



Enviva Inc.

Biomass Energy Industry



Environmental Impact
Report

March 2022

Confidential, 2022-03-17

Company Description

Enviva is a renewable energy company supplying alternative energy in the form of biomass feedstock. Enviva collects and repurposes forest residues, sawmill and wood industry residues, and semi-natural forest thinning residues as a form of renewable energy. Enviva aims to reduce greenhouse gas (GHG) emissions by replacing fossil fuels with its wood pellets.

Headquarters	Bethesda, MD
Founded	2004
Business model	C-Corp
Employees	1,139
Intellectual property	No patents
Website	www.envivabiomass.com/
Strategic partners	Finite Carbon, Longleaf Alliance, GoChain, North Carolina Coastal Land Trust

Alignment with the United Nations' Sustainable Development Goals



Affordable and Clean Energy

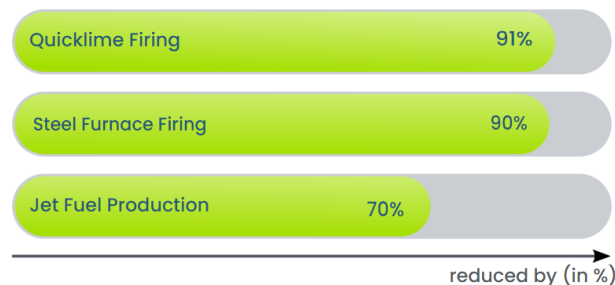


Responsible Consumption and Production



Climate Action

Estimated Greenhouse Gas Savings*



*Relative to conventional fossil fuel alternatives.

Boundless Analysis

- ▶ This report presents the results of a Boundless assessment of Enviva's biomass pellets and competing conventional fuel inputs to produce quicklime, steel, and alternative jet fuels.
- ▶ Boundless modeled scenarios assuming the industrial consumers of Enviva's biomass pellets are located in Rotterdam in the Netherlands.
- ▶ When evaluating the quicklime and steel production processes, Enviva's biomass pellets are assumed to compete with petroleum coke and coal.
- ▶ In its evaluation of alternative jet fuel production options, Boundless compared jet fuel produced from Enviva's biomass pellets with jet fuel produced from conventional crude oil, palm oil, and camelina oil blends.
- ▶ Enviva's forecasted GHG Footprint for quicklime production is 0.03 kg CO₂e / kg quicklime, which is approximately 91% lower than the emissions from European-sourced petroleum coke and coal.
- ▶ Jet fuel derived from Enviva's biomass pellets would have an approximate GHG Footprint of 26 g CO₂e/MJ, which is 70% lower than that of conventional jet fuel.
- ▶ Boundless estimates that if Europe were to displace conventional fossil fuels with Enviva's projected supply of biomass pellets for quicklime firing, steel furnace firing, and alternative jet fuel production, the resulting GHG savings between 2022 and 2030 could amount to 8.5, 21, and 8.5 million metric tons (megatons) of CO₂e, respectively.

Management Team

- ▶ John Keppler, Chairman and CEO, defined Enviva's growth strategy and is responsible for transforming the start-up in 2004 to the world's largest producer of utility-grade biomass pellets. He brought Enviva partners into its initial public offering in 2015. Mr. Keppler is a member of the Board of the Sustainable Biomass Program (SBP), a non-profit organization that defines a standard for energy production from wood.
- ▶ Shai Even, Executive Vice President and CFO, has been with Enviva since 2018. He previously served as the Senior Vice President and CFO of Alon USA Energy, Inc. and served as the President of Alon USA Partners. He led both Alon's major acquisitions and its parent company to a successful initial public offering.
- ▶ William Schmidt, Executive Vice President, Corporate Development and General Counsel, expanded Enviva's operations to a global scale. He has years of experience working on joint ventures, bank and capital market financing, mergers, and acquisitions.
- ▶ Thomas Meth, Chief Commercial Officer, co-founded Enviva. Thomas manages the marketing, sales, and business development for Enviva and is in charge of the company's sustainability initiatives.

Technology

- ▶ Enviva produces biomass pellets from wood product residues. Enviva sources its biomass feedstock from the wood chips, shavings, and sawdust residues that result from wood mill operations. By sourcing wood feedstock from the residues of other industrial processes, Enviva aims to minimize pressure on deforestation and reduce net GHG emissions.
- ▶ Enviva pellets can be used in a variety of industrial applications to displace fossil fuel consumption. In this report, Boundless estimates the GHG Footprints of fueling lime kilns and steel mill operations with biomass pellets, in addition to alternative jet fuel production. Boundless results indicate that Enviva's biomass pellets offer the potential to reduce GHG emissions in each of these industries.

Operations and Partnerships

- ▶ The Enviva corporate headquarters are located in Bethesda, MD, and its operations headquarters are located in Raleigh, NC.
- ▶ Enviva has strategic partnerships with Finite Carbon, GreenX Utility, FLA, GoChain, the Longleaf Alliance, North Carolina Manufacturing Extension, and North Carolina Coastal Land Trust.
- ▶ Enviva also has offices in Berlin, Germany; Tokyo, Japan; and York, United Kingdom.



GHG Footprint Approximations

Boundless evaluated the life cycle inputs and GHG emissions impacts of using Enviva's biomass pellets and other fuels (or fuel feedstocks) for three hypothetical industrial scenarios: quicklime production, steel production, and alternative jet fuel production. In each scenario, Enviva's pellets were assumed to be produced in the United States and transported to industrial end users of the pellets near Rotterdam in the Netherlands.

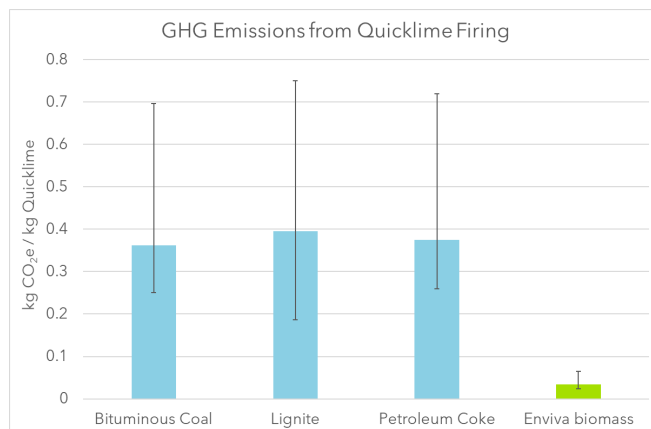
The life-cycle GHG emissions of the woody biomass feedstock that Enviva is expected to use to produce pellets for each of the three industrial applications is assumed to have zero life-cycle GHG emissions up until the point of collection, given that this material is described by Enviva to be processing residues from forestry and wood mill operations.

Boundless treats wood combustion as carbon neutral in accordance with data provided by Enviva on material sourcing. Enviva states their wood is sourced from the final harvest of semi-natural forest residues, thinnings from semi-natural forests, and sawmill and wood industry residues. Boundless does not make claims about the validity of these statements and only estimates emissions based on the information provided by Enviva.

GHG Footprint: Quicklime Kiln Firing

The GHG Footprint of quicklime firing represents the GHG emissions from the kiln combustion of Enviva's pellets in addition to coal and petroleum coke. The functional unit for the analysis is considered a kilogram of quicklime produced, but only emissions associated with the fuel used for kiln firing were considered; other life cycle emissions associated with quicklime production were not addressed.

- ▶ The GHG Footprint of quicklime firing with Enviva's biomass pellets as the fuel source is 0.03 kg CO₂e / kg quicklime, which is less than one third of the emissions associated with quicklime fired with petroleum coke, lignite, or bituminous coal.
- ▶ Lignite, bituminous coal, and petroleum coke transportation emissions were approximated assuming fuels exported from Russia to Rotterdam, NL. Enviva's biomass pellets were assumed to be transported by sea from Cottondale, FL, to Rotterdam, NL.
- ▶ The large range of uncertainty presented in the graph for each fuel option is largely attributed to variability in rotary kiln efficiencies.

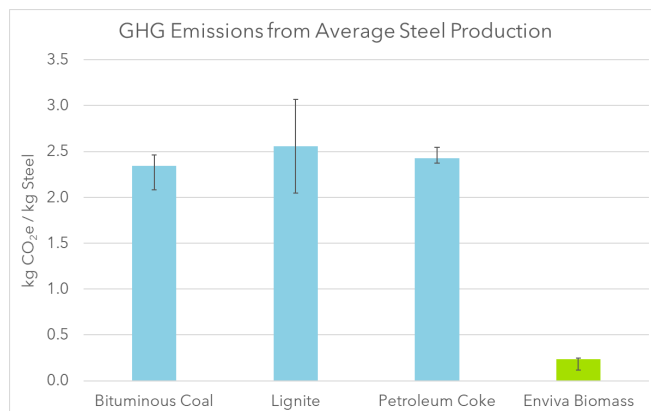


GHG Footprint Approximations Continued

GHG Footprint of Steel Furnace Firing

This metric represents the GHG emissions that would result from steel furnace firing in Europe if Enviva pellets, coal, and petroleum coke were used as the primary fuel. The functional unit of this analysis is 1 kilogram of steel produced. The emissions considered only include firing and do not include other life cycle emissions associated with steel production (e.g., iron ore mining and transportation). The calculations for Enviva's biomass pellets include torrefaction of the biomass, a process that upgrades and improves the biomass-derived fuel quality.

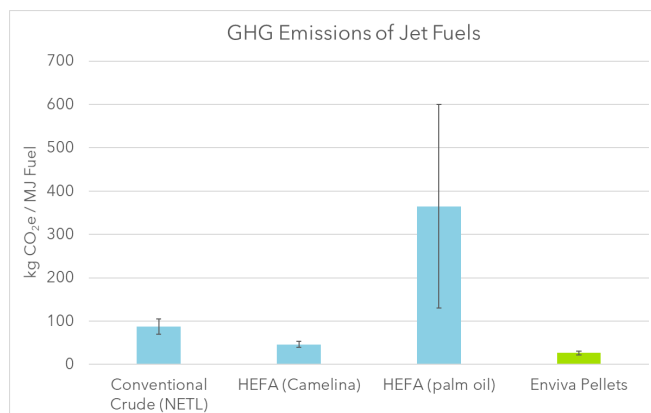
- ▶ Boundless approximated the GHG emissions from crude steel, average steel, and stainless steel furnace firing, but results are only presented graphically for average steel. Crude steel is the primary product of the steel production process, and is further refined into different types of steel (and thus will always have a lower GHG Footprint than average or stainless steel).
- ▶ The approximated GHG Footprint of crude steel firing with Enviva pellets is 0.19 kg CO₂e / kg, compared with 1.9 kg CO₂e / kg crude steel or 2.0 kg CO₂e / kg fired with either bituminous coal or lignite.
- ▶ The expected GHG Footprint of average steel fired with Enviva pellets is 0.23 kg CO₂e / kg. Average steel produced using petroleum coke, lignite, or bituminous coal would have a GHG Footprint nearly ten times this value.



GHG Footprint of Jet Fuel Production

This metric approximates the "well-to-wake" emissions, or the sum of upstream and downstream emissions, resulting from the production of various alternative jet fuels in Rotterdam. The functional unit for this analysis is a megajoule of jet fuel (a term also used to represent alternative jet fuel blendstock), and emissions from feedstock and fuel production, transportation, and combustion are included.

- ▶ Alternative jet fuel derived from Enviva pellets in Rotterdam through the fast pyrolysis pathway is estimated to have a GHG Footprint of 26 g CO₂e / MJ fuel.
- ▶ Palm-oil-derived jet fuel is expected to have a higher GHG Footprint than fossil fuel alternatives due to the deforestation and peatland drainage attributed to common palm oil production processes. The large uncertainty associated with the GHG Footprint of palm-oil-derived jet fuel results from the significant variability in land use impacts, as regional variation (e.g., soil type, propensity to fires) will have a large impact on the GHG emissions. The high end of palm oil includes methane emissions from peatland and forest conversion.



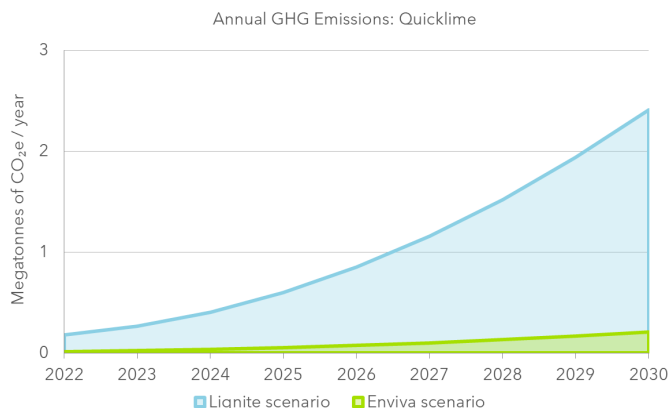
GHG Emissions Projections

Long-term potential GHG emissions and savings were projected for two scenarios in which each shares the same annual fuel energy demand (proportional to the potential Enviva biomass pellet energy-based demand in each respective industry). Scenarios are not based on Enviva's actual growth projections. The scenarios in green are based on hypothetical European market growth rates for biomass, and the blue scenarios assume coal or conventional jet fuel will continue to satisfy the same annual fuel demand in the absence of Enviva's biomass pellets or other alternative fuel pellets. For each industry, Enviva's products are assumed to compete with conventional products on an energy basis. The projections cover the years 2022 to 2030.

- ▶ The Enviva scenarios represent the projected emissions associated with the potential biomass market share in Europe in the quicklime, steel, and jet fuel industries.
- ▶ The conventional fuel scenarios represent the emissions if coal or petroleum continue to satisfy the same amount of fuel demand for each sector (i.e., in the absence of an alternative biomass fuel).
- ▶ All three scenarios assume Enviva would sell their product in Europe starting at the beginning of 2022. The projections assume Enviva would market all of the pellets to the current European market in 2022.
- ▶ The projections assume a hypothetical scenario of Enviva marketing all of their product to the European market starting in 2022, hence the scenario graphs do not start at zero. The calculations assume that Enviva would market all of its pellets to Europe starting in 2022 proportional to the percentage of total projected biomass share and growth rate in each respective industry. They also do not account Enviva's sales elsewhere.

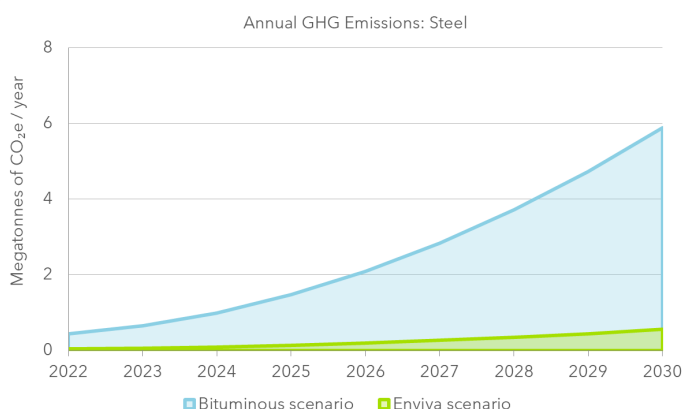
GHG Savings Projection: Quicklime Kiln Firing

- ▶ Lignite coal scenario: This scenario presents the GHG emissions associated with coal production and combustion (on an energy basis) equivalent to the potential demand growth rates of biomass pellets in the European quicklime industry.
- ▶ Enviva biomass pellet scenario: This scenario projects the GHG emissions, and GHG emissions savings, associated with the quicklime market projection rates in Europe. They do not reflect Enviva's actual growth rates, but rather reflect the hypothetical growth of biomass adoption as a fuel for the lime industry.
- ▶ Boundless estimated the GHG emissions savings that could be achieved if Enviva pellets were to replace coal in the European lime industry to be approximately 8.5 million metric tons (megatonnes) of CO₂e between 2022 and 2030.



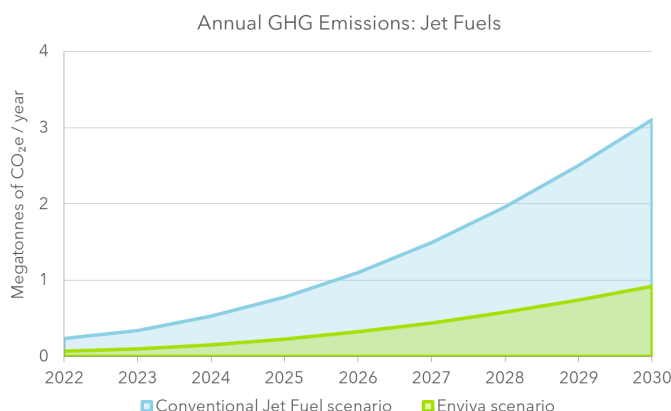
GHG Savings Projections: Steel Furnace Firing

- ▶ Boundless projected the estimated GHG savings realized if the Enviva biomass pellets were to replace coal in the European steel market between 2022 and 2030.
- ▶ Bituminous coal scenario: This scenario presents the GHG emissions associated with coal production and combustion (on an energy basis) equivalent to the market production and projection rates of biomass pellets in the European steel industry.
- ▶ Boundless estimated the GHG emissions savings that could be achieved if Enviva pellets were to replace bituminous coal in the European steel industry to be 21 million metric tons of CO₂e between 2022 and 2030.
- ▶ Projections are proportional to Enviva's current production rates and compared on a MJ enviva pellets to MJ bituminous basis. The graph shows hypothetical emissions based on the projected growth rate of the biomass sector in the limestone market and does not reflect Enviva's actual projected growth rates.



GHG Savings Projections: Jet Fuel Production

- ▶ The conventional jet fuel scenario presents the GHG Emissions associated with jet fuel production and combustion scaled to the market projections for woody biomass in the European jet fuels market. The jet fuel projections assume production in the United States, include shipping to Rotterdam, and fast pyrolysis.
- ▶ Boundless estimated the GHG emissions savings that could be achieved if Enviva pellets were to replace conventional petroleum jet fuel in Europe to be 8.5 million metric tons of CO₂e between 2022 and 2030. The calculation assumes 145,000 metric tons of pellets in 2022, which is a fraction of Enviva's total production proportional to the biomass fuel market share.



About Boundless Impact Research & Analytics

Boundless Impact Research & Analytics is a market intelligence and impact analytics firm that provides quantitative and evidence-based research and data for investors, companies, and funds. Driven by the latest research from independent industry and academic experts, Boundless Impact Research & Analytics offers analysis, market trends, and evidence of best practices in a growing number of emerging sectors that address significant environmental and health challenges. Our research into emerging technologies, impact assessment of companies, and thought leadership provide investors with the latest and most relevant information to drive their investment decisions.

Contact Us

Boundless Impact Research & Analytics

www.boundlessimpact.net

Michele Demers, CEO and Founder

mdemers@boundlessimpact.net

The information provided in this report by Boundless Impact Research & Analytics and accompanying material is for informational purposes only. The information in this report should not be considered legal or financial advice, nor an offer to buy or sell or a solicitation of an offer to buy or sell any security, product, service, or investment. Boundless Impact Research & Analytics does not make any guarantee or other promise, representation, or warranty as to the accuracy or completeness of the statements of fact contained within, or any results that may be obtained from using our content. Neither this content, nor the investment examples cited, should be used to make any investment decision without first consulting one's own financial advisor and conducting one's own research and due diligence. To the maximum extent permitted by law, Boundless Impact Research & Analytics disclaims any and all liability in the event any information, commentary, analysis, opinions, advice, and/or recommendations prove to be inaccurate, incomplete, or unreliable, or result in any investment or other losses.