Bio-mass Power Generation and its challenges especially in reference to Co-firing in Coal based Thermal Power Plants

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SYNOPSIS

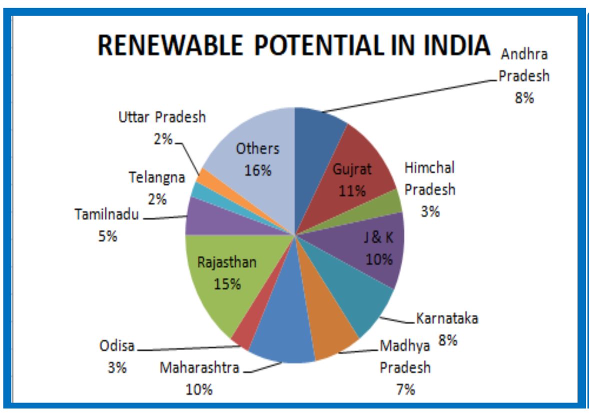
In India, majority of power generation is through coal-based thermal power plants. Thermal-based generation gives rise to carbon emissions, Sox, Nox emissions, along with suspended particulate matter, thereby polluting the environment. As per the Paris Agreement 2015, India is now prepared to march ahead towards zero carbon emissions through the penetration of renewable energy into the national grid.

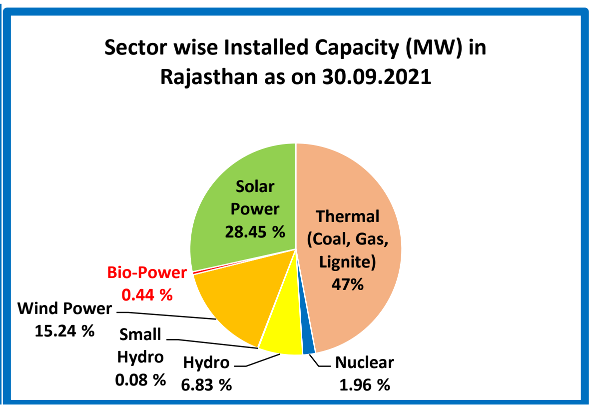
The stubble burning by farmers also plays a major role in air pollution across the country to a great extent. The air pollution level rises after the Kharif harvest season in autumn and winter, especially in the NCR region. Thus, to keep a check on the fast depletion of coal reserves in India, the vision of reducing carbon footprints and power generation using biomass is gaining importance along with solar, wind, and hydro power generation. The Ministry of Power, Government of India, has issued a revised policy for biomass utilization through co-firing in coal-fired thermal power plants, vide circular no. 11/86/2017-Th, II dated 08.10.2021.

The largest power markets within India are the states of Maharashtra, Uttar Pradesh, Madhya Pradesh, Chhattisgarh, Gujarat, Tamil Nadu, West Bengal, Andhra Pradesh, Rajasthan, and Karnataka. Rajasthan State has immense potential for electricity generation through renewable energy sources and wind power. Rajasthan is the largest renewable energy producer in India.

Hydro and Gas based power generation in Rajasthan is very low, so the state is consistently enhancing the renewable power generation to achieve the zero-emission target along with meeting the increased power demand. Bio-Mass-based generation will also add to the contribution in this regard.

The percentage contribution of renewable potential of India and various modes of power generation in Rajasthan is as under:





What is Biomass?

Biomass is plant or animal material used as fuel to produce electricity or heat. Examples are wood, crops, and waste from forests, yards, or farms. Biomass has always been an important energy source for the country considering the benefits it offers.

Stubble is the straw-type material that remains after grains, like paddy, wheat, etc., have been harvested. This stubble is a good biomass resource that has the potential to create efficient biomass-to-energy chains.

Torrefaction of biomass stubble, combined with densification (pelletisation or briquetting), is a promising step towards overcoming the logistical challenges in developing large-scale sustainable energy solutions through biomass by making it easier to transport and store.

Pellets or briquettes have higher density, contain less moisture, and are more stable in storage than the biomass they are derived from. When agro residue-based fuel, in the form of pellets, is utilized in coal-fired power plants, it burns completely in the power plant, and ash emitted from its combustion gets absorbed in an Electrostatic Precipitator (ESP), which prevents air pollution while generating power from it.

Benefits: It is renewable, widely available, carbon-neutral and has the potential to provide significant employment in rural areas. It is also capable of providing firm energy. About 32% of the total primary energy used in the country is still derived from biomass, and more than 70% of the country’s population depends upon it for its energy needs.

Biomass power & cogeneration programme: The Ministry of Power, Government of India, issued the Policy of Biomass Utilization for Power Generation through Co-firing in Pulverized Coal-Fired Boilers in November 2017, requiring generating utilities to use a 5-10% blend of biomass pellets of agro-residue along with coal.

Further, in Oct-2021, MoP modified the policy wherein it was stated that coal-fired TPPs in India must mandatorily co-fire biomass with coal in their power plants.

Biomass co-firing has gained pace after the announcement in the Union Budget-2022, mandating 5-10% co-firing at every TPP in the country.

For efficient utilization of biomass, bagasse-based cogeneration in sugar mills and biomass power generation have been taken up under the Programme. Biomass materials used for power generation include rice husk, straw, cotton stalk, coconut shells, soya husk, de-oiled cakes, coffee waste, jute wastes, groundnut shells, saw dust etc.

With the objective of promoting technologies for optimum use of the country's biomass resources for grid power generation, a national mission called SAMARTH (Sustainable Agrarian Mission on use of Agro-residue in TPPs) has been setup by MoP, which estimates that around 95000-96000 tonnes of biomass pellets are required per day for co-firing.

The Standard Operating Procedures (SOP) for Biomass Pellet Co-firing have already been established by the mission for Handling, Storage, and Blending of Biomass.

What is Biomass Co-firing?

Biomass co-firing is the practice of substituting a part of the fuel with biomass at coal thermal plants. Biomass co-firing stands for adding biomass as a partial substitute fuel in high efficiency coal boilers. Coal and biomass are combusted together in boilers that have been designed to burn coal. For this purpose, the existing coal power plant has to be partly reconstructed and retrofitted. Co-firing is an option to convert biomass to electricity, in an efficient and clean way and to reduce GHG (greenhouse gas) emissions of the power plant. Biomass co-firing is a globally accepted, cost-effective method for decarbonizing a coal fleet. India is a country where biomass is usually burnt on the field which reflects apathy towards resolving the problem of clean coal using a very simple solution that is readily available.

Significance: Biomass co-firing is an effective way to curb emissions from open burning of crop residue. It also decarbonizes the process of electricity generation using coal. Substituting 5-7 % of coal with biomass in coal-based power plants can save 38 million tonnes of carbon dioxide emissions. It can help cut emissions from the combustion of fossil fuels, address India’s burgeoning problem of farm stubble burning to some extent and reduce waste burden while also creating jobs in rural areas. India has large biomass availability as well as rapid growth in coal-fired capacity.

Average calorific value of biomass: Mustard Crop Residue and Juliflora are major biomasses being utilized by the power plant. The average GCV in Kcal/Kg and moisture level for Mustard Crop Residue and Juliflora are tabulated below.

Biomass	Average Moisture (%)	GCV (Kcal/Kg)
Mustard Crop Residue	10 to 12	3353
Prosopis -Juliflora	35 to 40	2845

Specification of Pellets-

- Base material- agro residue/ crop residue
- Maximum diameter -25mm.
- fines% (length less than 3mm) wt less than or equal to 5% fineness
- Gross calorific value Kcal/kg-min 2800 Kcal/kg
- Moisture wt % not more than 14 %
- Particle Size dist.- Wt% passing proportion from 1mm mesh size sieve -75%
  -Wt% passing proportion from 3mm mesh size sieve -100%

Comparison of coal and biomass parameters:

Parameter	Coal	Biomass Pellets (Paddy straw)
Carbon content	34-35%	10-15%
Volatile content	20-21%	60-66%
Ash content	38%	15%
Moisture	6%	8%
GCV	3500 Kcal/Kg	3650 Kcal/kg
Alkali content (K, Na)	-	6-8%
Chlorine content	0.05-0.08%	0.8-1.5%
Density	833 kg/m3	700 Kg/m3
Ignition temperature	454 C	240 C
Grind ability index	70-80	Fibrous
Particle type	Brittle	
Ash Fusion Temp.	1150 C	850-900 C
Ash resistivity	Moderate	High
Cost		10-20% more than coal

Source: NTPC & CEA compilation

Biomass power- Need of the hour

Current Scenario:

According to IEA data, bioenergy and waste are the largest sources of renewable energy in India's primary energy supply (21% of total primary energy supply (TPES), the third-largest energy source in India). However, more than two-thirds of India's bio-energy consumption comes from traditional use of biomass in the residential sector, resulting in negative environmental and health impacts.

The GoI has introduced policies promoting modern and clean use of bioenergy in households as well as the replacement of the traditional use of biomass with alternative cooking and heating fuels, both renewable (solar cooking) and non-renewable (such as LPG).

About 15 nos. of bio-mass power plants were installed in Rajasthan, having a capacity of 105.45 MW, out of which 3 major plants having a capacity in the range of 8-20 MW has stopped its operation.

Infrastructure and Technical Viability Check for Biomass Co-firing Implementation at coal-based Power Plants-

Substituting 5-7% of coal with biomass in coal-based power plants can save 38 million tonnes of carbon dioxide emissions, but the existing infrastructure is not robust enough to turn this into reality.

To implement the concept of co-firing coal with bio pellets, the following observations are to be taken into consideration so that the safe and economical operation of thermal plants is ensured:

1. Availability, transportation, and storage of biomass.
2. Feasibility of co-firing; technical modification/retrofit requirements in various areas.
3. Fire and safety requirements.
4. The impact of per unit cost on power generation.
5. Advantages and disadvantages.

1. **Availability, Transportation, and storage of Biomass:**
   - The biomass pellet must be stored in a dry place and any water should not be in contact with the pellet before it reaches to the mill. Only pellets with up to 14% of moisture can be used for combustion along with coal.
   - Handling and Shifting of Biomass Logistic problems in procurement, storage, and handling of biomass fuels. Ensuring biomass quality as dust and moisture can affect operation of the plant. Plants require regular cleaning to remove choking in the plant caused by the dust in the fuel. Minimize losses due to transportation, handling, storage, and wind/storms in the region.
   - At present, biomass pellets are not easily available on the market in bulk quantity.
   - Around 95,000-96,000 tonnes of biomass pellets are required per day for co-firing, but India's pellet manufacturing capacity is 7,000 tonnes per day at present, despite a surplus of 228 million tonnes of agricultural residue available in the country.
   - This is because the pellet suppliers favor selling their product to textile, food processing, metal-based industries or in the open market at Rs 12-13 per kg (even higher in some states) instead of supplying it to thermal power plants, which offer a price of around 8-9 Rs per kg. In 2021 NTPC-Dadri procured these pellets at 5.35 Rs. per kg. This huge gap is due to the seasonal availability and unreliable supply of biomass pellets to the utility.

2. **Feasibility of co-firing; Technical modification/retrofit requirements in various areas:**

   a. The biomass pellets are eco-friendly fuel made from different types of leftover green waste and have low ash content and high VM. The list of bio-mass pellets along with ash content, VM, and GCV made from different types of raw material is:

Particulars	Wood chips	Wood pellets	Torrefied wood pellet	Charcoal	Coal
Moisture content wt.%	30-55	7-10	1-5	1-5	10-15
Calorific value, LHV, MJ/k	7-12	15-17	18-24	30-32	23-28
Volatile matter wt.% db	75-84	75-84	55-65	10-Dec	15-30
Fixed carbon wt.% db	16-25	16-25	22-35	85-87	50-55
Bulk density kg/l	0.20-0.30	0.55-0.65	0.65-0.80	0.18-0.24	0.80-0.85
Vol. energy density (GJ/m3)	1.4-3.6	8-Nov	Dec-19	5.4-77	18-24
Hygroscopic properties	Hydrophilic	Hydrophilic	(Moderately Hydrophilic)	Hydrophilic	Hydrophilic
Biological degradation	Fast	Moderate	Slow	None	None
Milling requirements	Special	Special	Standard	Standard	Standard
Product consistency	Limited	Limited	High	High	High
Transport cost	High	Medium	Low	Medium	Low

   b. As per trials conducted by NTPC, Tanda, for bio-mass blending, it is recommended that bio-mass pellets feeding should be done through an emergency feeder in a controlled manner by adjusting the rack and pinion gate and blending with coal coming from the track hopper at TP. The blending ratio of 5-10% (as per heat value) needs to be maintained.

   c. Due to the low ignition temperature and high volatile matter of biomass, the fire safety in the milling system is to be ensured by taking the following measures: -

   - Mill PA (Primary Air) temperature should be maintained below 170° (for coal > 240°) to achieve mill classifier outlet temperature below 65° (for coal 75°)
   - As a modification, a steam inerting system (from PRDS steam) should be introduced to allow automatic quenching of accidental fire.
   - Proper display, alarm, and protection systems for biomass operation are to be introduced in the C&I system to protect the mill system from fire and ensure operations from control room in automatic mode.

   d. Operational strategies to be adopted:

      i. **CHP Operation:**

      - Biomass pellets will be fed into the emergency feeder in a controlled manner by adjusting the rack and pinion gate and blending with coal from the track hopper at the TP. The blending ratio of 5-10% (as per heat value) needs to be maintained.
      - Feeding is to be done only along with coal, as the pellets are highly inflammable due to their high VM content. Suitable conveyor interlocks should be modified.
      - To minimize fire hazards, conveyor streams and chutes used for pellet firing must be thoroughly emptied after feed operations.
      - Biomass storage areas should have firefighting facilities.

ii. **Mechanical Maintenance:**

- Steam inerting valve in mill servicing to be done and making it motorized for remote operation.
- The fire-fighting system is to be strengthened near Bunker and Mill during biomass co-firing.
- Lighting arrangement in side feeder to be provided and view glass to be cleaned.

iii. **Control and Instrumentation:**

- Pellets mode/normal mode selection scheme/display and alarm shall be provided in the DCS system.
- Modulation control for hot air damper and cold air damper is to be provided from mill inlet temperature rather than the mill outlet temperature. Provision for variable mill inlet temperature set point is to be done so that set point can be varied as per requirement.
- Mill air inlet (hot, cold, and common) and outlet temp probe to be re-checked and validated.
- Mill outlet temperature high alarm to be given at 70 degree C.
- Alarm to be provided for rate of rise of mill outlet temperature.
- Steam inerting valve operation from UCB to be made ready for firefighting.
- Installation of a temperature sensor in each of the coal pipes of corresponding mill to keep track of on any volatile combustion due to biomass co-firing in coal pipe.
- For regular biomass co-firing, installation of CO monitors in mills also needs to be done for fire detection.

3. **Fire & Safety requirement:**

Biomass is highly fire-prone substance. Adequate safety measures must be taken while co-firing biomass

i. Role of Operation**:**

- Mill outlet temperature range-> 65-75C
- Mill inlet temperature -> not more than 180 C
- PA header pressure-> slightly more than 800 MMWC
- Pre start and post shutdown purging of mill is mandatory.
- Continuous monitoring of mill parameters most importantly mill inlet air temperature , mill outlet temperature, mill current and mill DP
- Mill inlet temperature high alarm to be provided at 190 C
- Mill reject system to be kept under observation continuously
- Due to fire prone nature of biomass, operator should be deployed at local for monitoring.
- In case of fire, the mill should be tripped and steam inerting should be done immediately by opening the steam inerting motorized valve, keeping watch on furnace pressure. A fire -fighting hose and a fire tender may also be used as and when required.
- FG temperature in SH zone and APH FG outlet temp to be monitored continuously.
- Clinkering and slagging tendency to be observed from local as well as from rise in SH zone FG temperature. Soot blowing and LRSB are to be done accordingly.

ii. Impact of biomass co-firing on combustion:

- The process of biomass combustion may be associated with certain risks that do not occur during the combustion of coal. These include fuel pre-processing (fire explosion risk), combustion e.g. including excessive slagging and ashing, and chlorine corrosion.
- The content of oxygen in biomass is very high compared to coal.
- The substantial proportion of volatile matter in the biomass fuel can be a positive factor in the improvement of ignition and flame stability. However, volatile matter enhances the fire explosion risk in the preprocessing system.
- In biomass, elements such as chlorine and potassium are mostly present as water-soluble inorganic salts, and primarily as chloride, nitrates, oxides, etc. which can be easily volatilized during the combustion, resulting in high mobility for alkali materials and, consequently, high pollution tendency. This can have a significant impact on corrosion, particularly at high metal temperatures on superheater surfaces, if the co-firing ratio is higher.
- One area of particular concern is the ash composition of biomass fuels. Most of these ashes are high in alkali and alkaline earth elements, which are known to promote deposition in the boiler. Even though the ash quantity in the biomass is small, high alkali and alkaline earth materials tend to act as fluxing agents and reduce the melting temperature of the coal ash. This should be evaluated. One characteristic feature of the ashes yielded by biomass combustion is the considerable content of phosphorus, potassium, and their compounds, calcium, magnesium, etc., Biomass ash is thus characterized by a low melting temperature and a high tendency to slagging and fouling. Ca and Mg compounds usually increase the ash melting temperature, while K and Na reduce it. In combination with potassium, silicon can induce the formation of low-melting silicates in volatile ash particles. These processes are highly important, given the risk of fouling and ash slagging on the walls of furnaces or heated surfaces.
- If fly ash and bottom ash are currently sold in the concrete market, an evaluation must be made since current standards are for coal ash only. Elemental analysis of biomass should be performed for each sample or lot to monitor the chlorine content and alkali content such as sodium, potassium, and so on, which have high slagging and fouling tendencies due to sodium and potassium compounds formed and mixing with bottom ash. Similarly, chlorine content is to be kept under control, which tends to cause corrosion.
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iii. Combustion issues in pellet firing

- Clinkering and slagging tendencies are to be observed with any rise in SH zone FG temperatures. The frequency of soot blowing and LRSB is to be determined accordingly.
- Flue gas temperature profile increased unburnt, changes in spray and metal temperature to be monitored, and any abnormality to be discussed with OEM.

4. **Per unit cost impact on power generation:**

Economic Analysis of Co-firing (10% co-firing)

Parameter	10% Co-Firing
Cost of Pellets	Raw material cost= Rs. 1500-2000/tonne Conversion cost into pellets (including electricity, labour, land etc.)=Rs. 2000-2500/tonne Transportation cost= Rs. 1000-1500/tonne depending on distance Total Cost (approx.): Rs. 5500 to 6000 per MT At 100% PLF, 1000 MW plant requires daily 1600 MT biomass @ 10% Co-firing ratio.
CO2 footprints	900-1000g/kWh

SO2 reduction	10% direct reduction
NOx reduction	0-5% reduction possible
Tariff (Rs/kWh)	Variable Cost=Rs. 0.05 to Rs 0.09/kWh
Return on investment	5-10 years

Source: NTPC and CSE Analysis

Factors Affecting Biomass Pricing: The price matrix is governed by real-time and static factors –

- Weather disruptions and its effect on crop aggregation and storage.
- Transportation model variations will include multiple modes, including tractor, trucks, etc. An additional cost of transportation is required to move stored material to the point of use.
- Availability of labor at all concerned sites and depots.
- Indulgence of the Village level entrepreneurs (VLE) and ex-trade suppliers.
- Price variation is high and rapid after commissioning; thus, policies should be developed by the government to cap the variation at a level that allows for faster adaptation and implementation.
- Escalation of manpower costs due to covid impact.
- Due to aging of power plants major expense on maintenance (every year replacement of tubes of primary and secondary heater is required).
- Plants must be cleaned to remove choking caused by dust in the fuel. Dust also affects plant operations, and plants must pay per weight for the same.
- Huge land is required for biomass storage.

Way forward to stabilize Biomass Pricing Mechanism-

- Have farmers incentivized through govt schemes supporting them to join this initiative.
- State govt to allocate an area for the storage of biomass.
- De-risk the supply chain by having more suppliers if you're dealing directly with farmers and not going through supply chain management companies.
- Develop supply chain management through selected biomass supply chain management companies.
- Initiate a contract-based logistics system, which will de-risk the transportation system.
- Sign long-term partnership contracts to keep the selected suppliers onboard with the power plants for longer-term development of this clean energy initiative.
- Ensure suppliers have inventory in case they have to face market volatility.
- Have storage facilities and climate control systems for the storage of biomass.
- Have farmers incentivized through govt schemes supporting them to join this initiative.

5. Advantages & Disadvantages of Co-firing

Advantages:

Biomass co-firing has been recognized by the UNFCCC as a technology to mitigate GHG emissions. Directly reduce CO2 emissions equivalent to the coal it replaces. The net CO2 emissions from biomass co-firing are approximately 2300 kg per ton.

Biomass co-firing enables coal plants to reduce SO2 emissions as biofuels frequently contain less sulphur than coal. (Due to 0- 0.2%sulphur)

Biofuels also tend to contain less nitrogen and more moisture, which leads to lower NOx emissions. Furthermore, biofuels have higher volatile matter contents than coal, which results in less NOx formation in low NOx burners.

<u>Other advantages include</u>:

- Reduce the carbon footprint, thereby reducing the threat to the environment threat.
- Reduce the depletion of coal resources in country by shifting to alternate sources of generation.

<u>Disadvantages:</u>

Slagging and fouling:

Slagging is the deposition of fly ash on heat transfer surfaces and refractory in the furnace, both primarily subject to radiant heat transfer. Fouling is the deposition of fly ash at temperatures below its melting point in the heat recovery sections, subject mainly to convective heat transfer.

Substances that vaporize in the combustion zone condense on heat transfer zones by the condensation of the volatiles or sulphation by reacting with SO3. These deposits range from light sintering to complete fusion. The degree of slagging and fouling depends on local gas temperatures, tube temperatures, temperature differences, tube orientation, local heat flux and fuel composition. The deposit's formation depends on the release and chemistry of chlorine, sulphur, aluminum, silicates, and alkalis during combustion.

Biomass fuels can contain a higher proportion of alkaline species compared with coal, though the total ash content must also be considered. The constituents of the ash, such as alkali metals, phosphorous, chlorine, silicon, aluminum, and calcium affect ash melting behavior. Alkaline metals readily vaporize during combustion. A key reaction that needs to be considered is the release of volatile species, such as alkali metals and phosphate compounds, and their subsequent deposition on boiler surfaces and on surfaces of ash particles and deposits.
The major proportion of inorganic materials in biomass is in the form of salts or bound in organic matter, whereas in coal they are bound in silicates which are more stable.

Coal ash is composed mainly of alumino-silicates and quartz, with the other significant constituents being compounds of iron, calcium, magnesium, potassium, and sodium. The sulphur, chlorine and phosphorous contents of coal ash are low. As coal contains relatively low levels of fluxing elements such as iron, calcium, potassium, sodium and magnesium, the ash is relatively refractory and has low propensity for slagging and fouling. Straw ash, like most biomass ashes, is not composed of alumino-silicates but of quartz and inorganic salts of potassium, calcium, magnesium and sodium, principally phosphates, sulphates and chlorides. These ashes would have fusion temperatures in the range 750–1000ºC compared with fusion temperatures well in excess of 1000ºC for coal ash and are hence much more likely to cause slagging and fouling. Wood ash is similar to straw in that it is not composed principally of alumino-silicates. However, it differs from straw in that wood contains very little chloride and lower levels of alkali metals. The fusion temperatures of wood ash can be similar to coal ash. The presence of significant levels of alkali and alkaline-earth compounds in mixed ashes reduces fusion temperatures by 100–200ºC and dramatically increases the likelihood of slagging.

<u>Other disadvantages include</u>:

- Reduced heat absorption in furnace --- higher FGET
- Higher excess air --- higher flue gas velocity
- Slight reduction in boiler efficiency
- Some biomass materials have low bulk density (e.g., straw), resulting in the handling and storage area of large quantities of materials.
- Moisture content may be high, reducing overall plant efficiency.
- A closed shed is required for storage as biomass is hydrophilic in nature.
- Prone for fire hazard due to high VM. Hence demands special care.
- Depending on the feedstock, the complexity of fuel feeding requirements may be increased;

some materials can be co-fed using a single feed system, whereas others require a separate, dedicated system.

The cost of biomass is 10-20% higher than coal for biomass co-firing upto 5-10%. At higher co-firing ratios, the cost may go higher since longer biomass supply chains needs to be maintained.

Conclusion:

- There are no two opinions about the fact that power plants are not only generating adequate power while meeting the statutory regulations but also maintaining efficiency despite ageing of the equipment's by adopting proactive, preventive maintenance. Coal plants have been dealing with emissions by incorporating renewables, and biomass co-firing is a cost-effective approach to reduce CO_2 emissions with minimal investment.
- However, tough competition from other renewables like solar and wind is also proving to be a bane for biomass-based power. The focus is more towards solar power as its generation cost is coming down (Rs. 2.25 to 2.50) because of the reducing cost of photovoltaic technology and batteries, but in case of biomass, the cost is going higher (Rs. 8.0) and Discoms are reluctant to buy at such a high rate.
- Therefore, gap funding should be promoted in Discoms to sustain these Biomass Plants. The Ministry of Power should make provisions for tariff determination and scheduling to promote generation through co-firing.
- Also, the mission team with their specialized members of central and state gencos engineers, should first study govt and private plants, thereby suggest modification/ retrofit and then assist in implementation. Also, ensure the availability of pellets for the next 10 years so that payback can be achieved.
- It is not just the high cost of generation and competition that is a matter of concern but the storage, collection, and transportation chain of biomass, rendering them useless for co-firing. Thus, MoEF&CC and MoP and other concerned agencies should promote torrefied pellet manufacturing which can be a game changer for biomass co-firing in India.
- National Mission called SAMARTH (Sustainable Agrarian Mission on use of Agro-Residue in TPPs) has been setup by MoP, which estimates that around 95000-96000 tonnes of biomass pellets are required per day of co-firing, but India's pellet manufacturing capacity is 7000 tonnes per day at present despite a surplus 228 million tonnes of agro-residue available in the country. The huge gap is due to the seasonal availability and unreliable supply of biomass pellets to the utility.
- Therefore, need of the hour is to increase India's pellet manufacturing capability if we need to increase dependency of power generation on biomass. Specifically for Rajasthan state, the major agro biomass surplus available is 15.30 million MT. Priority, should be given to biomass-based power plants which have a requirement of 11.26 million MT, which leaves only 3.74 million MT biomass availability for State TPP's who have a requirement of 12 million MT. RUVNL on behalf of Discoms has already entered in PPAs for set up of biomass-based power plants of 119 MW which are expected to be commissioned in next 2 years. Hence there will be very little biomass fuel left for co-firing in state TPPs.
- Platforms need to be established to ensure farmers have an intrinsic role in this business model of pellet manufacturing and co-firing in power plants.
- To exploit co-firing potential without adverse environmental impact, emerging economies need technology and policy preparation.
- Sustainability indicators for bioenergy, including protection of soil and water resources, biodiversity, land allocation and tenure, and food prices, also need to be integrated into policy measures.

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