

Research on the Sustainable Development of Biomass Plants toward the
Construction of the Carbon-Neutral Society
in 2050

This is a report on “Research on the Sustainable Development of Biomass Plants toward the construction of Carbon-Neutral Society in 2050”, which the Engineering Academy of Japan conducted with funding from the Watanabe Memorial Foundation for the Advancement of New Technology in Japan.

RESEARCHERS

Project leader: Tomoko Saiki, EAJ, Tokyo Institute of Technology

Co-researchers: Akio Nishijima, EAJ, Waseda University
Norio Ohto, The Takeda Foundation
Hideo Samura, EAJ, FS Corporation
Kinya Sakanishi, EAJ, National Institute of Advanced Industrial
Science and Technology (AIST)
Masayuki Kamimoto, EAJ, Hirosaki University
Masakatsu Nomura, EAJ, Osaka University
Masayuki Sagisaka, AIST
Kazuhiko Takeuchi, AIST
Hideyuki Murakami, EAJ, Waseda University
Issey Sawa, Nippon Environmental Energy Development Co., Ltd.,
Masayuki Otake, Mitsubishi Chemical Research
Yuko Yasunaga, EAJ, UNIDO

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Summary

1. Background

This research was conducted to clarify the conditions and environments of current biomass plants that support sustainable operation, and to propose policies toward the construction of the Carbon-Neutral Society in 2050. The research focused on several successfully operating biomass plants that differ in location and raw material supply (domestic site/domestic raw materials, domestic site/imported raw materials, foreign site/foreign raw materials). Based on the results of this research and the former Policy proposal made in 2020, we have compiled strategies and policy proposals as follows.

2. Results

(1) Biomass power plants

Biomass power plants generate 36 TWh, 3.6 % of all electricity generated (1000TWh) in Japan, and about 20% of all renewable energy including hydro, solar, wind, and others. Small scale biomass power plants (under 10,000kW) generate 9.8 TWh, 27% of all biomass power electricity including biomass co-firing and in-house power generation, while mid to large scale biomass power plants (over 10,000kW) generate 9.3 TWh, 26% of all biomass power electricity in Japan. Biomass power plants provide a stable electricity supply regardless of weather conditions. The research revealed the following features.

① Domestic power plants with domestic fuel

Biomass power plants of this type are mostly small scale, and constructed through local initiatives to use unused local woods. They provide not only electricity but also employment to the local community, and act as a profit center in the local forestry value chain. They are located near local forests, and use local biomass fuels, which guarantee a stable supply of fuel for the power plants but at the same time limiting their expansion.

② Domestic power plants with imported fuel

Biomass plants of this type are mid to large scale (over 10,000kW), and located next to harbors. They can expand in scale and improve efficiency in generating electricity by importing more biomass fuel, but at the same time may face difficulty in importing sufficient amounts of biomass when world biomass market conditions get tighter.

③ Foreign biomass plants with foreign biomass fuels

The plant of this type that we selected is not operating yet, but would seem to have the advantage of a stable supply of biomass fuel since it is located next to a palm processing factory, and can use palm byproducts as fuel.

④ Conditions for stable operation

Conditions for the stable operation for all domestic biomass power plants include a stable fuel supply and stable sales of the generated electricity based on Feed-in Tariff (FIT). Stable operation will be difficult when FIT ends.

(2) Biorefineries

Biorefineries produce commodity goods from renewable raw materials including biomass and recycled plastics, and are becoming a key tool for a circular economy. The research reveals the following trends in circular economy.

① Biofuels

The world consumption of aviation fuels is 330 Mt, 2.4 % of the world primary energy consumption, and it is becoming an urgent matter for airline companies to replace fossil fuels with sustainable aviation fuels (SAF) derived from renewable materials such as biomass. Currently, the International Civil Aviation Organization (ICAO) recommends the use of SAF by international airlines, but Members of the ICAO have reached an agreement by which all international airlines should use SAF by 2027. On and after 2027, airlines can not use international airports if they don't use SAF.

② Bioplastics

Society is quickly moving toward the use of electric vehicles (EV), and it is expected that naphtha production will be significantly slowed down in the future since EV do not use oil. All chemical companies are trying to deal with this trend by using bio-naphtha or recycled naphtha from recycled plastics. Manufacturing commodity goods requires the stable supply of huge amounts of starting materials, which means that huge amounts of bio-naphtha will be necessary. Biorefineries are expected to play a key role in fulfilling this requirement by producing bio-naphtha from biomass.

③ Sustainability of biorefineries

The French biorefinery and Thai biorefinery are integrated types located on farming sites and sustainably manufacture multiple products from single or multiple starting materials. Integrated biorefineries seem sustainable by not depending on a sole product. They can develop new products, and the expansion of product families contribute to sustainable operation.

3. Strategies for the construction of the Carbon-Neutral Society in 2050

(1) Biomass power plants

Biomass power plants provide stable electricity regardless of weather conditions. They should be maintained or expanded as a stable source of electricity in the course of constructing the Carbon-Neutral Society in 2050. Domestic power plants using domestic raw material supply are environmentally friendly and can act as a profit center in the value chain of the forestry economy. Domestic power plants with imported raw materials can contribute to the expansion of the renewable energy supply. They should improve their power generation efficiency through capacity expansion and technological progress, and maintain sustainable operation through international cooperation with biomass supplying countries.

(2) Bio-clusters

Biorefineries convert renewable materials (biomass and recycled plastics) into commodity goods such as biofuels and bioplastics, and are expected to play a major role in the circular economy. Integrated biorefineries, bio-clusters, represent a sustainable form of biomass refinery. Biomass power plants should be integrated with bio-clusters to maintain a sustainable power supply.

(3) Development of new biomass starting materials

The Carbon-Neutral Society will use huge amounts of renewable commodity goods such as biofuels and bioplastics to replace commodity goods derived from fossil resources. The development of new biomass starting materials is necessary without changing current land use.

4. POLICY PROPOSALS

We propose the following policies to promote the Carbon-Neutral Society in 2050.

- (1) Short term policies include improvement of power generation efficiency, lowering biomass fuel costs, use of agricultural byproducts for biofuels, funding the improvement of existing facilities, and promoting traceability of biomass operation.
- (2) Mid to long term policies include the development of high efficiency power generation technologies, cooperation between biomass power plants and integrated biorefineries, designation of certain districts for bio-cluster formation, and granting incentives to biomass products.
- (3) International cooperation includes the development of new biomass starting materials without changing current land use, and the promotion of sustainable palm plantations by helping palm plantations solve local environmental problems.