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Colocation project Memo

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Biochar production and CO_2 sequestration project

Background

No. Act No. 39
VT LEG #356787 v.1

No. 39. An act relating to extending the baseload renewable power portfolio requirement. **(S.1)**
Sec.3. BASELOAD RENEWABLE POWER PORTFOLIO
REQUIREMENT; COLOCATION REPORT
On or before January 15, 2023, the owner of the baseload renewable power plant subject to 30 V.S.A. § 8009(b) shall report to the General Assembly on whether a project utilizing the excess thermal energy generated by the plant has been developed and is operational, or when a project utilizing the excess thermal energy generated by the plant will be operational.

About Stored Solar:

Stored Solar New England Biomass Plants Portfolio

Stored Solar currently owns and operates 8 biomass power plants in New England totaling 156 MW. Stored Solar is developing collocated energy consuming hosts in their vicinity, such as bio-based industries, biochar production, CO_2 capture and conversion, greenhouses, fish farms, etc. to convert the biomass plants outputs into beneficial use (power, heat, CO_2, ash, …) therefore improving their overall efficiency, while providing the co-hosts the benefit of fast track development, lower overall implementation costs, competitive utilities costs, sustainable and renewable features and on-location operation and maintenance support.

1. Ryegate, Vermont: A 20 MW power plant located in East Ryegate, VT.
2. Bethlehem, New Hampshire: A 16 MW power plant located in Bethlehem, NH.
3. Tamworth, New Hampshire: A 20 MW power plant located in Tamworth, NH.
4. Whitefield, New Hampshire: A 17 MW generation facility located in Northern NH.
5. Springfield Power, New Hampshire: A 17 MW generation facility located in Southern NH.
6. West Enfield Maine: A 25 MW power located 30 minutes North of Bangor Maine.
7. Jonesboro, Maine: A 25 MW power located 60 minutes Southeast of Bangor Maine.
8. Fitchburg, Massachusetts: A 16 MW power plant located in Fitchburg, MA.

The link below shows a short video clip on the NE biomass portfolio.
https://www.youtube.com/watch?v=ddks2HpKA30

The Ryegate Biochar Production colocation Project

BIOCHAR

Biochar is a highly adsorbent, specially produced charcoal originally used as a soil amendment. Scientists theorize biochar was first used in the Amazon Basin thousands of years ago where extensive regions of dark, highly fertile soil known as ”*terra preta*” were discovered, revealing high concentrations of biochar and organic matter.

Similar to charcoal, biochar is produced using the ancient practice of heating wood or other plant material (biomass) with little to no oxygen. However, unlike charcoal, which is often used for cooking, biochar is made under specific conditions with the intent to be applied to soil as a means to increase soil fertility and agricultural yields and sequester carbon to reverse global warming. Other market uses of biochar are being discovered regularly as universities and large industrial partners conduct extensive research into this versatile material and its cation exchange properties.

In the Ryegate Biochar Production project, biochar is produced by thermo-chemical conversion (pyrolysis followed by gasification) of biomass, yielding a stable, porous material that is near pure carbon. During pyrolysis, biomass is heated in an oxygen limited chamber to release volatile gasses, which in the Ryegate plant process will be co-fired in the existing boiler; about 50% of the carbon in the original biomass remains in the charcoal like material, biochar. Biochar degrades very slowly in nature and is believed to keep carbon out of the atmosphere for at least 1,000 years. Stored Solar expects this colocation project facility to remove over **15,000** tons per year of atmospheric carbon by producing biochar.

Biochar is considered to be the key component in a carbon-negative strategy to resolve several critical current ecological challenges.

In addition to sustainably producing food, biochar is now seen as a simple, relatively low-cost tool for mitigating climate change. The production and use of biochar in soils create a long-term carbon-negative cycle by sequestering atmospheric carbon over long periods of time and reducing nitrous oxide and methane emissions from soil.

Carbon Sequestration

Biochar is referred to as “carbon-negative” because it sequesters more carbon than is produced when it is created. During pyrolysis, approximately 50% of the biomass’ carbon content is held by the biochar, compared to 10-20% that remains in biomass after 5-10 years of natural decomposition. When biochar is added to soil, the carbon is sequestered for centuries, thereby reducing atmospheric carbon dioxide. Biochar also improves soil fertility, thereby enhancing plant growth which absorbs more carbon dioxide from the atmosphere.

Reduction in Greenhouse Gas Emissions

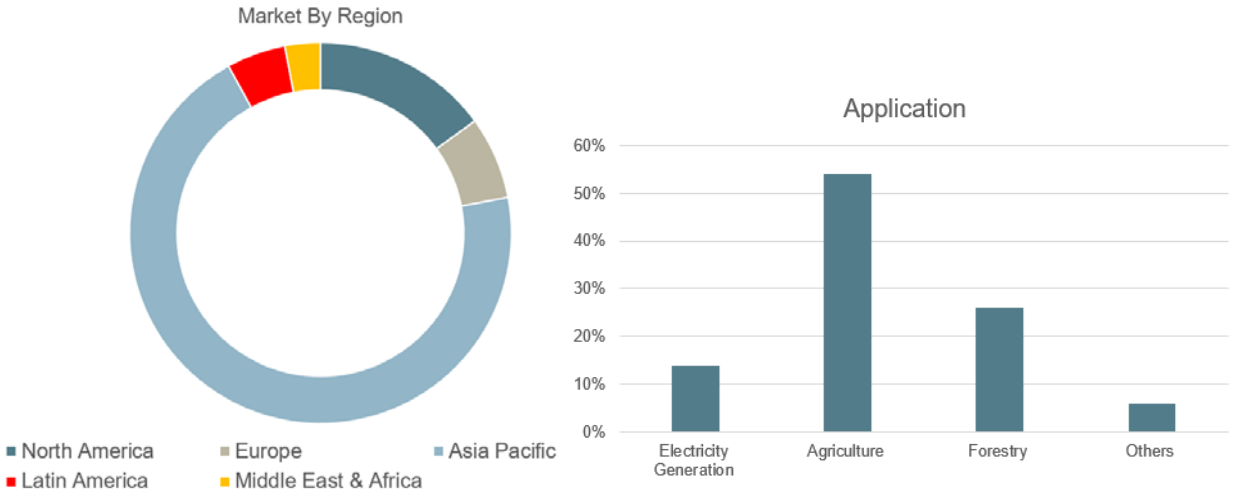
Biochar also retains nitrogen, thereby reducing emissions of another alarming greenhouse gas, nitrous oxide. Research indicates that biochar-amended soils can provide anywhere from 50-80% reduction in nitrous oxide emissions, which is significant considering that the nitrous oxide released from certain fertilizers is 310 times more potent than an equal amount of carbon dioxide. Turning agricultural and forestry waste into biochar also reduces methane generated by natural decomposition.

Global Biochar Market

According to Transparency Market Research's latest research report on the biochar market for the historical period of 2020 and the forecast period of 2021 to 2031, environmental benefits and advantages associated with biochar are expected to fuel the biochar market across the globe

In terms of revenue, the global biochar market is estimated to exceed US$ 6.3 Bn by 2031, expanding at a CAGR of 15.35% during the forecast period. Industrialization and urbanization have been increasing significantly across the globe since the past few years. This has boosted the demand for renewable energy as an alternative to coal.

Demand for electricity is expected to continue to rise across the globe during the forecast period. The world is focusing on renewable energy, such as biomass, to cater to the high demand for electricity. Biochar is a prominent source of renewable energy, as it helps sequester a billion tons of carbon annually. Thus, rise in demand for electricity is anticipated to propel the biochar market during the next 10-year period.



Biochar adds environmental value to various industries

Steel

Shows substantial decarbonization potential that could improve the quality of steel in properties and behavior

Asphalt

Reduces Temperature Susceptibility, improves Resilient Modulus, Binder Performance, and has Self-fixing Properties

Concrete

Allows for carbon sequestration, and mitigates the climate change effects of concrete production. It also reduces the concrete's thermal conductivity

Agriculture & Forestry

High Potential for Carbon Sequestration and stable storage, in addition to water retention because it increases soil fertility, provides protection against soil-borne diseases, increases agricultural productivity, and cleanses contaminated air and soil

Water Purification

Biochar can absorb and filter pollutants out of water, including trace heavy metals. For this reason, Biochar has been successfully used in the wastewater treatment process as well

Air Purification

Biochar effectively removes metal vapors, particularly elemental mercury, acidic gases, ozone, nitrogen oxides, and organic contaminants as it can regulate humidity and withdraw toxins. It is also absorbent and can absorb water up to five times its weight

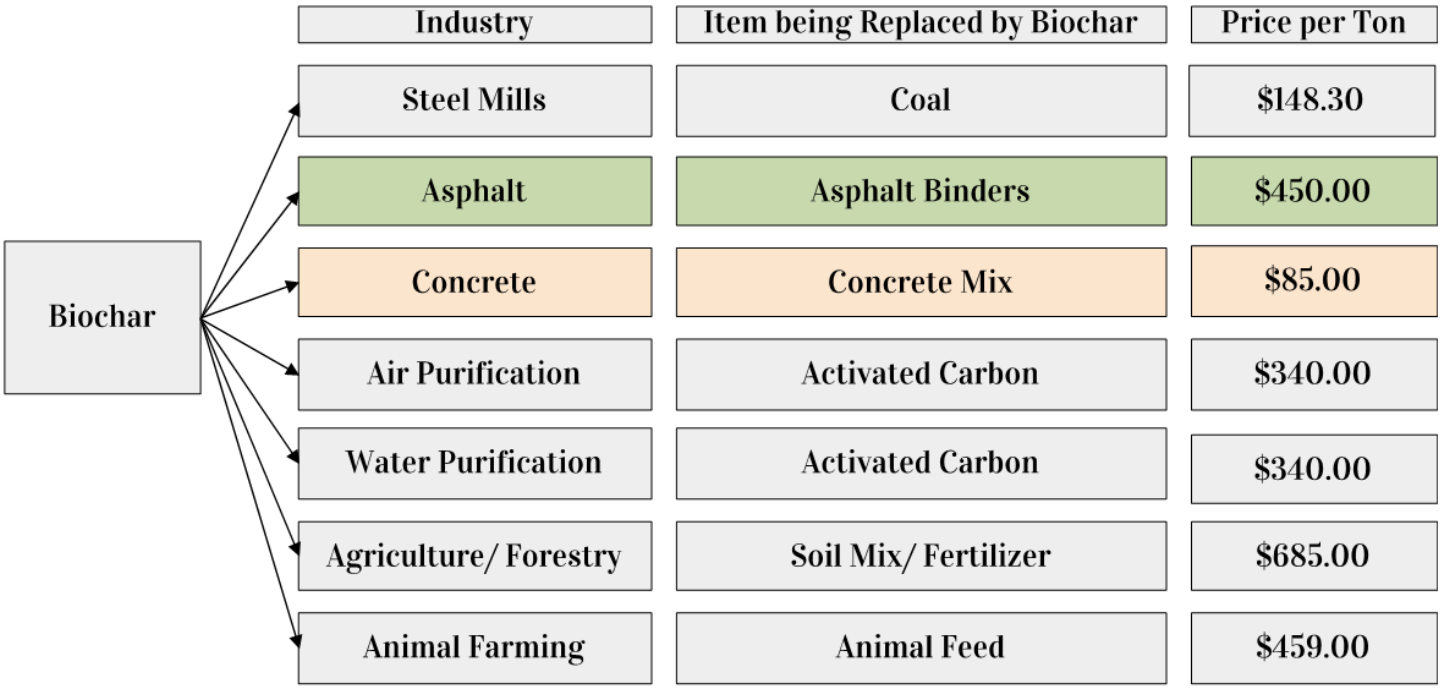
Animal Farming

Biochar has a positive impact on the animals' health and digestion when added to their feed. This also makes manure more fluid

Gardening

High Potential for Carbon Sequestration when used as a fertilizer and stable storage, in addition to water retention and increased nutrient absorption

Biochar pricing in different markets



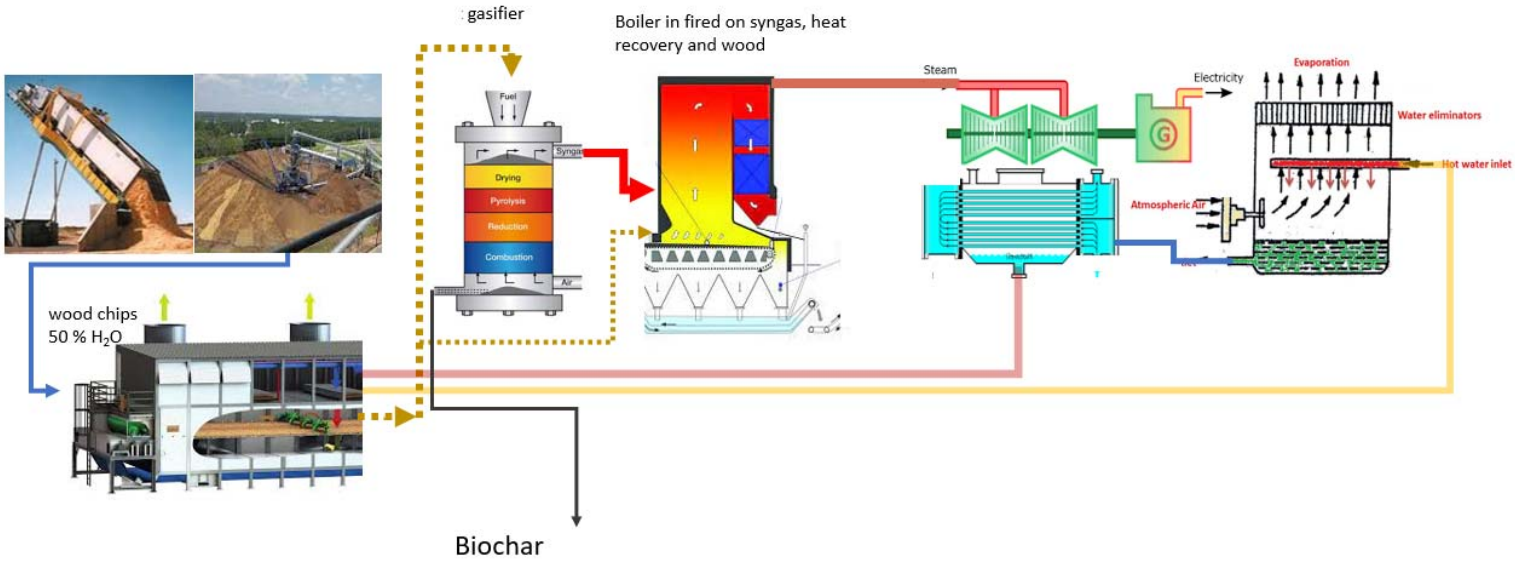
Industry	Item being Replaced by Biochar	Price per Ton
Steel Mills	Coal	$148.30
Asphalt	Asphalt Binders	$450.00
Concrete	Concrete Mix	$85.00
Air Purification	Activated Carbon	$340.00
Water Purification	Activated Carbon	$340.00
Agriculture/ Forestry	Soil Mix/ Fertilizer	$685.00
Animal Farming	Animal Feed	$459.00

Carbon credits are available to companies investing in decreasing carbon emissions

The Process

The planned process is a simple proven concept of drying the incoming biomass with the available waste heat of the plant, then feeding it to the pyrolysis/gasification module.

1 –low temperature dryer that utilizes waste heat from the power plant
2 - gasifier to produce biochar and feed syngas to the existing boilers for enhanced combustion



Process Validation

Stored Solar has been evaluating multiple technology providers in the US and Europe and has, at this stage shortlisted technology providers with substantial successful experience of over 10 years in both drying and gasification technologies, with biochar production. To finalize the selection of the technology providers, Stored Solar has mandated Stantec Consulting Services Inc. (https://www.stantec.com/en) to witness test the complete process of drying, gasification and biochar production and issue an independent engineering report with recommendations.

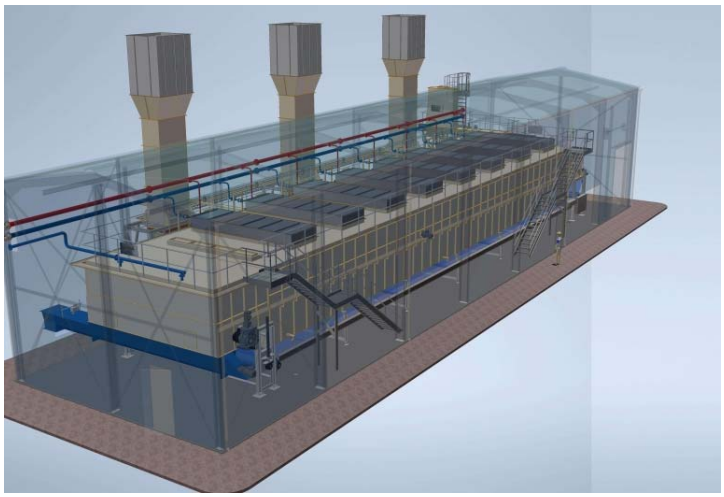
Tests performed in both the US and Europe with the shortlisted technology providers have proven to be successful. Biochar samples have been sent to specialized private and university laboratories to qualify the composition of the produced biochar and identify the highest value potential market applications.

Please find here below some photos of the different tests:

Downflow Gasifier – TN

Bottom part of the Gasifier – TN

Biomass feed system – TN




Low temperature belt dryer


Low temperature box/walking floor dryer


Biochar packing and shipping

2-stage gasifier

Biochar sample from the test