Low-carbon solutions by large scale co-firing of biomass fuel in coal power plant

~ Development of production/supply flow of new biomass fuel ~

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1. Outlook of Idemitsu Coal Business, harmonized with environment

2. Contribution to the increase of Renewable Energy, utilizing highly efficient coal power plant

3. Improvement of co-firing ratio with torrefied wood pellet (Black pellet)

4. Idemitsu Black pellet production/supply activity

5. Summary
Presentation Outline

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Idemitsu’s Coal Business outlook (1)

**Production**
Own Coal Mine

**Procurement**
(AUS, IDN, RUS, CHN)

**Logistics**
Idemitsu Bulk Terminal in Chiba

**Sale**
Proposal-based sale to customers

**Technical Support, R&D**
Coal & Environment Research Laboratory
Unique private research institute specialized for coal in Japan

**Own Use**

**Refineries**
Idemitsu’s Coal Business outlook (2)

Production & Procurement

- Coal Mine Operation in AUS (3 Mines)
  - Production: 12 Mt* (2018)
  - * Equity portion
- Shareholder for 2 coal mines in IDN
- Procurement: AUS, IDN, RUS, CHN

Logistics

- Idemitsu Bulk Terminal (Chiba)
- Shunan Bulk Terminal (Yamaguchi)

Sale

- Sales volume: 20 Mt (2017)
  - Japan: 12 Mt (2017)
  - Overseas: 8 Mt (2017)

Own Use At Refineries

- Pulverized coal-fired boiler
  - (Aichi, Tokuyama)
- CFBC boiler (Chiba)
Coal business harmonized with environment

Pursuit of environmentally harmonized business in total coal supply chain

**Coal Mine**
- High-quality coal with low sulfur and low ash
- Coal washing
- Coal preparation plant at Boggabri mine in Australia

**Coal stockyard**
- Watering by sprinkler
- Prevention of dust emission
  - Sprinkling of water
- Prevention of spontaneous combustion
  - Sprinkling of water and displacement of piles

**Boiler**
- Proposal of coals with good environmental feature and economics
  - “Coal evaluation system”
- Proposal of steady operation conditions with high efficiency
  - “Combustion simulation”

These activities lead to reduction of CO$_2$ emissions
Business menu harmonized with environment

In addition to stable energy supply to Asian countries including Japan, we provide various business menu harmonized with environment.

- Supply High grade coal
- ULTY-V plus (Reduce fuel consumption by combustion control)
- Technical Consulting for Combustion
- Biomass Co-firing (Black pellet Supply)
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All energies have merit/demerit and no energy is versatile

Because of the lack of resources, it is important for Japan to have a balanced use of energies ("Energy Mix").

**Coal keeps to play an important role for power source composition**

As the way to utilize existing coal power plant...

**Biomass co-firing**

- Efficiency improvement for coal power plant
- Increase RE without additional investment
Realistic solution for maximum introduction of renewable energy

- Power plant by renewable energy
  - Solar
  - Wind
  - Biomass
  - Hydro
  - Geothermal

- Features of Biomass for power plant
  - Easy to fuel stock
  - No restriction by natural conditions
  - Not enough availability of biomass in Japan

- Especially for co-firing in coal power plant...
  - No need for additional investment for power plant
  - No concern about grid connection issue
  - Enabling load adjustment for other RE (Solar, Wind)
  - Further Efficient use for coal power plant
To achieve the target, Large power companies need to reduce the fossil fuel use.

Biomass co-firing in coal power plants is realistic solution.
How to increase biomass with economic efficiency?

Highly efficient combustion & Increase of co-firing ratio

Power generation efficiency: 
CFCB < PCB

Black pellet co-firing at pulverized boiler is the best match!

High grade black pellet
To achieve Energy Mix, Coal will decrease and RE will increase. Biomass co-firing in coal power plant is realistic and efficient solution.

Due to high efficiency combustion, biomass fuel consumption is less in large coal power plant than small biomass power plant.

Biomass co-firing in coal power plant can make load adjustment which is needed because solar and wind power run with a lot of output fluctuation.
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## Comparison among woody biomass

<table>
<thead>
<tr>
<th>Type</th>
<th>Shape</th>
<th>CV (kcal/kg)</th>
<th>Characteristics</th>
<th>Co-firing</th>
</tr>
</thead>
</table>
| Wood Chip          | ![Image](image1) | 1600-2800    | • High moisture  
                     • Outdoor storage  
                     • Low transport efficiency | △         |
| White Pellet       | ![Image](image2) | 3600-4000    | • Indoor storage  
                     • High transport efficiency | △         |
| Black Pellet       | ![Image](image3) | 4500-5200    | • Outdoor storage  
                     • High transport efficiency  
                     • Good grindability | ◎         |
| PKS (Palm Kernel Shell) | ![Image](image4) | 4000-4500    | • Poor grindability  
                     • Outdoor storage  
                     • High transport efficiency | ×         |
Features of black pellet - comparison with white pellet

1. Enhance energy density  →  Efficient for logistics
2. Good grindability  →  Higher co-firing ratio (White:1~3% ⇒ 50%?)
3. Waterproof  →  No investment for storage
4. Diversification of feedstock  →  Unused materials, Agricultural residue etc. can be utilized

Handling like coal is promising.

Already produced and traded worldwide
(500kt imported pellet into Japan in 2017)

Not yet distributed in commerce in Japan
Technical improvement for commercial production is required.
Efficient production process with self supply of heat source for torrefaction and drying.

Key factor to produce high quality black pellet is reaction temperature and retention time.
Black pellet can be fed without any improvement of existing facilities.

When black pellet is blended 50% with coal, CO2 emission per 1kWh become less than LNG power plant.
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# Idemitsu Business plan for biomass

## Business model

To establish value-chain for woody biomass business

<table>
<thead>
<tr>
<th>Procurement of feedstock</th>
<th>Logistics</th>
<th>Sales and technical support</th>
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<tr>
<td>Production of torrefied pellet</td>
<td></td>
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</table>

- **Feedstock in Southeast Asia.**
- **Torrefied pellet**
- **Shipping**
- **Storage at coal stockyard**
- **Technical support by our laboratory**
- **Co-firing with coal and biomass in customers' boilers**
Black Pellet Production in Thailand

- **Producer**: Joint Venture Company to be organized with local partners.
- **Location**: Surat Thani
- **Raw materials**: Waste of rubber tree
- **Production**: Sample pellet production from demo plant has started. Investment decision for the commercial plant will be made after evaluation of sample pellet by customers.

- Establish the scheme to procure raw materials stably by local partners.
- Contribute to the economic growth of local society by providing the stable income.
Collaboration with Rubber Authority of Thailand

- Meeting was held to discuss about the long and stable supply for raw materials from rubber wood.
- Rubber authority has high expectation for our activity, since it leads to the additional income for farmers and prosperity for local society.

From HP of RAOT
Black Pellet Production in Thailand
Joint Study with customers toward the increase of co-firing ratio

- Joint study will start soon with a power company, aiming high co-firing ratio in coal power plant.
- Try and Error will be repeated for the improvement of black pellet quality to increase co-firing ratio.

High grade black pellet

Torrefaction Equipment at Idemitsu Coal & Environment Research Laboratory

Power company

Biomass Co-firing

50%

30%

10%
Construct the pellet plant in the location where the raw materials can be supplied on stable and long-term basis.

We expect that torrefaction technology will enable the diversification of raw materials.
Possibility on domestic biomass resources

- Japan has enormous forestry resources.

- However, it is not fully utilized due to the lack of forestry road and so on.

- Idemitsu starts the supply of biomass fuel with imported biomass, but we will seek the possibility of the supply of the domestic biomass and of the contribution to the improvement of energy self sufficiency ratio and local revitalization in Japan.
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As a part of "Coal business harmonized with environment", Idemitsu is preparing the supply business of biomass fuels (Torrefied pellet) mainly for the co-firing in large coal power plant.

We recognize that biomass co-firing in large coal power plant is efficient means to reduce CO2 emission and realistic solution to achieve "Energy Mix" in Japan.

Key factor of biomass business is stable and long-term procurement of raw materials. First, we cooperate with local partners in South East Asia and establish total system from securing raw materials, production, transportation and sales to customers in Japan.

In the future, we would reduce the effects on environment by producing and supplying of domestic biomass.
Thank you very much for your kind attention.
As a unique private research institute specialized for coal in Japan, we are working on the technical consulting to help solving our customers’ technical issues and environmental problem and developing various kinds of technical products for promoting highly efficient coal utilization and environmental protection.

- Highly efficient Coal Combustion Technology
  - Combustion Simulation
  - Coal Evaluation System
- Dust handling, Feedstock Management
- Environment Technology Products
- Biomass Co-firing technology