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# BIOCOAL

## Bioenergy Game Changer in Asia?

Written by Andreas Teir & Rickard Frithiof
for Centre for Management Technology
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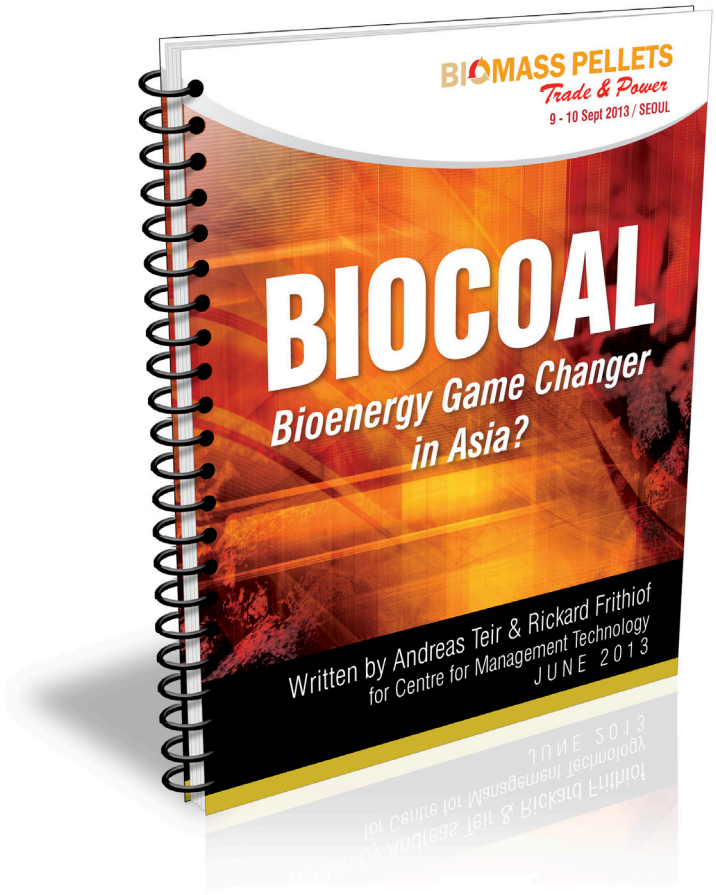


# Biocoal - Bioenergy Game Changer in Asia?

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**Climate change concerns have created pressure to reduce fossil fuel consumption. Once heralded as the next big thing - the potential of co-firing biomass in coal boilers has been limited by the significant capital investment required to modify fuel handling and combustion systems. However, biocoal can be co-fired in existing coal fired power plants, produced from a vast array of feedstock, and is efficient to ship, even over long distances. Is biocoal a game changer?**

Biocoal introduces a new class of solid biomass-based fuel for global power and heat generation. In order to reduce carbon dioxide (CO2) emissions, power generation companies aim to increase the amount of power and heat from renewable energy sources. Combustion of biomass, either in dedicated boilers or co-firing with coal, has been identified as a potential way forward, however, it has been proven challenging. High procurement costs, low energy density, high water content as well as challenging logistics, storage and handling; unprocessed biomass is also non-homogenous, leading to challenges in terms of efficiency and combustion optimisation. Processing biomass into biocoal and densified biocoal would facilitate the use of biomass in energy generation and create opportunities for fuel sourcing from further distances at reduced costs.

# BIOCOAL MARKET POTENTIAL

Pöyry forecasts the global pellet market will reach around 60 million tonnes in 2020. The share of biocoal will largely depend on the development and commercialisation of processing technology by the end of 2014. Europe will continue to dominate the market, consuming the majority of the volume, but North East Asia emerges as an important market. The share of biocoal in a co-firing setup has been demonstrated to up to 50%, depending on the biocoal quality and boiler type. Utilities have invested in technology developers and have publicly promoted their desire to start using pelletised biocoal in large quantities. However, it is important to note that the biocoal market is still in development, and commercial scale production facilities are limited. Wider commercialisation will begin in 2018 if financing and off-take opportunities maintain momentum of technology development. In the long term, biocoal is expected to become a standardised and commodity traded product.

In Asia Pacific, the biomass trade is still in its infancy which may provide a beneficial timing for technology innovations such as biocoal. The market potential is certainly there with more than 62,000 MW installed coal-fuelled power plants only in Japan and South Korea. Assuming an overall 10% co-firing share this corresponds to more than 22 million tonnes of wood pellets!

# GROWTH OPPORTUNITIES

Why would a power utility consider procuring biocoal when the production cost is typically more expensive than wood pellets? A few key factors will support the growth of biocoal pellet consumption globally over the coming years:

- Lower logistics costs - Biocoal has higher specific energy content per volume compared to other forms of biomass.
- Lower investment requirements – Biocoal requires lower capital expenditure for handling and storage at power plants.
- Improved safety - The less reactive nature of biocoal pellets compared to standard pellets provides better long term storage safety.
- Similarity to coal - Biocoal's fuel characteristics are similar to coal, reducing the retrofitting requirements in the power plant.
- Security of supply – Given biocoal's fuel properties the boiler is less sensitive to variability of the co-firing share. Should the biocoal supply fail, which may happen particularly in juvenile markets, coal can temporarily compensate for the lacking biocoal volume.
- Wide range of potential sources - Biocoal can be derived from alternative biomass sources, such as agricultural residues and short rotation crops.

# VALUE ADD THROUGH PROCESSING BIOCOAL

Biomass is processed to biocoal through a number of technologies, including torrefaction and steam explosion techniques. Biocoal can then be densified to pellets or briquettes to increase the bulk density and decrease transportation costs. Biocoal pellets have hydrophobic characteristics and can be received and handled by the power plants in the same manner as fossil coal. Processing biomass to biocoal gives it coal-like characteristics such as darkness in colour, brittleness and requires less energy for milling and pelletising than traditional biomass. Biocoal contains up to 90% of the original energy content of the biomass used. In pelletised form, biocoal has a 30% higher energy density than white pellets, which decreases transportation costs. Biocoal can be co-fired directly, and used in gasification processes or densified. Utilities have already successfully co-fired biocoal in both densified and powder form. Biocoal densified into pellets / briquettes as a fuel provides additional value and has a promising market outlook. The distribution of densified biocoal is more efficient compared to other forms of solid biomass. Storage requirements of densified biocoal will enable the end-user to easily manage handling and minimise security and safety concerns. Densified biocoal provides an opportunity to create considerable savings in dry bulk shipping. It is safer to handle than traditional white pellets, because of the off-gasing and temperature changes often experienced with conventional biomass pellets. Densified biocoal can be co-fired in existing power plants, with minimal need to make modifications to fuel handling systems.

# DENSIFIED BIOCOAL TECHNOLOGY

Examples of potential alternate feedstocks include wood, grasses, biowaste, digestate and bagasse. In order to make biocoal more easily transported and increase the volumetric energy density, the biocoal can be densified into pellets or briquettes. When the wood is heated in the torrefied production technology, the lignin and cellulose break down, especially in higher temperatures. The densification of torrefied biocoal is more challenging and will likely require the use of a binding agent. Biomass end-users often require a bio-based binding agent. Steam explosion technology does not break down the lignin in the same way, eliminating the need for additives. The amount of binding agents needed in the densification process depends greatly on the feedstock. The suitable processing method depends on the chosen feedstock for the biocoal production. Many pilot projects have successfully produced densified biocoal from numerous biomass feedstocks over the past decade. In the case of South East Asia it would certainly be very beneficial to leverage low-cost biomass such as residues from the palm oil industry, but it remains to be tested.

# PRODUCTION COSTS

By and large, the production costs of biocoal and densified biocoal are built up by the same components as wood pellet production, such as:

- Production yield and specific heat and electricity consumption
- Quality, availability and price of the feedstock
- Capital expenditure, operations and maintenance costs
- Technical knowledge transfer amongst producers and technological development

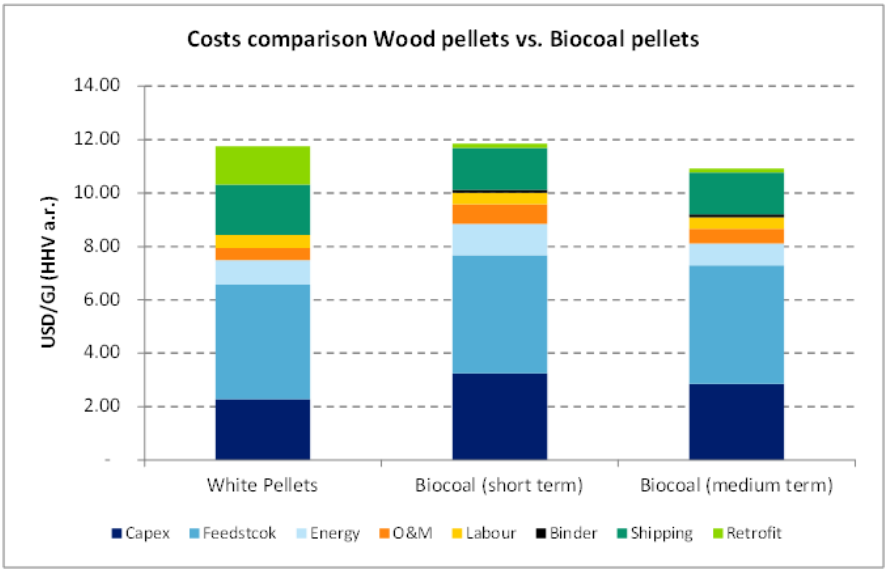
However, the weighting is slightly different to wood pellets and creates a case to case scenario what is the preferred technology. The development of process technology has demonstrated promising results and Pöyry envisages further technology improvements.

# WHAT'S IN IT FOR THE ASIAN MARKET?

Biocoal has the potential to become a game changer in the bioenergy market as developers execute plans for ramping up demonstration-scale operations within the next few years. Hence, the timing of the technology development is well aligned with the market growth in Japan and Korea.

The general drivers for the deployment of renewable energy in Korea and Japan are the RPS scheme and Feed in Tariffs (FiT) respectively. In Japan, the FiT discriminates between biomass sourced domestically or overseas, and currently the scheme clearly favours domestic biomass. This raises a question mark in terms of short-term viability of importing biomass, however, in the long term imports will be required to reach indicated targets. In Korea, imported biomass face less competition from domestic biomass and the RPS scheme currently provides a strong paying capability. However, the financial support is highly dependent of the value of the Renewable Energy Certificates (RECs) as well as what tariff co-firing is remunerated from the Korea Power Exchange. The introduction of the Emissions Trading Scheme (ETS) in 2015 is also likely to further strengthen the competitiveness of biomass compared to other renewable energy sources. The Korean policies signal a strong "Go" to biomass imports.

What the Korean RPS and future ETS don't distinguish is the type of biomass. The competition between wood pellets and lower-quality biomass is well understood, however biocoal pellet is a new product in the market. The relative economics of wood pellets and biocoal pellets is very much from case to case, but some general patterns and conclusions can be drawn. Assuming a case where the respective pellets are produced in Indonesia at a 200,000 tonnes per annum mill, and used for co-firing in a 500 MW coal-fuelled power plant, the economics may look like below figure.




At the current stage of technology development there are primarily two cost components that make biocoal pellets a more expensive product to manufacture than wood pellets. The torrefaction step adds further equipment to the production line which obviously increases the costs. The additional step also requires energy which currently increases the overall energy demand, however, there is potential to integrate the processes so as to improve the energy recovery. On the upside, shipping costs and associated costs in the receiving power plant may be significantly reduced by biocoal pellets. Given the higher energy content, all logistics and handling are more cost effective for biocoal pellets, in this fictive case around $0.30 per GJ. The key component however is the avoided costs at the power plants. The costs of retrofitting the power plant facilities to wood pellet utilisation vary significantly from cases to case and the actual cost may deviate both ways from the indicative example in the figure. Due to the lack of industry-scale demonstration projects it may also turn out to be costs associated with consumption of biocoal pellets in the power plants. Yet, the hydrophobic characteristics should require limited storage criteria, and the coal-like properties should indicate negligible boiler tunings. These competitive advantages will remain also in the future, however Pöyry expects that investment cost and energy recovery in the pellet plant will improve significantly in the medium term.

In 2013, the RPS mandates the Gencos to produce 2.5% of their reference generation from New and Renewable Energy (NRE) sources. This may not constitute any major technical challenges as the co-firing rates are low, however, as the target approaches 5-10% the choice of technology gets more important. Thanks to its coal-like properties biocoal allows for higher co-firing rates and freedom of choice, which unlike intermittent power provides desirable possibilities to control the renewable energy output. On the flip-side, biocoal pellets is not yet a proven technology in large-scale applications and the development may not be as straight as it seems.

All in all, biocoal pellets provides an interesting potential to a market with great ambitions but less clear-cut solutions. Is biocoal a game changer?

# ABOUT THE AUTHORS

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Mr Teir has 15 years of management consulting experience in the bioenergy sector and forest industry with Pöyry. He is a specialist in new business and strategy development in the bioenergy sector. He advises clients in the bioenergy sector on biomass sourcing, corporate planning and valuation, and investment analysis. In his role, as Director of the Global BioFutures Practice at Pöyry Management Consulting, he advises clients in developing and assessing new business opportunities in emerging bioenergy sectors such as torrefied and conventional pellets, pyrolysis oil, and advanced wood biomass based liquid biofuels, globally.

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Mr Frithiof has 5 years of bioenergy expertise in Europe and Asia. His focus areas are development of feasibility studies for pellet and biofuel projects, evaluation of bioenergy opportunities and assessment of sustainability for bioenergy markets.

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