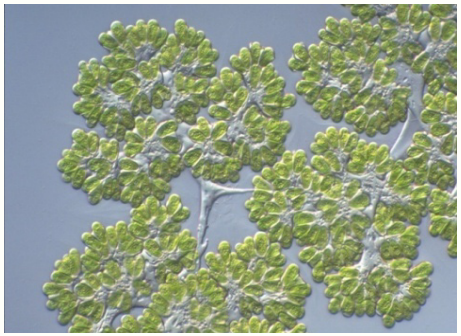
Projects to develop next-generation biofuels

Overview and objectives

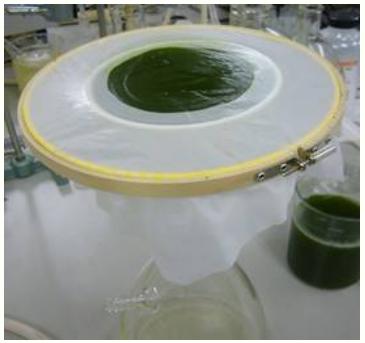
- Develop next-generation technology using biomass , which does not affect food supplies, micro algae in particular.
- Identify algae, which have a good potential use in producing oil and develop technology for improving the productivity and oil content of those algae.
- Development of technology to optimize systems for culturing algae, extracting oil.
- Render the entire process economical

Example of projects

Botryococcus braunii



Concentration



Solvent extraction

Source: METI

Projects to develop base technology for non- edible plant -derived bio-ethanol

Overview and objectives

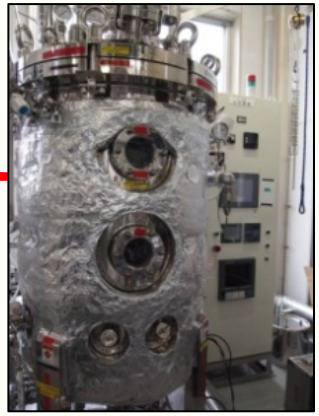
The projects aim to indentify and cultivate seeds for a wide range of medium – to long-term technologies, including biomass resource engineering, thermo and biochemical conversion and utilization technologies.

1. Bench scale plant for bio-ethanol production
2. Saccharification and fermentation technology development

Example of projects

Saccharification and fermentation

Saccharification



Pretreatment

Source: METI

Project to develop integrated production system for non-edible plant-derived bio-ethanol

Overview and objectives

- A comprehensive system, which includes processes for cultivating cellulosic biomass resources, for producing non-edible derived bioethanol has been developed by means of innovative technologies.
- Scale-up and commercialization of integrated ethanol production system.

Example of projects

Eucalyptus

Erianthus

Woody Biomass, 1ton/day(max.)
Ethanol 250-300 L/day

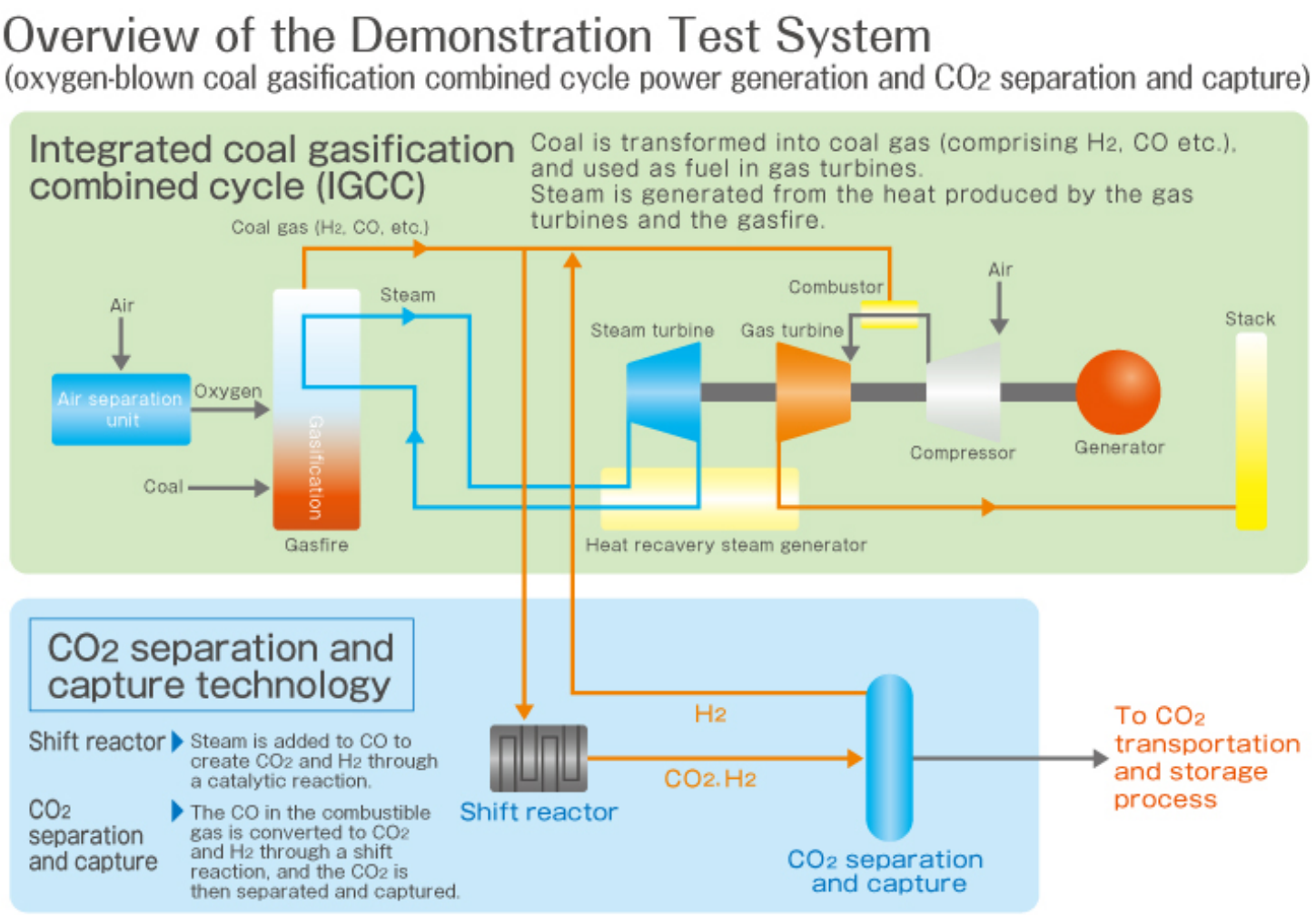
Pilot plant (example)

CO_2 capture and storage (CCS)

- Japan has 25 years of CCS related R&D activities which include both technological and non-technological ones for the whole CCS chain. IAE involved in Japanese CCS R&D from initial stage and advised energy and environment R&D portfolio including CCS to the government.
- Capture projects in Japan: Small scale demonstration in the power plants (NGCC, IGCC) and industries (iron&steel)
- Storage projects in Japan: Deep saline formations (onshore-completed, offshore), ECBM (completed)

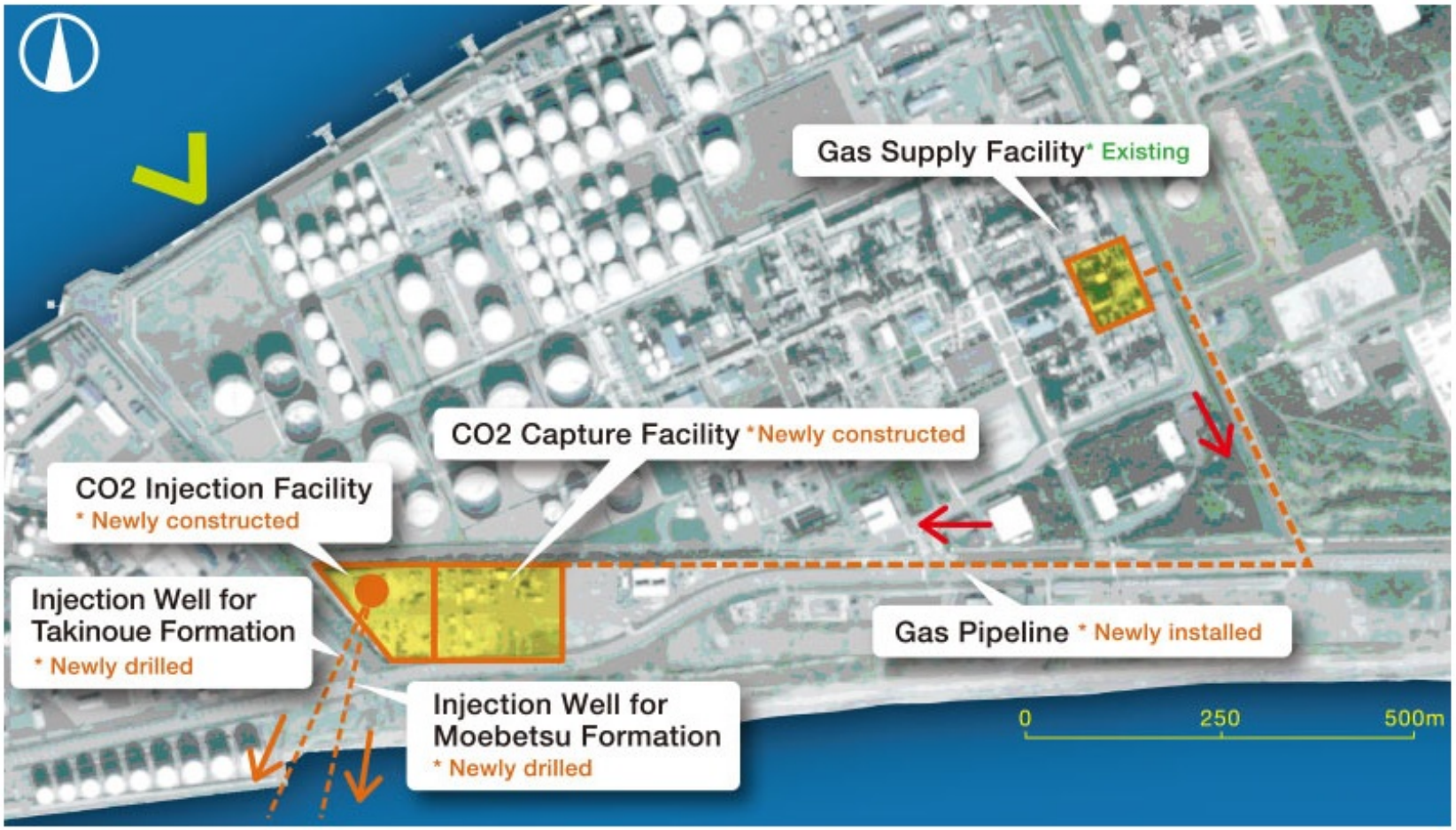
Osaki Coolgen (under construction)

Coal IGCC, 166,000kWe, slip stream

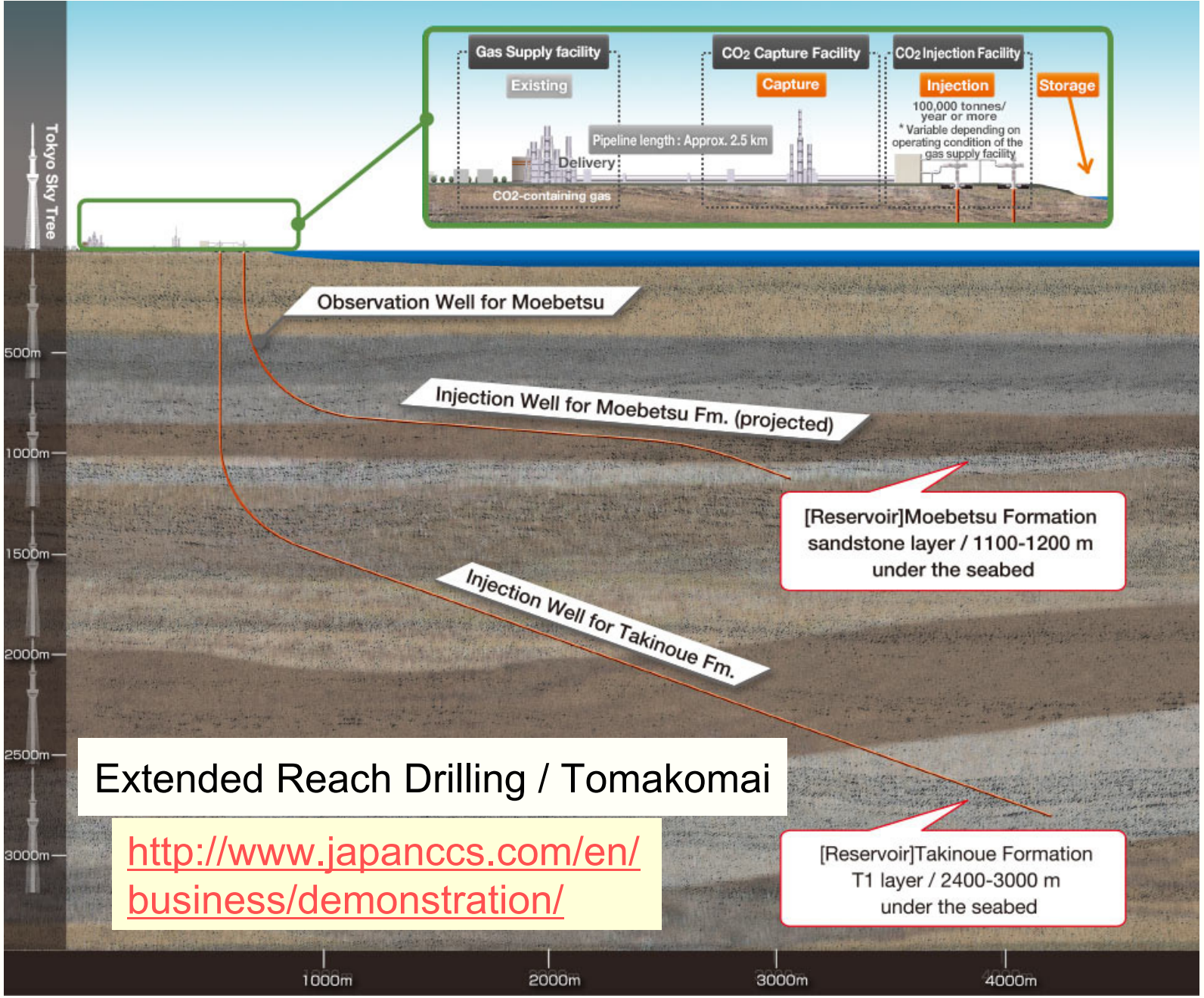


http://www.osaki-coolgen.jp/english/index.html

Tomakomai CO_2 Storage Project



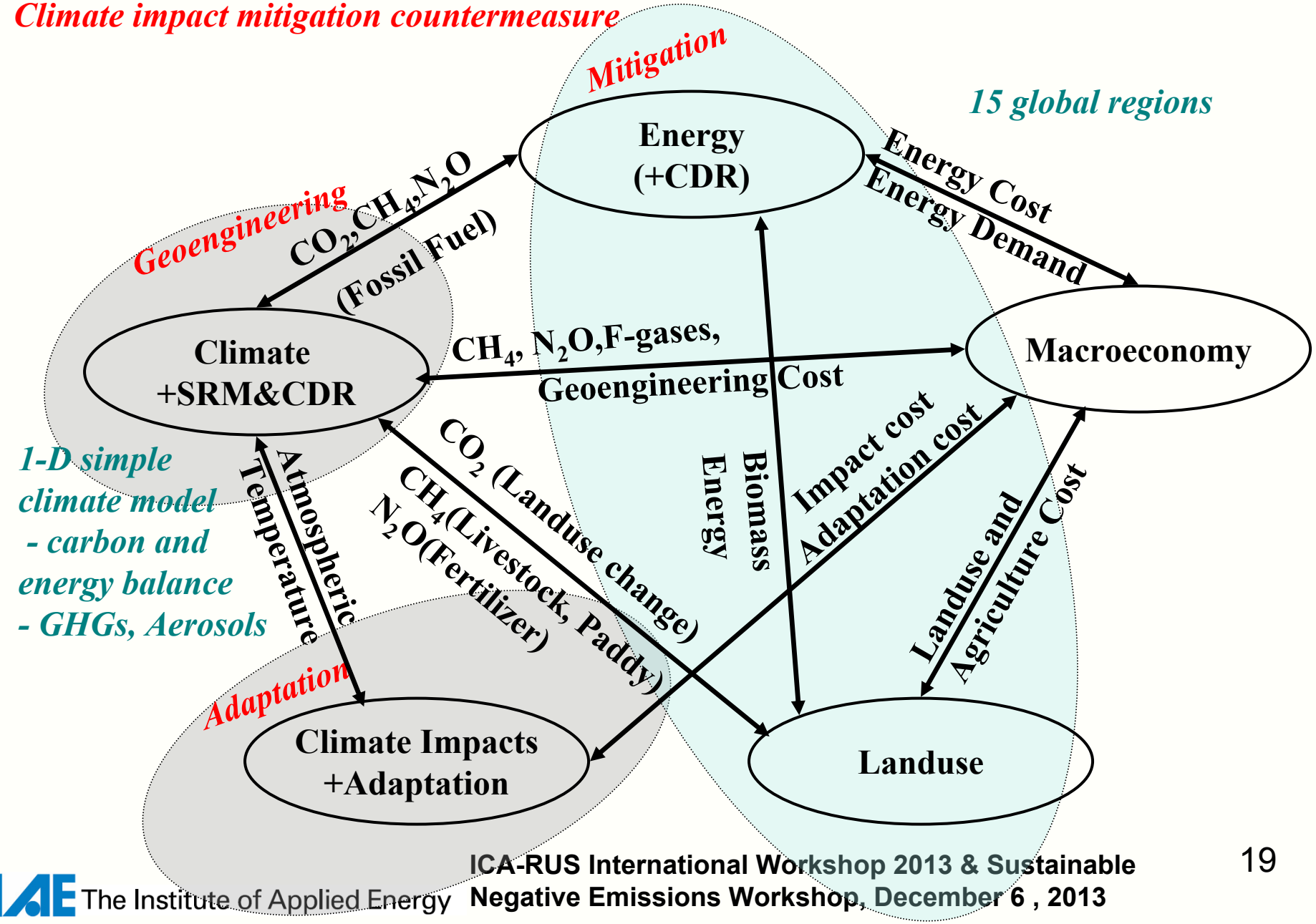
http://www.japanccs.com/en/business/demonstration/



Extended Reach Drilling / Tomakomai

http://www.japanccs.com/en/business/demonstration/

Integrated Assessment Model GRAPE - Proposed Modified Framework -



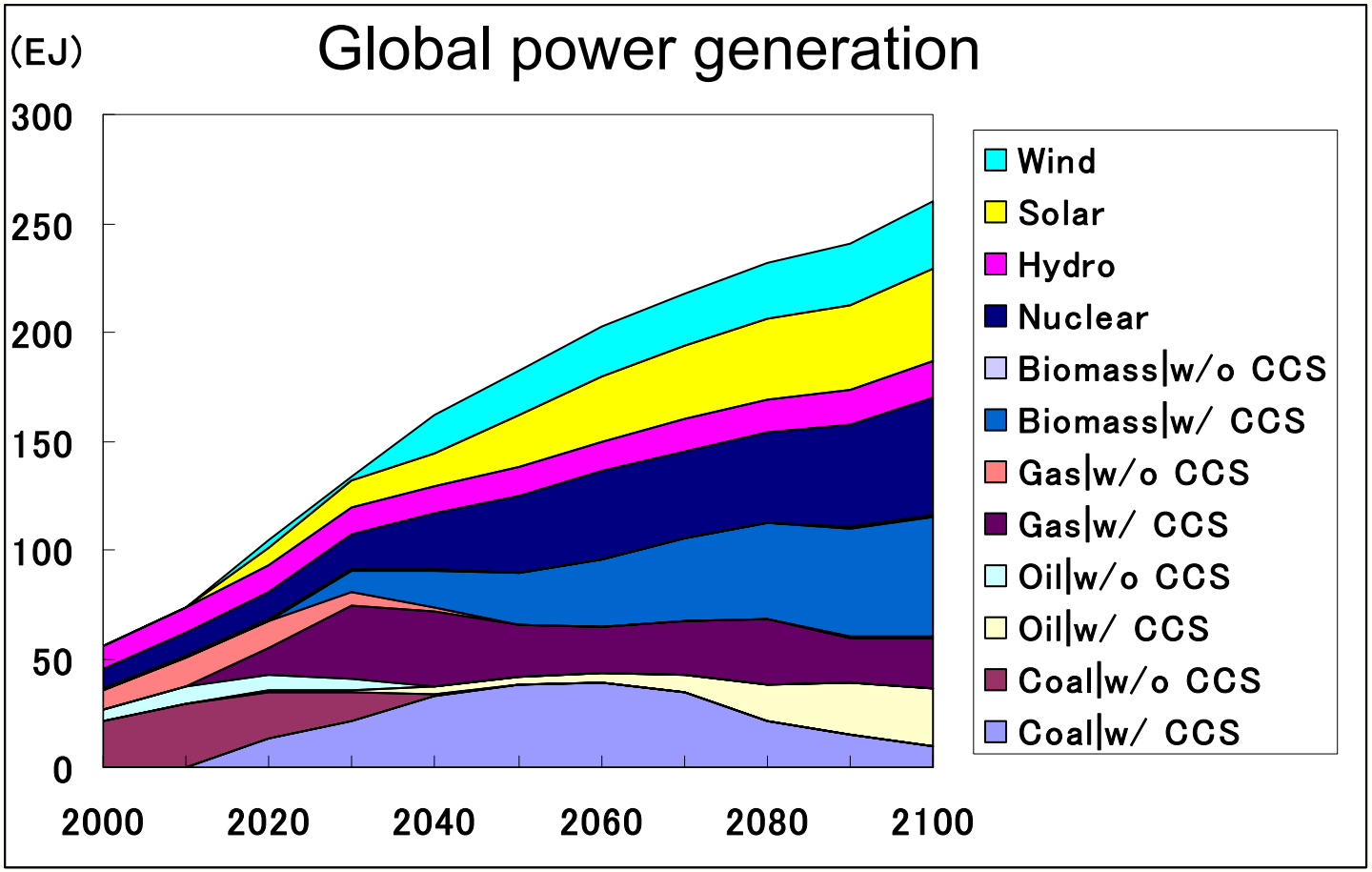
Bioenergy conversion process and potential CO_2 capture rate

Category	Conversion Process	Product	Potential CO_2 capture rate included in the feedstock
Thermochemical conversion	Power generation	Electricity	High
	Combustion	Heat	High
	Gasification	Liquid fuel	Moderate
	Pyrolysis	Liquid fuel	Moderate
	Direct liquefaction	Chemical product	Moderate
Biochemical conversion	Fermentation	Methane, Ethanol, Hydrogen	Moderate (methane and ethanol) / High (hydrogen)

Kurosawa, Moriyama and Murakami (2013)

BECCS in power generation

- EMF27 / 550e, full technology portfolio
- Other BECCS technology options (e.g. biofuel for transport) will be included.



Summaries

- Japanese industries have technology basis for bioenergy utilization and CCS.
- Scale-up demonstrations for both bioenergy and CCS technologies in Japan.
- There is no integrated BECCS demonstration project in Japan. We need to build a bridge between two technologies.
- Cost reduction and policy support of bioenergy and CCS to assist the road to BECCS.
- BECCS should be assessed in the broad conversion technology portfolio.

Thank you for kind attention.

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