POWER GENERATING PLANT USING CORN STOVER

Proposal to Montgomery County
Draft 2
9/29/2022

Table of contents

1. GENERAL OVERVIEW OF PROJECT

The Green House Gas reduction project (hereafter referred to as “the Project”) will be sited within the deactivated Dickerson Power Plant in Montgomery county Maryland. The objective of the Project is to utilize local surplus biomass residues, specifically corn stover, to produce Biomass Briquettes, a clean, renewable energy alternative that can be used in industrial boilers to generate electricity and supply to the Maryland Power Grid (hereafter the “MPG”). The corn stover will first be used to manufacture high calorie Biomass Briquettes.

The Project will use biomass residues of corn stover from farmland in Montgomery County within 20 miles around the Project. The Project will involve repurposing the three 182 MW coal-fired steam generating plants, two 147 MW gas and oil-fired simple cycle combustion turbines, and one 13 MW black start and peaking turbine that are currently at the deactivated Dickerson Power Plant. It is estimated that the Project can deliver 149.7 GWh to MPG per year while consuming 171,400 tons of biomass residues as feedstock. The estimated emission reductions generated by the Project are 149,250tCO_2e per year. Before implementation of the Project, except for part of the stover used as forage in livestock husbandry, about 1,350,000 ton of corn stover is left in the field to natural decay. Equivalent amount of electricity is from fossil fuel fired power plant in MPG.

The Project clearly fits into the development priority of the USA. The Project will not only supply renewable electricity to grid, but also contribute toward the sustainable development of the local community, the host country and the world by way of:

- reducing emissions of other pollutants by the energy industry of USA, compared to a business-as-usual scenario;
- reducing the water pollution, atmospheric pollution and landscape pollution caused by the natural decay of stover;
- reducing the emissions of other pollutants resulting from the power generation industry in USA which are estimated to be 1026 tons of SO_2 and 326 tons of suspended particulate matter, compared to a business-as-usual scenario;
- The project has an important social and economic impact for the farmers in the area in question as the briquetting plant creates job opportunities and farmers will increase their sales income from farm residue sales.
- Biomass Briquettes will be consumed by the power plant and could also be exported to other plants across the country.
- Similar projects can be commissioned around the state where feedstock is available and off takers identified (power plants or other industrial entities.

2. PROJECT PARTICIPANTS

The Project participants to the project activities are the following:

a) Global Supply Solutions Limited (GSSL)

Global Supply Solutions Limited (GSSL) is a renewable energy company that focuses on the large-scale production of biomass briquettes from the waste leaves of the pineapple plant. The company was established in 2003 and has since the focused its attention on using biomass as a way of developing briquettes as a source of renewable fuel. The company currently runs a 50,000-metric tonne per annum plant is based in Thika, Kenya that converts pineapple plant waste into biomass briquettes for industrial use. Allan Marega is the Principal Consultant. Has over 15+ years in business. Allan has overseen the company transformation from a supply business into a modern manufacturing business and a patented innovative product/solution for both industry and households.

b) Montgomery Farmers Cooperative Union

Organizations that govern farmers interests will be key in structuring the methodology of collection, baling and transportation of the baled feedstock to the GSSL processing plant

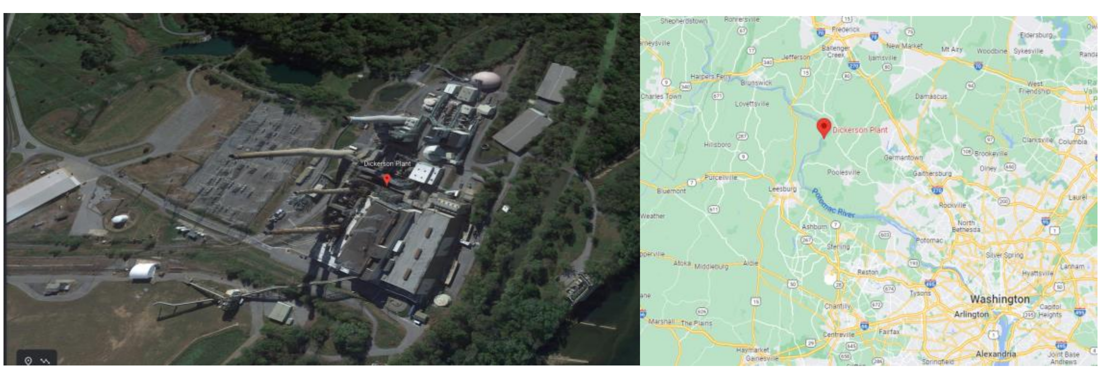
c) Dickerson Generation Station

An electrical power generating station installed with industrial boilers used to generate heat for the production of steam to drive power producing generators. These boilers were previously and mainly coal fired.

3. TECHNICAL DESCRIPTION OF PROJECT ACTIVITIES

a) Location of the anticipated Product – Dickerson Generation Station

The Dickerson Generating Station was a 853 MW electric generating plant owned by NRG Energy, which was deactivated in 2020 due to environmental concerns. It is located approximately two miles west of Dickerson, Maryland.



Description

The facility consists of three 182 MW coal-fired steam generating plants, two 147 MW gas and oil-fired simple cycle combustion turbines, and one 13 MW black start and peaking turbine. The three coal-fired units are base-loaded and went into operation in 1959, 1960, and 1962 respectively. Condenser cooling for these units was accomplished with once-through cooling water from the Potomac River at a rate of up to 400 million US gallons (1,500,000 m3) per day. Coal was delivered to the Dickerson Generating Station by CSX Transportation train. The two combustion turbines are General Electric Frame 7F gas turbines which went into operation in 1992 and 1993, and were fired with natural gas from a Consolidated Natural Gas company pipeline which traverses the Dickerson site.

A 20-mile radius from the Dickerson Power Plant (21200 Martinsburg Rd, Dickerson, MD 20842) covers a majority of Montgomery County, MD, and Loudon County, VA. It also covers part of Frederick County, MD (northernmost point is approximately the town of Walkersville), as well as a few miles into Washington County, MD, and Jefferson County, WV. Below is the corn production for Montgomery, Frederick, and Loudon Counties[1].

a) Montgomery County: In 2021, there were 10,500 acres of corn grain harvested with an average yield of 179 bu/A.
b) Frederick County: In 2021, there were 37,000 acres of corn grain harvested with an average yield of 168 bu/A.
c) Loudon County: In 2017, there were 5,050 acres of corn grain harvested with an average yield of 125 bu/A.

The projected plant would use corn stover as feedstock. However, there are plans to multiply the briquetting concept to utilize other type of biomass such as soyabean husks.

b) Corn Stover availability in Maryland as Feedstock

Corn stover is a widely available biomass resource in the United States, particularly in the Midwest where corn is the predominant grain product. The USDA estimates that approximately 75 million dry tons of corn stover are available annually to support a biomass industry. The energy content of corn stover 7,697 to 7,967 BTU/lb[2].

Montgomery County's diverse agricultural industry is home to 558 farms, employs more than 10,000 people, and contributes $281 million to the County's economy. Grain farms (corn, wheat, soybeans, and barley) are the predominant agricultural use in the County, covering 34,526 acres. Much of the grain produced in Montgomery County goes to support Maryland's poultry industry on the Eastern Shore and other livestock production in the region. In addition to this, wheat produced here is made into cookies, crackers, cakes, and bread products; corn may go toward ethanol production; and some barley is now going to local breweries for the production of beer. The availability of corn stover for briquetizing purposes in Montgomery County is very obvious as there are several corn farmers in the Maryland.

---

[1] Data source: USDA National Agriculture Statistics Service. Information retrieved using the Quick Stats tool.

[2] Source: U.S. Department of Energy, 2006, Biomass Feedstock Composition and Property Database: All Sample Types, All Heat Properties, http://www1.eere.energy.gov/biomass/feedstock_databases.html, accessed September, 2011.

Farmers in Montgomery County produce around 5,000,000 MT of corn stover per year and production is planned to increase. Today corn farmers are not utilizing the corn stover, or are selling them as bulk material, and are willing to sell corn stover for briquette manufacturing. There are three main strategies to manage fodder (also called stover or residue) after corn grain harvest: keep it in the field; bale it; or graze it.

Keeping fodder in the field

One of the benefits of keeping corn fodder in the field is soil conservation. The NRCS recommends keeping soils covered as much as possible for improved soil health. High levels of soil cover and roughness reduce soil loss according to RUSLE2, a tool used by NRCS to estimate erosion potential. Corn fodder left on the soil surface after grain harvest can easily provide 90-95% cover; additionally, the remaining standing cornstalks increase field roughness. Conversely, removing fodder through baling or grazing can reduce cover by 25 to 80% depending on the method used (chopping, raking, and baling vs. baling combine wind rows only vs. strip grazing, etc.), leaving the soil more vulnerable to erosion, especially on sloping ground.

Soil conservation does not just help the environment—it also makes financial sense. Iowa State University Extension summarized in a 2012 factsheet that soil erosion can cost farmers more than $20 per acre (adjusted for inflation) per year. This estimate accounts for a number of factors, including nutrients in the soil that are unavailable to the next crop, resulting in increased fertilizer costs; reduced crop yield when topsoil moves and poorer soil remains as substrate for crop growth; loss of land value; potential damage to property and roads; and water body impairment from moving soil.

Beyond keeping soil and soil-bound nutrients in place via erosion protection, maintaining corn fodder in the field allows nutrients tied up in leaves, stalks, and cobs to become available to subsequent crops as the residue breaks down. It is important to consider the value of these nutrients, and their cost of replacement, when deciding how to manage fodder. Corn fodder dry matter yield is approximately the same as corn grain yield—so, for 150 bu/A corn, we estimate approximately 3.5 tons of dry fodder (150 bu/A x 56 lb/bu x 84.5% DM / 2,000 lbs/Ton).

Table 1 shows the approximate nutrient content of corn fodder per dry ton (based on calculations by Michigan State University Extension). Current national average prices are listed in the table—these are for demonstration purposes only.

Table 1. Corn fodder nutrient removal

Nutrient	Fertilizer Source	Fertilizer Price Per Ton	Fertilizer Price Per Pound	Fodder Pound Nutrient Per Ton
Nitrogen	UAN (32-0-0)	$254	$0.40	22
Phosphate	DAP (11-52-0)	$431	$0.47	8
Potassium	Potash (0-0-60)	$348	$0.29	32
				Total

Using the values from Table 1, the value of nutrients contained in the fodder is $21.76 per ton.
Considering corn fodder as a nutrient and conservation resource reveals the value of keeping it in the field. However, doing so may be a missed opportunity for an economical feed or bedding source. Additionally, corn fodder can harbor pathogens that may harm the next crop, and slow soil drying and warming in the spring.

Grazing

Grazing corn fodder left in the field after harvest is one way to extend the grazing season and lower feed costs. For every bushel of corn taken from the field, there are approximately 18 lbs. of stem, 16 lbs. of husk and leaves, and 5.8 to 6.0 lbs. of cobs left as fodder (all on a dry matter [DM] basis).

If given free access to an entire field of fodder, cattle will first select any grain remaining, followed by the husk and leaf, then cob and stalk. Adaptive grazing techniques (like using strip grazing) can optimize the amount of fresh fodder available and structure what the cattle are able to selectively graze. This can create a more uniform diet. Because cattle will selectively graze on remaining grain first; it is important to scout the field for excess grain piles that can cause grain overload and related animal health issues. Fields with more than 8 to 10 bushels on the ground should be managed in a way that moderates grain intake. Adapting cattle to grain supplementation before turnout is another way to minimize digestive upset.
It is important to recognize that the quality of the fodder will change as the season progresses. The rate of quality decline is depending on stocking rate and environmental factors like moisture, precipitation, and field condition. It can be advantageous to graze during the first months after harvest (October, November, December) instead of using the field in late winter (January, February). Nutrient composition of the fodder at the start of the grazing period is approximately 6-7% crude protein and 65-70% TDN compared to lower levels (5% crude protein and 40% TDN) at the end of the grazing period.

Availability of fodder for cattle can be dictated by snow depth and especially ice cover, plan to have alternative sources of forage available to prepare for weather-related limitations.

Economics of Grazing Corn Fodder

According to research from Iowa State University, corn fodder can replace approximately 25 lbs. of hay equivalent per day for a medium-sized cow (not nursing) or 0.375 tons per month. Depending on the class of cattle consuming corn fodder, additional supplementation may be required. Salt, mineral, and Vitamin A supplements are recommended for cattle grazing crop fodder. To read more about supplementation for different classes of cattle and develop stocking rates, see Grazing Corn Stalks with Beef Cattle.

Additional Considerations for Grazing Corn Fodder

From the approximate 56 lbs of fodder left in the field per bushel of corn, cattle will remove close to 25% during feeding activities, with other losses related to animal movement and weather. Research on nutrient removal from the University of Nebraska – Lincoln found that a pregnant cow grazing at suggested stocking rates for 90 days on a 230 bu/ac cornfield will remove approximately half a ton of fodder, and 2 lbs of nitrogen (N) per acre. Potassium removal is negligible. The amount of phosphorus (P) and calcium (Ca) available in fodder is generally less than sufficient to meet nutritional needs. As a result, producers providing a free-choice mineral containing both would result in an addition of these nutrients through manure deposition. There were no significant changes in the status of nitrogen (N), phosphorus (P), potassium (K), and organic matter (OM) in studied fields that were grazed compared to un-grazed.

Additional studies, coming from the University of Nebraska-Lincoln, showed no detrimental impact on soil properties like bulk density and penetration resistance (a measure of compaction). Continuous grazing of fodder did not change corn yields in rotation, and slightly improved soybean yields by 3.4 bu/ac. In wet conditions, researchers noted rough soil surfaces that dried unevenly. This has the potential to impact seed set and yields due to difficulty planting. Removing animals during spring months, when soils are saturated and no longer frozen can prevent impacts to our seedbed.

During dry years, the potential for increased nitrate concentrations are a risk when grazing (or baling) corn fodder. Corn fodder should always be tested for nitrates to guide decision making. Generally, the more palatable grain, husk, leaves, and cob will be consumed first. The lower portion of the stalk (ie. that 6 to 8 in. closest to the ground) is typically highest in nitrates. If nitrates are a concern, cattle can be supplemented with hay or grazed to minimize stalk consumption to reduce the risk of nitrate poisoning.

C. Stages in the Production of Biomass Briquettes

2) Economics of Baling

The preceding section demonstrates that stover can provide economic forage for cattle. But how much do you get, and is it worth it? Assume a 150 bu/A corn yield and 3.7 dry Ton/A stover. Depending on whether the stover is baled from combine windrows; raked and baled; or chopped, raked and baled, an expected 50%, 65%, or 80% of the stover will be harvested, or approximately 1.8, 2.4, or 3, 1,200-pound bales per acre, respectively.
This could replace part of the medium-quality hay in a feed ration when supplemented with additional protein. For example, following this Iowa State University Extension calculation, corn stover can replace about 1.16 tons of grass-legume mix hay, with an additional 0.22 tons of whole soybeans needed to bring up protein levels (this is a 1:1 replacement for DDGs [dried distillers grains]). Using the current mixed-hay price of $198 per ton, and soybeans currently at $316 per ton, the value of the feed replaced per ton of stalks is approximately $160. At 0.6 tons per bale, that's $96 of feed replaced per bale.

Before logging a net gain from selling bales or saving money on your feed ration, remember account for the cost of baling and transporting stover in addition to the fertilizer replacement cost mentioned in Table 1. Baling and transportation cost can vary widely depending on if custom operators are hired, or personal machinery and labor costs included. Iowa State University has another factsheet that can help and drill down specifically on the economics of harvesting and transporting corn stover, whether custom hire or on-farm machinery and labor are used. As always, use current local values for accurate estimates. Most recent custom rates are linked for Pennsylvania, Maryland, and Ohio.

For example, custom hire for stalk chopping, raking, and baling, and transporting bales 25 miles to end location using approximate current local prices adds up to $27 per bale. Accounting for nutrient replacement per 0.6 ton bale brings the total to produce one bale to approximately $40.
The total cost to the producer per bale is the minimum amount farmer should be willing to accept, while the feed value is maximum the livestock producer would be willing to pay—the actual price paid should be negotiated somewhere within this range. A realistic range would be from $40 to $96 per 1,200-pound bale for the scenario given above. It is important to consider current local pricing as well as reports from local hay auctions. Remember the above values include custom work and hauling, which increase the cost of production significantly. Baling stover with your own equipment and keeping it on-farm will drastically reduce the cost of production per bale.

Additional Considerations for Baling Stover

Initial moisture of stover at harvest and storage conditions can influence dry matter retention and nutritional composition. Plan for losses of material related to storage and feeding. If stover bales are fed free-choice anticipate feed refusal of less palatable

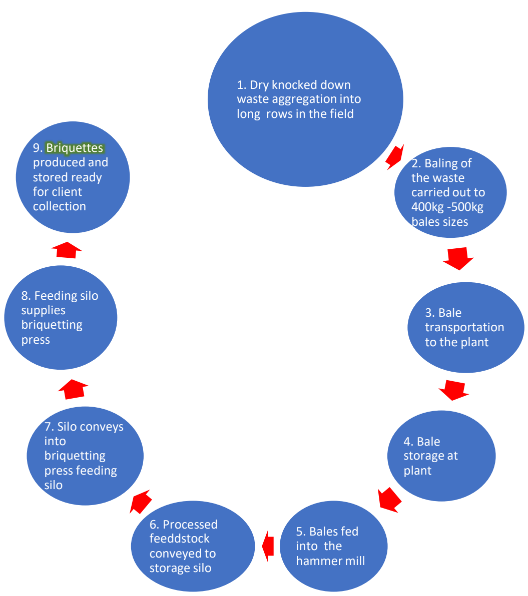
components. Bale feeders can be moved to allow cattle to access and utilize refused feed as bedding.
If you choose to bale stover, the University of Minnesota Extension recommends not removing fodder from the same fields every year; using manure to replace organic matter; reducing tillage; and planting cover crops as best practices.

4. **Project Activity / Briquette Manufacturing and Power Generation Scenario**:

The project will encompass:

• Volumes of un-utilized Corn Stover being within a radius of 20 miles of the project manufacturing site.
• Baled Corn Stover being transported to the project manufacturing site. The continuous production of several tons of Biomass Briquettes every hour.
• The transportation of manufactured biomass briquettes to the power generating site by truck. The loading of these Biomass Briquettes into the power plants industrial boilers every hour.
• The power plant connected physically to MPG for distribution of the produced electricity.

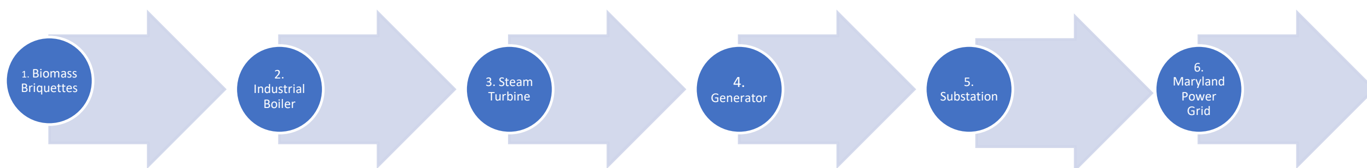
Figure 1. Biomass Briquette manufacturing process



The biomass residues utilized in the project will be mainly corn stover which will be transported to the manufacturing site and processed into Biomass Briquettes (bio fuel). The processed Biomass Briquettes (bio fuel) are then transported or conveyed to the industrial boilers in power production plant. The bio fuel in the industrial boilers is burnt at high temperatures to heat water and generate super-heated steam, which turns large turbines resulting in power generation.

The minimal boiler smoke emitted in this process will be well treated by filters. The envisaged project will use biomass briquettes as the main sole fuel source. Minimal diesel oil may be used for the start-up/maintenance of the boilers.

Figure 2. The Power Production Process



5. **Estimated Emission Reduction – Carbon Mitigation Potential**

It is expected that the project activities will generate emission reductions for about 149,250tCO2e per year over the first 7-year renewable crediting period from 1st Jan, 2023 to 31stDec, 2029.

Years	**Annual estimation of emission reductions in tonnes of CO2e**
2023	149,250*
2024	149,250*
2025	149,250*

2026	149,250*
2027	149,250*
2028	149,250*
2029	149,250*
Total estimated reductions (tCO_2e)	1.044,750*
Total number of crediting years sampled	7
Annual average over the crediting period of estimated reductions (tCO2e)	149,250*

*Subject to the volume of briquettes produced and consumed with the Power Plant operating at its design electrical generation capacity

6. Stakeholder Comments