Abellon CleanEnergy

COFIRING

with BIOPELLETS

An efficient way to reduce greenhouse gas emissions

Abellon pellexo

ECO-FRIENDLY BIOMASS PELLETS

Biopellets cofiring in large thermal power stations - an effective way to reduce Greenhouse Gas Emissions

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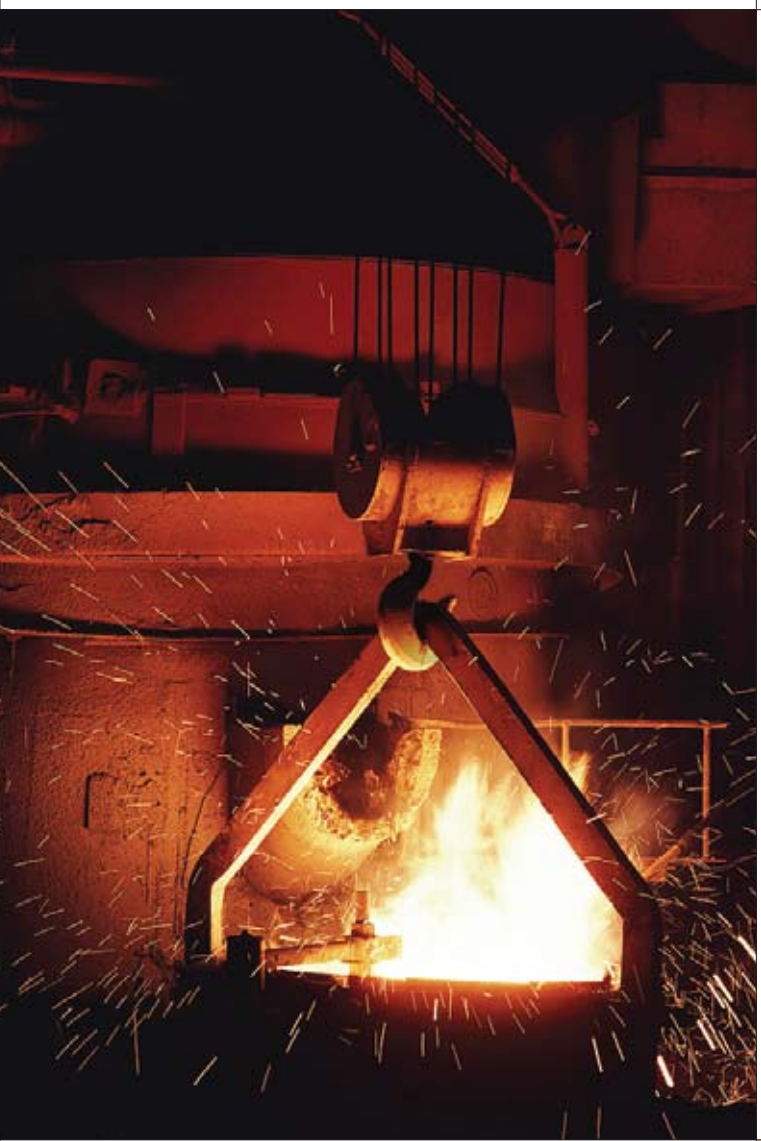


PREFACE

Achievement of long term climate change mitigation objectives will ultimately require a transition from fossil fuel energy to renewable energy. Biomass cofiring is one such quick and inexpensive way to replace fossil energy with renewable energy.

Concerns regarding the potential global environmental impacts of fossil fuels used in power generation and other energy supplies are increasing worldwide. The primary driver of climate change is the emission of greenhouse gases, including carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) that arise from a number of human activities, the primary contributors being deforestation and the burning of fossil fuels for energy generation. Achievement of long term climate change mitigation objectives will ultimately require a transition from fossil fuel energy to renewable and sustainable energy. A number of techniques and methods have been proposed for reducing gaseous emissions of NO_x , SO_x and CO_2 from fossil fuel combustion and for reducing costs associated with these mitigation techniques. Some of these control methods are, however, expensive and increase the overall production costs.

BIOMASS COFIRING : A POTENTIAL OPTION TO A CLEAN FUTURE

One of the key areas of environmental concern globally is power generation in coal power plants. ***Coal fired power plants account for 41% of global electricity, and the importance of coal to electricity generation worldwide is set to continue with coal fuelling 44% of global electricity in 2030.***

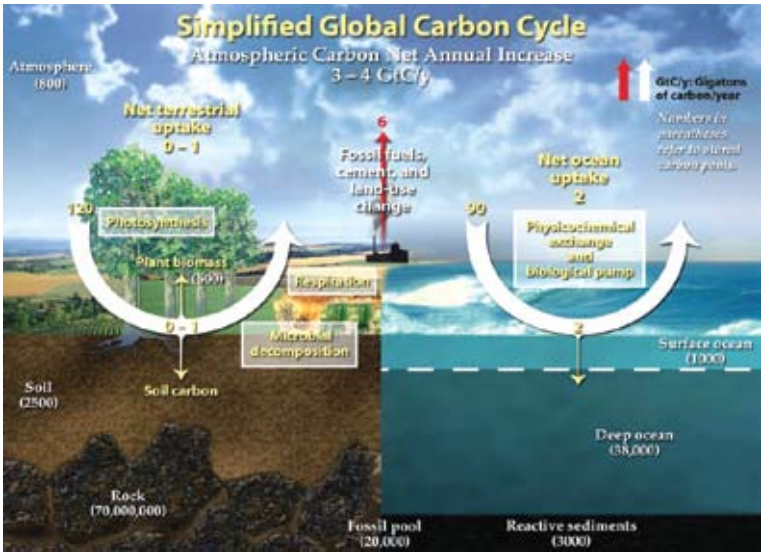
There is an increasing interest worldwide in generation of energy from biomass, as a carbon neutral alternative to coal. Among the quickest and most cost-effective alternatives for large electric utilities producers is the technique of "Biomass cofiring"

Biomass cofiring refers to the simultaneous combustion of a biomass fuel and a base fuel to produce energy, usually electrical power.

"Biomass cofiring" in coal based power plants involves replacing a certain percentage of coal with biopellets, to reduce GHG emissions at source. This technology is emerging as a sustainable model for mitigating environmental degradation due to carbon emissions from large coal based power plants.

This handbook highlights the methodology, benefits and trends across the globe for cofiring biopellets with coal. The technology has successfully moved from engineering studies to parametric tests to long term demonstrations. As it gains acceptance world wide, cofiring technology will address many environmental issues facing the world today.

Worldwide, about 40% of electricity is produced using coal. If only 5% of coal energy is replaced by biomass in all coal-fired power plants, this would result in CO_2 emission reduction of around 300 Mton CO_2 / year.



- A continuous cyclical process in the ecosystem to exchange carbon between biological sources and the environment.
- Carbon dioxide, a form of carbon, is absorbed from the atmosphere by carbon pools (plants and oceans).
- Plants convert carbon to carbohydrates (source of energy) by photosynthesis.
- Carbon is then passed into the food chain and returned to the atmosphere by the respiration and decay of plants, animals and other organisms.
- Cycle repeats itself over a period of 6 month to 2 year.
- Without Greenhouse Gases, Earth would be a frozen world.
  - Carbon dioxide is a Greenhouse Gas & traps heat in the atmosphere.
- However, humans have dumped excess Greenhouse Gas into the atmosphere by burning of fossil fuels.
- The actual Greenhouse Gas level has increased in atmosphere, which has made the planet warmer.
- According to an estimate the current level of carbon dioxide in atmosphere is 819 GtC or 384.8 ppm which is 37% more than 1750 level of 280 ppm.

INTRODUCTION

The scope of cofiring biopellets in utility boilers is significant. Based on the positive results of recent cofiring studies conducted across the globe, coupled with more strict environmental regulations and associated penalties, utilities are seriously adopting the technique of cofiring biopellets with coal in their boilers.

Climate change is one of the biggest threats facing the world today. It has the potential to produce widespread and devastating environmental changes, many of which may be difficult to predict and impossible to reverse. The repercussions of these changes will be far-reaching, with particular effects not only on the environment and the economy, but also on human health and welfare.

COAL FIRED POWER PLANTS: A MAJOR CONTRIBUTOR TO GHG EMISSIONS

Globally power generation emits nearly 10 billion tonnes of CO_2 per year, accounting for about one quarter of total CO_2 emissions. Most of the industrial sources of pollution come from coal fired power plants, necessitating the need to find ways to decrease the greenhouse gas emissions from these sources. The emphasis is on conventional coal-fired utilities to burn renewable fuels such as biomass residues or energy crop-derived biomass fuels. One of the simplest and most cost effective options that merits consideration is the application of cofiring technologies in coal fired power plants.

COFIRING WITH BIOPELLETS

Cofiring is the simultaneous combustion of a supplementary fuel with a base fuel. The most common base fuel is coal. Biopellets are a carbon neutral, renewable fuel source produced using farm residues, left over forest residues and other natural organic stuff, as well as through farming of dedicated energy crops and plants on marginal or wasteland.

Cofiring with biopellets incorporates environmental, socio-economic and larger strategic advantages including

- Lower capital costs for power generation.
- Reduced coal usage without major technology and infrastructural changes.
- Highest electrical conversion efficiencies amongst all biomass power technologies.
- Proven model world wide in installations for most fuel combinations and boiler types.
- A clean, renewable fuel for power plants with reduction in GHG emissions and ash content.
- People friendly alternative that improves hygiene, maintains cleanliness and lowers dust generation.
- Ease of compliance with emission norms as compared to solar and wind technologies.
- Greater employment and income generation opportunities to support rural economies.
- Encourages the formation of a biomass commodity market.

Cofiring with biopellets is, therefore, a long term, sustainable alternative that has the potential to meet the global climate challenge, as well as generate grassroots growth and development for nations.

TABLE 1 : SUMMARY OF CRITERIA FOR SUSTAINABILITY

Social	Economic	Environmental
Labor conditions	Viability in long term	Reduce GHG emissions and use of fossil fuels
Local food and energy supply	Low investment opportunity	Conserve local resources and local environment
Fair Trade	Fit with wider regional economic aims	Meet local renewable energy portfolio and standards of environmental policies

ABOUT BIOPELLETS

Half a kilo of dry plant tissue can produce as much as 1890 kcal of heat which is equivalent to the heat available from a quarter of kilogram of coal.

Biomass is a renewable energy resource derived from numerous sources, such as left over farm residues, left over forest residues and other natural organic stuff, as well as farming of dedicated energy crops and plants. Biomass is the most important fuel worldwide after coal, oil and natural gas.

Biomass is abundantly available on earth in the form of agricultural residues that lie unutilized and can be effectively used for power generation.

BIOPELLETS

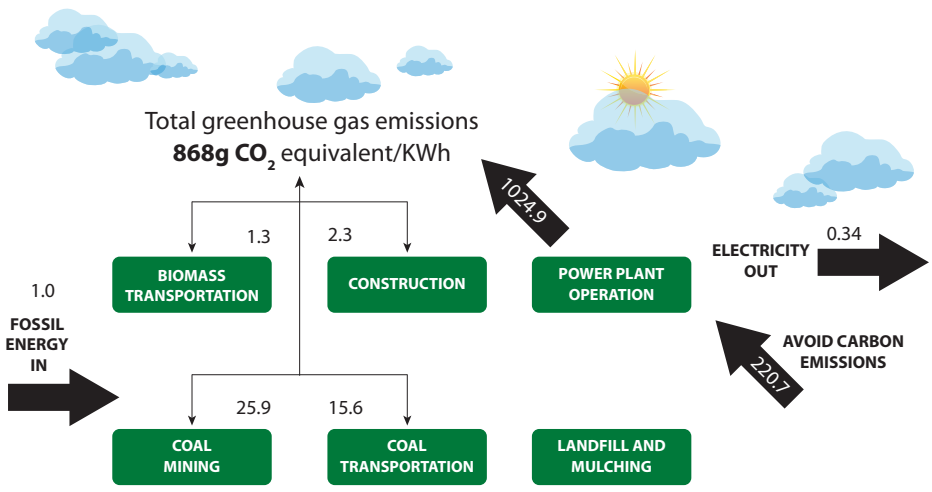
Biopellet is a fuel material that is uniform in size, shape, moisture, density and energy content, produced by drying and compacting different types of biomass. During the production process, biomass is dried in the most efficient way in order to ensure maximum heat generation when it is burned in the boiler.

BIOPELLETS ARE CARBON NEUTRAL

From a chemical perspective, biopellets contain carbon in simple or more complex combinations with other chemical elements -oxygen, hydrogen, etc. Carbon is the base element, which can be burned (by oxidizing it) to produce heat energy, which can thereafter be converted into other types of energy -steam, electricity, etc.

From an ecological point of view, biopellet is an ideal fuel material because it is considered carbon neutral. Using biopellet as an energy source creates a 'closed carbon cycle'. As a biomass energy source grows, CO_2 is absorbed from the atmosphere and when it is burned the same amount of CO_2 stored by the biomass is releasedensuring that the natural carbon cycle balance is maintained. This makes biopellets “carbon neutral.”

LIFE CYCLE CO_2 AND ENERGY BALANCE FOR COFIRING 15% BIOMASS WITH COAL



Coal/Biomass Cofired System
26% carbon closure

GREENHOUSE GAS EMISSIONS REDUCED BY 18%

As opposed to this, fossil fuels like coal are extracted from below the earth, releasing CO_2 trapped beneath the soil, into the atmosphere. As this process continues, there is a CO_2 overload in the atmosphere, which disturbs the natural carbon cycle, and is one of the ulprits behind climate change. Fossil fuels are, therefore, considered to be "carbon negative." Carbon dioxide emissions from the burning of fossil fuels currently account for about 65 per cent of the extra carbon dioxide in our atmosphere. Carbon from biomass is recycled within one year whereas carbon from fossil fuels such as coal takes 9000 to 12000 years for recycling.

BENEFITS OF USING BIOPELLETS

ENVIRONMENTAL BENEFITS

Biopellets V/s Coal & Lignite

Coal is a non renewable source of energy. Burning coal emits harmful gases and waste such as carbon dioxide, sulphur dioxide, nitrogen oxides, sulphuric acids, arsenic and ash, and has led to major environmental impacts like acid rain in some regions.Coal excavation requires a significant amount of energy and it is generally transported from remote locations through long distances, leading to higher carbon emissions.

Lignite causes problems in transportation and storage, due to its high moisture and ash content, and is susceptible to spontaneous combustion. It is also difficult to crush, pulverize, and combust. It has a lower heating value, which means that more fuel must be handled to produce a given amount of power. The high inherent moisture content of lignite decreases boiler efficiency. Its ash characteristics require more attention to soot blowing and boiler operation to maintain high availability and reliability.

Variations in quality parameters of lignite/coal like ash content, moisture, GCV result in efficiency losses and variations in steam pressure. High SPM content is also an area of concern, especially in the case of lignite, and adding to this is the pressure to abide by very strict laws of pollution control boards (Ref Table 2).

Biopellet manufacturing and transportation leads to lower carbon emissions as compared to fossil fuels, as biomass is abundantly available on site and can be easily collected without significant use of energy. Biomass, after collection, is processed in a vicinity of 50-100 kms from the site of cultivation/harvest, which further reduces the carbon emissions from processing. Biopellets are a carbon neutral, environment friendly fuel that provide a comfortable, healthy working environment to the manpower involved in collection, processing, manufacturing and usage.

Carbon Emission Reduction Potential

Biopellet cofiring reduces/displaces fossil fuel use in large coal fired power plants with higher CO_2 emission levels. Recognizing that about 50% of tree mass (on a dry basis) is carbon, tree energy crops represent a significant tool for carbon management - having an additional sequestration component which solar/wind energy do not have.

Reduced GHG Emissions

Cofiring biopellets with coal reduces concentration of GHG emissions by using waste residues,which would otherwise cause carbon dioxide emissions through open burning, or methane emissions through decay. Sustainable use of biopellets also addresses the threats associated with global warming, because they are carbon-neutral and reduce SO_x emissions to significantly lower levels as compared to conventional fuels.

TABLE 2 : BIOPELLETS V/S COAL & LIGNITE

Particulars	Lignite	Indian Coal	Biopellets
Sulphur	0.5-3 %	1.00%	0-0.6 %
Nitrogen	1.30%	1.30%	0-0.5 %
Ash Content	30-40 %	34-45 %	Less than 5 %
Moisture Content	15 %	20 %	Less than 7 %

ECONOMIC BENEFITS

Rural Income & Employment Generation

The use of biopellets as an energy source generates at least 20 times more local employment within the national economy than any other form of energy per unit. This is because a large amount of unskilled labor is engaged in growing, harvesting, processing, transporting and trading the fuels, which generates off-farm income for rural populations, either regularly or off-season. Thus, short term and long term employment is created through project activities associated with biomass energy.

There is also an opportunity for revenue generation for suppliers of agro residues viz., small-scale industries and farmers, which enhances development of the region and uplifts the local economy. It also fosters a sense of self reliance in local and rural communities and empowers them to a great extent.

Money Velocity within the Region

The most compelling principle of using biopellets in cofiring is that, since biomass is cultivated regionally, there is never a monetary drain on a town, city or country. Regional waste problems are addressed and supply is tailored to local needs.

Energy Efficiency V/s Wind & Solar

The average PLF for biomass power projects is much higher as compared to solar and wind, resulting in a significantly higher efficiency of power generation (Ref Table 3).

This means that for 1MW power to be generated, biomass stand alone or existing coal fired power plants (where cofiring needs to be done) need to have an installed capacity of 1MW, asthe PLF is 0.8.

In wind and solar power, the installed capacity needs to be as high as 4 MW or 5 MW as the PLF is very low, 0.2 and 0.15, respectively.

STRATEGIC BENEFITS

Investment & Benefits within Nation

Biomass based power generation requires comparatively less investment in technology than solar and wind energy, which are highly capital-intensive technologies. This allows for local industry investments, and larger benefits to the nation in the form of enhanced income and employment generation opportunities.

Increased Energy Security

Local availability and reliability of supply is one of the key advantages of biopellets. Modern applications have demonstrated that biopellet energy can be competitive for large-scale industrial applications. For fuel importing countries, the use of local biomass can save substantial amounts of foreign exchange and reduces dependence on other countries for conventional fuels.

Biomass co-firing is gaining increasing attention from both utilities and regulatory stakeholders. It offers renewable energy generation with low capital costs and takes advantage of the high electrical efficiencies of today's coal power plants.

TABLE 3 : BIOENERGY V/S WIND & SOLAR
COMPARISON BASED ON 1MW THERMAL POWER PLANT

Renewable Energy Technologies	Plant Load Factor	Installed Capacity required for 1 MW generation	Investment required per MW (in crores)
Cofiring with biopellets	80 %	1 MW	Nil / Negligible
Biopower (Stand alone)	80 %	1 MW	5.5
Wind	20 %	4 MW	26
Solar	15 %	5 MW	90

One of the fastest and easiest ways to increase the share of renewables is by replacing fossil fuels with biomass, and the cofiring of biomass fuels in mainly large coal-fired units, and thereby replacing part of the coal, has been adopted all over the world over the past few years.

ABOUT COFIRING

Cofiring can be done in existing power plants with little or no modifications, allowing for comparatively inexpensive technologies and resulting into rapid reductions in greenhouse gases and local pollutants like SO_x, NO_x and SPM.

Besides their potentially harmful effect on the environment, which is well documented, fossil fuels are also a scare resource, and the world is constantly looking for less harmful, more cost effective, and abundantly available renewable energy alternatives, that can replace fossil fuels in energy generation.

Biomass is a widely available resource that can be a powerful substitute for fossil fuels. Cofiring biopellets and coal is a win-win combination that offers several key advantages.

- Cofiring can be done in existing power plants with little or no modification, allowing for comparatively inexpensive and rapid reductions in greenhouse gases.
- It takes advantage of the high efficiencies obtainable in coal-fired power plants.
- It also maintains fuel diversity ,which reduces the need for a constant supply of biopellets that would be required in a stand alone biomass power plant.

COFIRING HELPS MEET RENEWABLE POWER PURCHASE OBLIGATION (RPPO) NORMS

Different strategies are promoting renewable energy sources for power generation globally. Biomass is a strong contender for renewable energy across the world.

In India too, power sector reforms are underway and the Indian government is promoting renewable energy as a tool to control energy-related GHG emissions.

The Renewable Power Purchase Obligation (RPPO) clearly sets a mandate for including the contribution of renewables to electricity generation.

The Ministry of Non-conventional Energy Sources is targeting the addition of a 10% share, i.e., 10,000 MW, from renewables to the country's power generation capacity by 2012 (Source : Policies for propagation of renewable power generation in Europe and India, Mahesh Vipradas, Article from OPET-India)

As cofiring needs less capital investment and less technological modifications, it emerges as a credible renewable technology and is the quickest and most cost effective option to help the country meet its RPPO norms.

Cofiring biomass with coal in traditional coal-fired boilers represents one combination of renewable and fossil energy utilisation that derives the greatest benefit from both fuel types ...while requiring only a relatively modest investment.

COFIRING WITH BIOPELLETS VIS-À-VIS LOOSE BIOMASS

Cofiring biomass in a dense pelleted form, known as Biopellets, offers a lot of advantages such as ease in handling, convenience in use, proper combustion and efficient transportation.

Instead of burning the loose biomass fuel directly, it is more practical to compress it into pellets (compressing them through a process to form blocks of uniform shapes) and thereby improve its utility and convenience of use. Biopellets can also be used directly as fuel instead of coal in the boilers.

BIOPELLETS V/S LOOSE BIOMASS

Biopellets are uniform in size, shape, moisture, density and energy content. During its production, biomass is dried in the most efficient way in order to ensure maximum heat generation when it is burned in the boiler. As opposed to this, when burning wet biomass, additional energy is consumed during the burning process to dry the biomass, thereby increasing the total fuel material consumption and decreasing heating efficiency.

Due to the high density of biopellets, they can be handled more easily and predicatably in large-scale applications. They also allow for a smaller and simpler conveying system that reduces costs and supports free flow of the biomass fuel through the conveyor system.

There is no technology upgradation required in terms of capacity enhancement for biopellets, whereas with loose biomass, it is important to consider the possibility of deterioration of capacity due to use of less densified fuel, which may require additional investments in capacity enhancement.

Biopellets reduce the actual fuel consumption because of proper combustion in the furnace area, thereby increasing the efficiency of the system. It is convenient for continuous mechanical feeding operation and there is an increase in the life of the boiler.

The high density and uniform shape of biopellets enables their storage in standard silos. Less storage space is required due to piling of standard sized bags, resulting in savings in storage space and manpower costs, as well as optimal utilization of space. In contrast, loose biomass requires more space due to irregular shaped packaging and piling of bags, leading to increased storage and manpower costs. Biopellets are also more efficient to transport than loose biomass, because no slack, air and water is being transported.

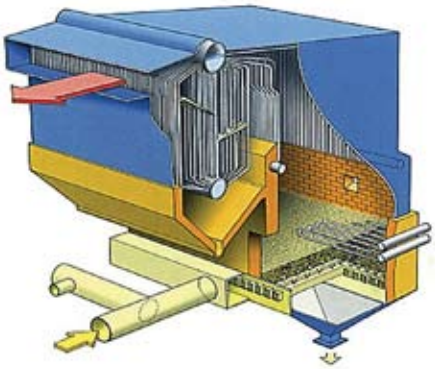
TABLE 4 : COMPARISON OF LOOSE BIOMASS WITH BIOPELLETS

Properties	Loose Biomass	Biopellets
Moisture Content	High	Low
Flammability	High	Low
Bulk Density	Very low	High
Ash Content	Moderate	Relatively less due to pretreatment
Particle Size	Irregular	Regular

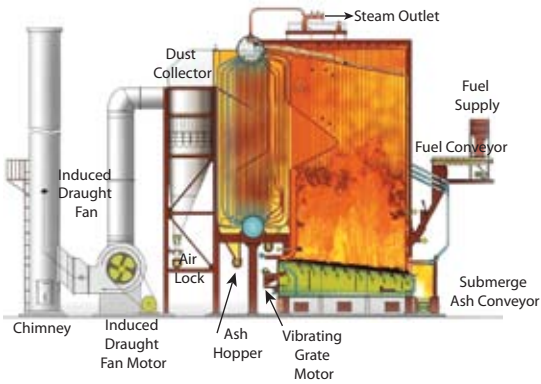
COMBUSTION TECHNOLOGIES

Various combustion technologies are being used, based on the type of fuel and availability. Biopellets are compatible for use in all kinds of combustion technologies without major issues. The key types of combustion technologies include...

1. FLUIDIZED BED COMBUSTOR (FBC)

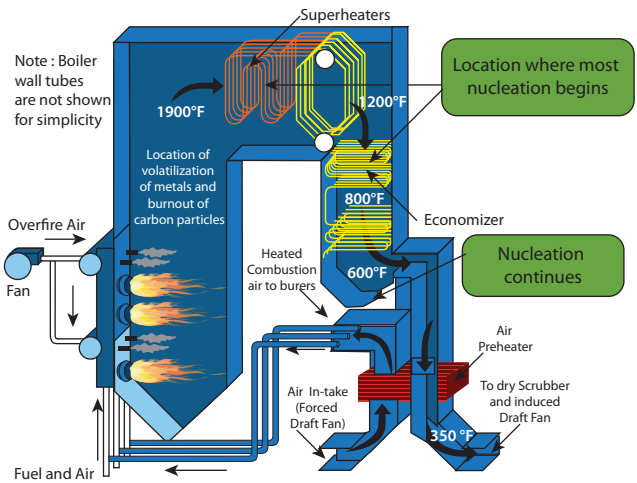


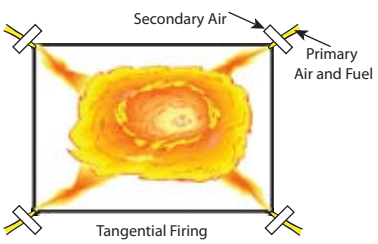
2. GRATE COMBUSTOR



3. PULVERIZED COMBUSTOR

In case of pulverized boilers, the grindability index of biopellets is a critical aspect . To produce pulverized boiler compatible biopellets, adequate care needs to be taken to ensure that the raw material is ground before pelletizing, in line with the pulverized technology.





Degree of cofiring, or coal-biopellet blend ratio, is also impacted by the type of combustor, a topic that has been discussed at length in one of the subsequent sections of this handbook (ref. page 13).

METHODS OF PREPARATION OF COFIRING WITH BIOPELLETS

Currently, direct cofiring is the most popular option for cofiring biopellets with coal , primarily due to relatively low investment cost of turning existing coal power plants into cofiring plants.

The concept of cofiring is quite simple. It consists of the use of two or more fuels inside the same combustion device. There are four approaches through which the fuel can be blended and fed to the combustion systems in cofiring, as shown in Fig 1.

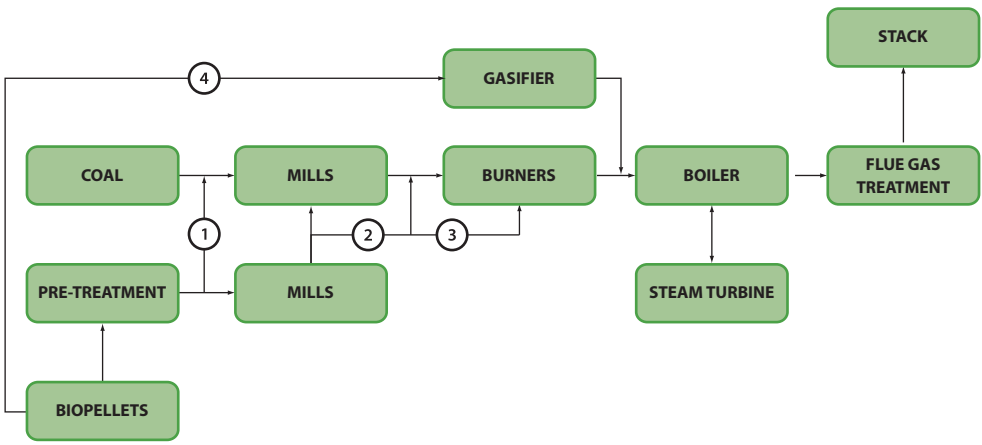


Fig. 1

1. CO-MILLING OF BIOPELLETS WITH COAL

This approach consists of blending biopellets with coal, together in the existing coal mill. Therefore, an additional dedicated biopellet mill is not required. Biopellets and coal are then burned together in the same furnace. It is the simplest, most cost-effective, and most common form of cofiring.

2. SEPARATE MILLING, INJECTION IN PF-LINES, COMBUSTION IN COAL BURNERS

This approach involves installing dedicated mills for coal and biopellets in the feedline, before the blend is burnt in the coal burner.

3. SEPARATE MILLING COMBUSTION IN DEDICATED BIOPELLETS BURNERS

This approach involves a completely separate feed line for the biopellets fuel, with separate handling, milling and burners/injectors. Although this is more expensive to install, it allows for greater flexibility of handling and processing the biopellets with less potential for adversely affecting the primary coal stream.

4. BIOPELLET GASIFICATION, SYNGAS COMBUSTED IN FURNACE BOILER

In this option, biopellets are gasified (or combusted) separately and the produced gas and coal are injected and burned in the coal boiler.This technique keeps the biopellet ashes separated from the coal ashes, while allowing very high cofiring ratios.

DEGREE OF COFIRING OR COAL-BIOPELLET BLEND RATIO

Cofiring biopellets and coal in the correct percentages takes advantages of high efficiencies obtainable in coal-fired power plants and also reduces the emission of greenhouse gases and other pollutants because of fundamentally different fuel properties of both the fuels.

Degree of cofiring is a function of various elements including

- Mineral impurities in biopellets
- Ash fusion temperature
- Chloride content of biopellets
- Sulphur content of coal/lignite
- Type of boiler
- Combustion temperature
- Steam parameters
- Emission reduction targets

GUIDELINES FOR DEGREE OF COFIRING

- At combustion temperatures between 700°C to 850°C, fossil fuel can be reduced to the maximum level.
- If the chloride content is relatively higher due to the mixture of ingredients in biopellets, and the expected steam temperature is above 400°C, then the degree of cofiring will depend on the sulphur content in fossil fuels.
- If the chlorine to sulphur ratio is above 4, then there are no issues with blend ratio, irrespective of the expected steam temperature. In fact, this greatly minimizes the negative impact, of both chloride in biopellets and sulphur in fossil fuels. Thus, burning both the fuels in the correct proportions can help neutralize their negative impact.
- The sulphur present in fossil fuels reacts with the alkali content in biopellets and converts it into various sulphates, which go into the resulting ash, instead of being released into the atmosphere in the form of SO_x emissions. This helps in lowering the stack flue gas temperature, and also reduces the formation of acid rain, as well as improving the overall efficiency of combustion.

TABLE 5 : THERMAL PROCESSING OF WOOD / BIOMASS / AGRI WASTE

Process / Parameters	Drying	Torrefaction (Roasting)	De volatilization (Pyrolysis)	Gasification	Combustion
Temp.(°C)	80-140	140-350	350-650	650-900	800-900
Volatiles (2) remaining	100%	75% - 90%	0-15%	0%	0%
Fixed Carbon remaining	100% FC	100% FC	90 –100%FC	0 –10% FC	0% FC
Process Oxygen	Low	0% O_2	Sub-stoichiometric O_2	Sub-stoichiometric O_2	Excess O_2
Fixed Carbon remaining	100% FC	100% FC	90 –100%FC	0 –10% FC	0% FC
Off-Gas	Water Vapor	Some CO, CO_2 , Organic Acids	$CO/CO_2/H_2/C_xH_y$	$CO/CO_2/H_2/C_XHy$	$CO_2 + H_2O$
Solids	Dry product	• Roasted product (smokeless fuel) • Embrittled & hydrophobic	• Char product • Most volatiles driven off • FC & ash remains	• Ash product • Low residual FC	• Ash product

Depends on Ash Characterization
As per Proximate Analysis

Source : Torbed, Topell

EMISSION REDUCTION WITH COFIRING

Cofiring biopellets with coal has the capability to reduces both NO_x and SO_x levels in addition to reducing overall CO_2 emissions as biopellets are carbon neutral.

Cofiring of biopellets with fossil fuels is a means to reduce CO_2, NO_x and SO_2 emissions. Every tonne of biopellets cofired directly reduces CO_2 emissions by over a tonne.

NO_x reduction is due to strengthening of reactions reducing NO in the furnace and/or lower nitrogen content in biopellets. The SO_2 reduction results both from substituting a sulphur-bearing fuel for a sulphur-deficient one, and a calcium-deficient fuel for a calcium-bearing one.

REDUCING NO_x EMISSIONS

In chemical terms, nitrogen oxides should constitute all oxides of nitrogen (N_xO_y), including nitric oxide (NO), nitrogen dioxide (NO_2) and nitrous oxide (N_2O). NO_x is generally defined as the sum of NO and NO_2. NO is the main contributor of NO_x in both pulverized fuel and fluidized bed combustion.

Because biopellet has a high volatile and hydrogen content, it can be successfully applied in NO_x reducing procedures such as air staging and re-burning. In contrast to the situation with pure coal flames, coal/biopellet blends and air staging, help attain low NO_x emissions under fairly air-rich conditions. In re-burning, biopellet is superior to bituminous coal as a reducing fuel with regard to both emissions and burnout. Reduction is based on reactions between hydrocarbon radicals and NO.

REDUCING SO_x EMISSIONS

SO_2 emissions invariably decrease during biopellet cofiring, often in proportion to the amount of biopellet used, as most types of biopellet contain far less sulphur than coal. The reduction can be even higher due to interaction of fuel constituents of different origin, i.e., biopellet and coal. The sulphur present in fossil fuels reacts with the alkali content in biopellets and converts it into various sulphates which go into the resulting ash, instead of being released into the air in the form of SO_2 emissions.

Based on sound science and engineering, biopellet fuel co-utilization with coal can achieve SO_2 , NO_x , and CO_2 reduction benefits, comparable with, or even exceeding that of renewable energy technologies such as wind or solar power.

BIOPELLET COFIRING ACROSS THE WORLD

In many countries, cofiring has been promoted within the 'Renewables Obligation' as a relatively low cost means of increasing renewable energy generating capacity.

Worldwide, biomass is the **fourth most used energy source,** commonly used for heating, transportation, cooking and power generation.

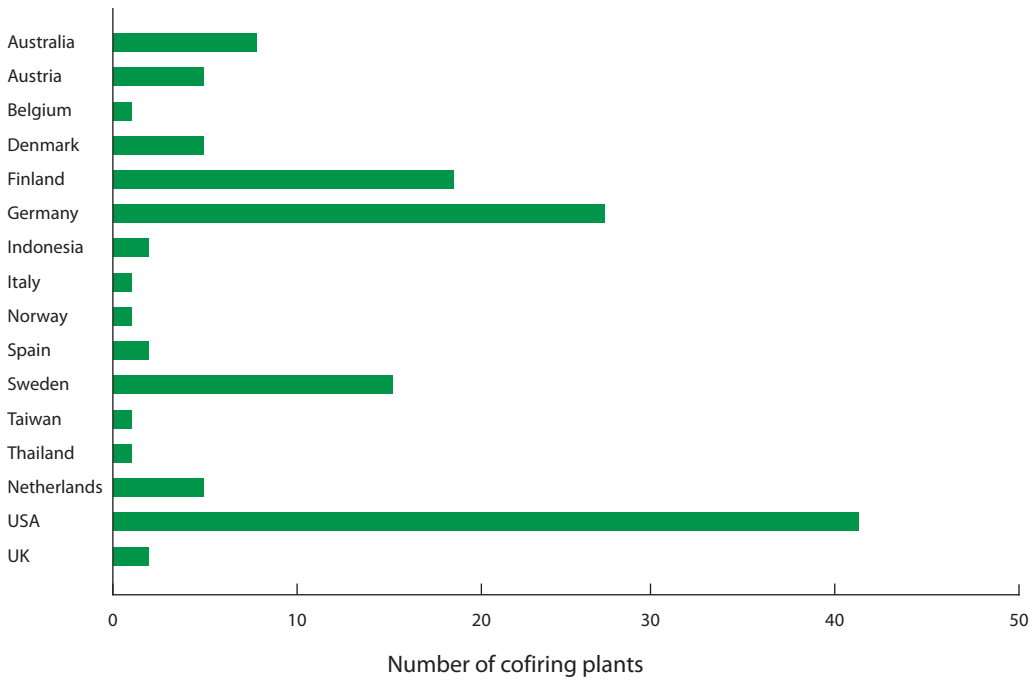
Port Talbot in the UK has been commissioned to become the world's largest biomass power station in 2010. The plant is expected to provide energy for over 550,000 homes. Where a 40 MW plant is considered to be average size, Port Talbot will be a 350 MW plant.

Swedish energy major Vattenfall, for instance, recently announced a major investment program worth more than €4 billion to develop projects to increase annual renewable generation by the company by approximately 10 TWh by 2016. Of this, biomass projects are expected to contribute 0.5 TWh.

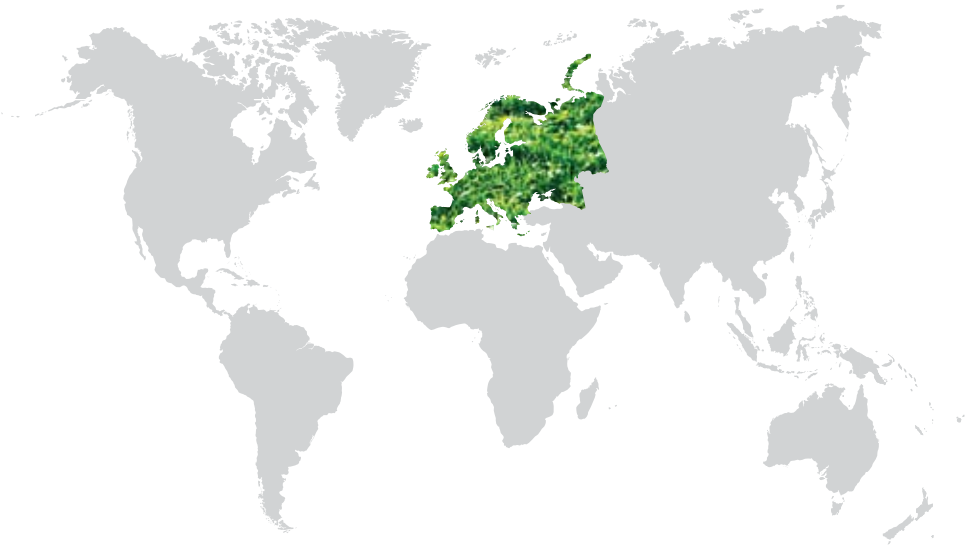
While today only a few coal plants use cofiring with biomass, it is projected that ***biomass plants and cofired plants have the potential to be the greatest renewable resource by the year 2030*** if there is an increase in plant development. Cofiring plant development is dependent upon location, plant type and biomass fuel price.

Cofiring has been demonstrated successfully in over 150 installations worldwide for most combination of fuels and boiler types

COUNTRIES THAT HAVE ADAPTED TO COFIRING



BIOPELLET COFIRING IN EUROPE



EUROPEAN UNION

COFITECK project - EU project which disseminates knowledge about cofiring biomass with fossil fuels in the central and eastern European countries There has been an increase in annual cofiring electricity production from around 620 GWh in 2004 to 2126 GWh in 2007.

Cofiteck Project

Szczecin and Konin power plant uses 50% biomass with Lignite for cofiring Ostroleka plant - cofiring is done in pulverized coal Fired boilers, grate boilers and fluidized bed boilers.

Szczecin and Konin Power Plant

GERMANY

Essent Energie's power plant cofires biomass with coal since 2004. Their ultimate aim is to fire 2 million tonnes of biomass, replacing upto 20% of fired coal. It is an ultra modern cofiring power station with a net capacity of 1070 MW and it will be the world largest cofired plant.

Essent Energie Power Plant

DENMARK

Europe Vattenfall, 4th largest electricity producer, has decided to replace 7,24,000 tons of coal per year with biomass resulting in reduction of 1.5 Million tons of CO_2 being released into the atmosphere.

All units at the company's large plants will be biomass fueled-either 100% or in combination with coal.

Europe Vattenfall Power Plant

BELGIUM

Belgium has committed itself to reduce the greenhouse gas emissions by 7.5% by 2012 by using biopellets.

Electrabel has two plants -

- Rodenhuize power plant
- Les Awirs power plant

The capacity of both plants together is about 2500 tons of wood pellets per day or 700000 tons per year

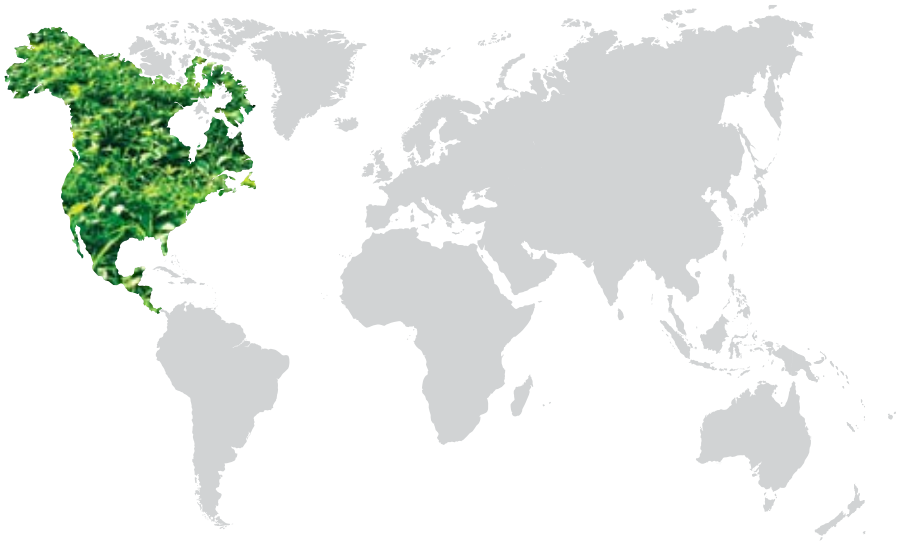
Electrabel Power Plant

POLAND

Polish Power Group (PGE) started using biomass since 2004 and has gradually increased production of green energy. The company targets around 4.0 TWh/annum energy be produced from biomass pellets before 2012.

Polish Power Group

BIOMASS PELLET COFIRING IN NORTH AMERICA



During the 1990s, electric utilities across the country implemented biopellets cofiring demonstrations and commercial operations. Extensive demonstrations and tests also confirmed that biomass energy can provide as much as 15% of the total energy input with only feed intake system and burner modifications. In the U.S., thirty percent of carbon dioxide emissions are generated by utilities and industry.

The U.S. economy uses biomass-based materials as a source of energy in many ways. In the electricity sector, biomass is used for power generation. By 2020, United States is estimated to have a maximum of 7.1 quadrillion Btu of biomass available at prices of $5 per million Btu or lower. Agricultural residues, forestry residues, and urban wood waste/mill residues are currently available. EIA also assumes that energy crops can become available on a commercial basis beginning from 2010.

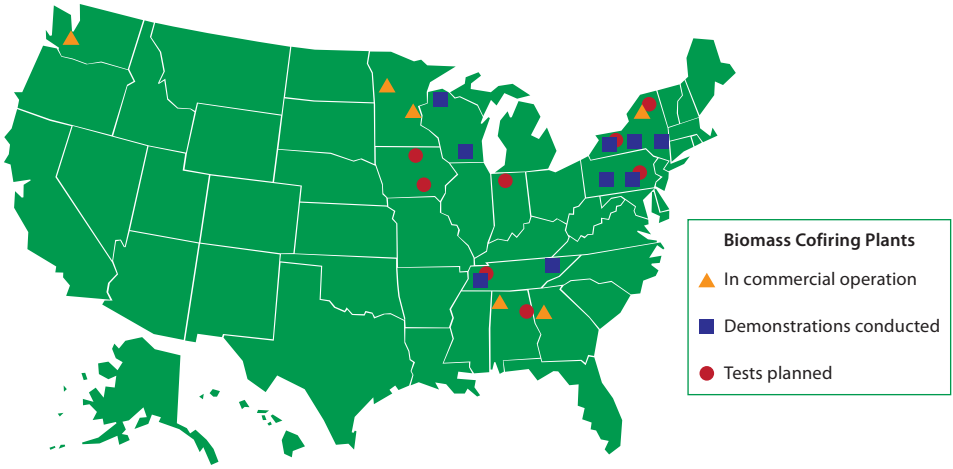
The opportunities for biomass are great because large scale coal-powered boilers represent 310 gigawatts of generating capacity. It has been demonstrated, tested, and proved in all boiler types commonly used by electric utilities. There is little or no loss in total boiler efficiency after adjusting combustion output for the new fuel mixture. This implies that biomass combustion efficiency to electricity would be close to 33%-37% when with coal.

BIOPELLETS FOR ELECTRICITY GENERATION

Biopellets cofiring is an opportunity for consumers and power companies. Recent polls in US have found that consumers are willing to support renewable energy programs with a higher price for electricity made from renewable sources. Thus, cofiring with biopellets can simultaneously provide a service to industrial customers and renewable energy for environmentally conscious electricity consumers.

Many researchers see biomass pellets cofiring as the most feasible answer for radical reduction of industrial CO_2 output.

BIOMASS POTENTIAL AS A PERCENTAGE OF TOTAL GENERATION



CANADA

Ontario Power Generation (OPG) has announced that it will replace all of its coal fired facilities with biopellets in the coming 5 years.

Ontario's plan to end coal fired generation will reduce Ontario's CO_2 emissions by upto 30 megatonnes.

In 2008, OPG ran their first no coal wood pellet test successfully producing 4 million KWh in their Naticoke plant, which displaced 4700 tons of CO_2

Ontario Power Generation

Diverse European countries have proven the promotion of cofiring as a key for the development of biomass markets along with the creation of expertise on biopellets, handling and combustion

RECOMMENDATIONS FOR SPECIFICATIONS OF BIOPELLETS

High calorific value - 4100 kcal/kg ± 2%

Low moisture content < 7%

Ash content < 5%

Low SO_x emission ≤10kg/tonne

CONCLUSION

Cofiring biopellets with coal represents a cost effective, low-risk, sustainable renewable energy option that promises effective reduction in GHG emissions including CO_2 emissions, SO_x and NO_x emissions, and offers several societal benefits.

It is an easily implementable technology for efficiently and cleanly converting biomass to electricity by adding biomass as a partial substitute fuel in high-efficiency coal boilers. It has been demonstrated, tested, and proved in all boiler types commonly used by electric utilities. There is little or no loss in total boiler efficiency after adjusting combustion output for the new fuel mixture. This implies that biomass combustion efficiency to electricity would be close to 33%-37% when cofired with coal. Extensive demonstrations and tests also confirm that biomass energy can provide as much as 15% of the total energy input with only feed intake system and burner modifications.

Cofiring with biopellets carries a great deal of promise as a potential "bridge-technology," for reducing overall fossil fuel use. However, it is important that cofiring serves as a stepping stone to a renewable energy future and not simply as a means to build new coal facilities or to keep outdated and inefficient power plants in operation. Cofiring with biopellets backed by an effective and responsible policy framework, could prove to be a vital tool in the effort to reduce global carbon emissions locally, nationally and internationally.

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November 19, 2009

CO_2 Reductions

Let's fight it with Biopellets

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