



DOCUMENT PREPARED BY RECAST
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Project title	Recast Energy Louisville Fuel Switch from Coal to Biomass for Thermal Energy
Project ID	1386
Monitoring period	01-January-2022 to 31-March-2023
Original date of issue	27-September-2024
Most recent date of issue	24-April-2025
Version	7.4
VCS Standard Version	VCS Standard v4.7 is used by the project
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PROJECT DETAILS

1.1 Summary Description of the Implementation Status of the Project

The project is a fuel switch conducted by Recast Energy Louisville by converting an existing coal boiler to biomass combustion in Louisville, Kentucky. The project will generate approximately 53,600 (tCO₂e) GHG reductions annually over a 10-year period by replacing the coal production with renewable biomass combustion. Prior to the project, steam was generated using a combination of coal and natural gas boilers for three existing chemical companies that shared some utilities and infrastructure. The project involved the acquisition of the boiler house from one of the chemical companies which was discontinuing operations at the location. Recast Energy continued to use natural gas to generate steam for the remaining two chemical companies while implementing the conversion of the existing coal boiler to biomass combustion. The project (boiler conversion) began in June 2011 and went into operation on Dec 10, 2012. The plant has been in continuous operation since then. The total GHG emission reductions generated in this period is **46,576.1 tCO₂e for 2022 and 11,799.5 for Jan 1 to March 31, 2023.**

1.2 Audit History

Audit type	Period	Program	Validation/verification body name	Number of years
Verification	(01-April-2013--31-December-2014)	VCS	First Environment, Inc.	One year, 9 months
Verification	(01-January-2015 - 31-December-2017)	VCS	NSF Certification LLC	Three years
Verification	(01-January-2018 - 31-December-2018)	VCS	NSF Certification LLC	One year
Verification	(01-January-2019 - 31-December-2019)	VCS	NSF Certification LLC	One year
Verification	(01-January-2020 - 31-December-2020)	VCS	NSF Certification LLC	One year

Verification	(01-January-2021 - 31-December-2021)	VCS	SCS Global Services	One year
Verification	(01-January-2022 - 31-March-2023)	VCS	SustainCERT	One year, three months

1.3 Sectoral Scope and Project Type

Sectoral scope ¹	01 Energy (renewable/non-renewable)
Project activity type	This project is not grouped.

1.4 Project Proponent

Organization name	Recast Energy Louisville, LLC
Contact person	Jamie Howell
Title	Plant Manager
Address	4200 Bells Lane, Louisville, KY 40211
Telephone	502-772-4135
Email	JHowell@recastservices.com

1.5 Other Entities Involved in the Project

Organization name	There are no other entities involved in the development of the project.
Role in the project	
Contact person	
Title	
Address	

¹ Projects, activities, or methodologies may be developed under any of the 16 VCS sectoral scopes: <https://verra.org/programs/verified-carbon-standard/vcs-program-details/#sectoral-scopes>

Telephone	
Email	

1.6 Project Start Date

Project start date	10-December-2012
Justification	The date the project started generating thermal energy from biomass instead of coal.

1.7 Project Crediting Period

Crediting period	☐ Seven years, twice renewable ☐ Ten years, fixed ☒ Other (the Project Crediting Period is 10 years, with the possibility to renew twice.
Start and end date of first or fixed crediting period	01-April-2013 to 31-March-2023 is the initial 10-year crediting period.

1.8 Project Location

The project is located in Louisville, Kentucky on land owned by one of the project customers, Lubrizol. The project site is leased to the project company, Recast Energy Louisville, LLC under a long-term lease. The address and approximate coordinates are as follows: 4200 Bells Lane Louisville, KY 40211 Latitude: 38.2226280 Longitude: -85.8235880.

The boundary of the project encompasses the following equipment:

- i) The Recast Energy facility including: (1) The truck tipper (2) Truck scales (Lubrizol truck scales) (3) The wood yard and associated material sizing equipment (4) Material handling equipment, including front-end loader, reclaim, and wood conveyors (5) Biomass-Fueled Boiler and emission controls (6) Ash and blowdown handling systems (7) Control rooms and (8) Other ancillary equipment
- ii) Steam and Return Condensate lines interconnecting the project activity with the project customers
- iii) Project Customers: Lubrizol Advanced Material, Inc. and Zeon Chemicals, LP, both located on Bells Road, Louisville, KY

1.9 Title and Reference of Methodology

Type (methodology, tool or module).	Reference ID, if applicable	Title	Version
Methodology	UNFCCC AMS-I.C.	UNFCCC Clean Development Mechanism AMS-I.C. for Small Scale “Thermal Energy Projection with or without electricity”	19
Tool		Tool to calculate project or leakage CO2 emissions from fossil fuel combustion	02
Tool		Tool to calculate baseline, project and/or leakage emissions from electricity consumption	01
Tool		Tool to calculate the emission factor for an electricity system	04
Guidance		General guidelines for SSC CDM methodologies	20
Guidance		Indicative Simplified Baseline and Monitoring Methodologies for Selected Small-Scale CDM Project Activity Categories, General Guidance on Leakage in Biomass Project Activities	03
Guidance		Annex 18, Definition of Renewable Biomass	
Guidance		Guidelines of the Demonstration of Additionality of Small-Scale Project Activities	09

1.10 Double Counting and Participation under Other GHG Programs

1.10.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

☐ Yes

☒ No

1.10.2 Registration in Other GHG Programs

Was the project registered or seeking registration under any other GHG programs?

☐ Yes ☒ No

1.11 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.11.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? See the *VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

☐ Yes ☒ No

1.11.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system? See the *VCS Program Definitions* for definition of GHG-related environmental credit system.

☐ Yes ☒ No

1.11.3 Supply Chain (Scope 3) Emissions

Do the project activities affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☐ Yes ☒ No

1.12 Sustainable Development Contributions

For this project, activities were implemented that contribute to three Sustainable Development Goals (SDG's) as defined by the United Nations:

- **Developing Clean Energy** by replacing a fossil fuel (coal) with clean energy (biomass) as an industrial fuel source.
- **Responsible Consumption** by diverting wood residuals from commercial and industrial activities to be used as fuel instead of disposal by open burning or landfilling.
- **Climate Action** by avoiding GHG emissions from coal combustion.

Table 1: Sustainable Development Contributions

Row number	SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
1)	7.2	7.2.1 Renewable energy share in the total final energy consumption	Implemented activities to increase	Using converted 190 MMBtu/hr industrial steam boiler from coal to wood fuel, the project replaced 562.50 TJ of energy produced from coal combustion with an equal amount of renewable energy.	The project has replaced 4902.73 TJ of energy produced from coal combustion with an equal amount of renewable energy.
2)	12.4	Environmentally sound management of waste by diverting tons of wood residuals from air and landfills.	Implemented activities to increase.	Residuals from land clearing/maintenance, and wood product manufacturing have been diverted 79,569 tons of wood from open burning and landfilling to be used as fuel in this project.	The project has used 702,075 tons of wood/biomass that may have otherwise been open burned or landfilled.
3)	13.0	Tons of greenhouse gas emissions avoided or removed	Implemented activities to increase	By converting from coal to wood/biomass fuel, the project has prevented the release of 58,376 tonnes CO ₂ e carbon into the atmosphere during the monitoring period	Avoided the release of 507,066 tonnes CO ₂ e of carbon from fossil fuels (coal) into the atmosphere.

1.13 Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of this monitoring report.

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

Stakeholder Identification

The requirements to identify, solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration.

The owner had a previous understanding of potential stakeholders. The company business case was specifically acquiring and/or operating existing industrial facilities, where there would be no new impacts to stakeholders, and generally previous impacts were improved.

Early stages of the project development (2009) included meetings with the previous owner (OxyVinyls) and energy buyers (Lubrizol and Zeon). Document provided by Oxy Vinyls (2010) provided historical regulatory agency interactions information, as well as limited community interactions.

The process also included reviews of similar projects (wood fired boilers), meetings with local regulators (Louisville Metro Air Pollution Control District in 2010), community leaders, and external research on regional suppliers and employees.

Stakeholders identified were biomass suppliers, employees, government regulators and energy users, The facility is located within a large industrial complex, so there is no direct interaction with the community.

Legal or customary tenure/access rights	The requirements to identify, solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. The project maintains agreements and contracts for land access (long term lease) and biomass procurement. The project maintains local government permissions to operate the project.
Stakeholder diversity and changes over time	The requirements to identify, solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. Stakeholder categories have remained consistent since the start of the project.
Expected changes in well-being	The requirements to identify, solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. There are no expected changes in well-being and other stakeholder characteristics relative to the baseline scenario.
Location of stakeholders	The requirements to identify, solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. Stakeholders are primarily located within the Louisville region, close to the project site, with suppliers providing biomass within the vicinity.
Location of resources	The requirements to identify, solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. The project maintains agreements and contracts for land access (long term lease) and biomass procurement. The project maintains local government permissions to operate

2.1.2 Stakeholder Consultation and Ongoing Communication

Ongoing consultation	The requirements to solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. For this project, local stakeholders can communicate grievances by phone, mail, the project website (emails), and at the main gate of the project site. During the monitoring period, stakeholders may have been engaged informally through project activities and communications. • Energy Buyers: As needed, but typically an annual meeting is held • Biomass suppliers: Initial contracting, and then as needed • Government Regulators: periodic inspections, annual compliance reports, 5-year permit renewals • Employees: Monthly safety meetings, annual safety training, employee union contract negotiation every 3 years
Date(s) of stakeholder consultation	The requirements to solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. During the monitoring period, no formal stakeholder meetings were held, However, the following stakeholder meetings were held: Energy Buyers: September 12, 2019 and July 31, 2023. (No meetings were held 2020-2022 due to COVID) Biomass Suppliers: As needed. No dates recorded Government Regulators: No on-site inspections during 2021-2022 due to COVID. Annual and semi-annual compliance reports were submitted to regulators. Employees: Monthly Safety Meetings. Annual Safety training in June each year. The employee union contract was renegotiated and signed on October 3, 2022.

Communication of monitored results	The requirements to solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. Results of meetings with stakeholders are communicated and stored electronically. Stakeholder can also log complaints at the Recast main gate and also at the Recast website. Information is available at https://recastenergy.com/contact/.
Consultation records	The requirements to solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. For this project, any grievance that is received is stored in electronic format.
Stakeholder input	The requirements to solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. No grievances were received during the verification period. Input from employees are incorporated in the employee union contract. Input from energy users and biomass suppliers is incorporated into their respective contracts. Input from regulators are incorporated into respective permits and inspection results.

2.1.3 Free, Prior, and Informed Consent

Consent	For this project, there was no communication with local stakeholders during the current verification period. The requirements to solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration.
Outcome of FPIC	For this project, there was no communication with local stakeholders during the current verification period. The requirements to solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration.

2.1.4 Grievance Redress Procedure

Grievances received	Resolution and outcome
None received.	For this project, The requirements to solicit and document local stakeholder consultation were introduced by VCSA after the project validation and registration. The project has well established grievance procedures that can be used by stakeholders. Stakeholders can log complaint at the Recast main gate, and also at the Recast website. Information is available at https://recastenergy.com/contact/. All grievances or complaints filed are recorded and responses documented. Complaints logged at the main gate or online are immediately forwarded to the senior manager on site, the operations manager, and the president of the company. Review and initial response are made within a few days, but no more than 7 days. However, during this monitoring period, no grievances were received.

2.1.5 Public Comments

Summary of comments received	Actions taken
None received.	For this project, there was no public comment period. The requirements for a public comment period was introduced by VCSA after the project validation and registration.

2.2 Risks to Stakeholders and the Environment

2.2.1 Management Experience

For this project, there was no evaluation of the management during the current verification period.

The requirements to evaluate management team experience were introduced by VCSA after the project validation and registration.

2.2.2 Risk assessment

	Risk identified	Mitigation or preventative measure(s) taken
Natural and human-induced risks to stakeholders' wellbeing	No risk identified	For this project, there was no risk assessment during the current verification period. The requirements to assess risk to stakeholder and the environment were introduced by VCSA after the project validation and registration.
Risks to stakeholder participation	No risk identified	For this project, there was no risk assessment during the current verification period. The requirements to assess risk to stakeholder and the environment were introduced by VCSA after the project validation and registration.
Working conditions	No risk identified	For this project, there was no risk assessment during the current verification period.

		The requirements to assess risk to stakeholder and the environment were introduced by VCSA after the project validation and registration. For this project, there are written company policies included in the Employee Handbook and Training Program.
Safety of women and girls	No risk identified	For this project, there was no risk assessment during the current verification period. The requirements to assess risk to stakeholder and the environment were introduced by VCSA after the project validation and registration. For this project, there are written company policies included in the Employee Handbook and Training Program.
Safety of minority and marginalized groups, including children	No risk identified	For this project, there was no risk assessment during the current verification period. The requirements to assess risk to stakeholder and the environment were introduced by VCSA after the project validation and registration. For this project, there are written company policies included in the Employee Handbook and Training Program.
Pollutants (air, noise, discharges to water, generation of waste, and release of hazardous materials and chemical	No risk identified	For this project, there was no risk assessment during the current verification period. The requirements to assess risk to stakeholder and the environment were introduced by

pesticides and fertilizers)		VCSA after the project validation and registration. For this project, there is a Title V Operating Permit for air emissions, and wood ash is sent offsite for beneficial reuse.
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2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

	Risks identified ²	Mitigation or preventative measure(s) taken
Discrimination	No risk identified	For this project, there was no risk assessment related to labor and work during the current verification period. The requirements to assess risk to rights related to labor and work were introduced by VCSA after the project validation and registration.
Sexual harassment	No risk identified	For this project, there was no risk assessment related to labor and work during the current verification period. The requirements to assess risk to rights related to labor and work were introduced by VCSA after the project validation and registration.
Gender equity in labor and work	No risk identified	For this project, there was no risk assessment related to labor and

² The identified risks and commensurate mitigation or preventative measure(s) for forced labor, child labor, and human trafficking, must be inclusive of staff and contracted workers employed by third parties.

		work during the current verification period. The requirements to assess risk to rights related to labor and work were introduced by VCSA after the project validation and registration.
Forced labor	No risk identified	For this project, there was no risk assessment related to labor and work during the current verification period. The requirements to assess risk to rights related to labor and work were introduced by VCSA after the project validation and registration.
Child labor	No risk identified	For this project, there was no risk assessment related to labor and work during the current verification period. The requirements to assess risk to rights related to labor and work were introduced by VCSA after the project validation and registration. For this project, there was no risk assessment related to labor and work during the current verification period. The requirements to assess risk to rights related to labor and work were introduced by VCSA after the project validation and registration.
Human trafficking	No risk identified	For this project, there was no risk assessment related to labor and work during the current verification period.

		The requirements to assess risk to rights related to labor and work were introduced by VCSA after the project validation and registration.
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2.3.2 Human Rights

Risks identified	Mitigation or preventative measure(s) taken
No risk identified	For this project, there was no risk assessment related to human rights during the current verification period. The requirements to assess risk related to human rights were introduced by VCSA after the project validation and registration.

2.3.3 Indigenous Peoples and Cultural Heritage

Risks identified	Mitigation(s) or preventative measure taken
No risk identified	For this project, there was no risk assessment related to indigenous peoples and cultural heritage during the current verification period. The requirements to assess risk related to indigenous peoples and cultural heritage were introduced by VCSA after the project validation and registration.

2.3.4 Property Rights

Risks identified	Mitigation or preventative measure(s) taken
No risks identified	For this project, there was no risk assessment related to property rights during the current verification period. The requirements to assess risk related to property rights were introduced by VCSA after the project validation and registration.

2.3.5 Benefit Sharing

Summary of the benefit sharing plan	For this project, there was no risk assessment related to property rights and benefit sharing during the current verification period. The requirements to assess risk related to property rights and benefit sharing were introduced by VCSA after the project validation and registration.
Benefit sharing during the monitoring period	For this project, there was no risk assessment related to property rights and benefit sharing during the current verification period. The requirements to assess risk related to property rights and benefit sharing were introduced by VCSA after the project validation and registration.

2.4 Ecosystem Health

Risk identified		Mitigation or preventative measure(s) taken during the monitoring period
Impacts on biodiversity and ecosystems	No risk identified	For this project, there was no risk assessment related to biodiversity and ecosystems during the current verification period. The requirements to assess risk related to biodiversity and ecosystems were introduced by VCSA after the project validation and registration.
Soil degradation and soil erosion	No risk identified	For this project, there was no risk assessment related to biodiversity and ecosystems during the current verification period. The requirements to assess risk related to biodiversity and ecosystems were introduced by VCSA after the project validation and registration.
Water consumption and stress	No risk identified	For this project, there was no risk assessment related to biodiversity and ecosystems during the current verification period. The requirements to assess risk related to biodiversity and ecosystems were introduced by VCSA after the project validation and registration.

2.4.1 Rare, Threatened, and Endangered species

Species or habitat	<i>For this project, there was no risk assessment related to rare, threatened and endangered species during the current verification period.</i> <i>The requirements to assess risk related to rare, threatened and endangered species were introduced by VCSA after the project validation and registration.</i>
Areas needed for habitat connectivity	<i>For this project, there was no risk assessment related to rare, threatened and endangered species during the current verification period.</i> <i>The requirements to assess risk related to rare, threatened and endangered species were introduced by VCSA after the project validation and registration.</i>
...	...

	Risks identified	Mitigation or preventative measure(s) taken
Habitats for rare, threatened, and endangered species	No risk identified	For this project, there was no risk assessment related to rare, threatened and endangered species during the current verification period. The requirements to assess risk related to rare, threatened and endangered species were introduced by VCSA after the project validation and registration.
Areas for habitat connectivity	No risk identified	For this project, there was no risk assessment related to rare, threatened and endangered

		species during the current verification period. The requirements to assess risk related to rare, threatened and endangered species were introduced by VCSA after the project validation and registration.
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2.4.2 Introduction of species

Species introduced	Classification	Justification for use	Adverse effects and mitigation
N/A			
N/A			
N/A			

Existing invasive species	Mitigation measures to prevent the spread or continued existence of invasive species
For this project, there was no risk assessment related to existing invasive species during the current verification period. The requirements to assess risk related to existing invasive species were introduced by VCSA after the project validation and registration.	
For this project, there was no risk assessment related	

to existing invasive species during the current verification period. The requirements to assess risk related to existing invasive species were introduced by VCSA after the project validation and registration.	
For this project, there was no risk assessment related to existing invasive species during the current verification period. The requirements to assess risk related to existing invasive species were introduced by VCSA after the project validation and registration.	

	Risks identified	Mitigation or preventative measure(s) taken
Invasive species	No risk identified	For this project, there was no risk assessment related to invasive species during the current verification period. The requirements to assess risk related to invasive species were introduced by VCSA after the project validation and registration.

2.4.3 Ecosystem conversion

	Risks identified	Mitigation or preventative measure(s) taken
Ecosystem conversion	No risk identified	For this project, there was no risk assessment related to ecosystem conversion during the current verification period. The requirements to assess risk related ecosystem conversion were introduced by VCSA after the project validation and registration.

3 IMPLEMENTATION STATUS

3.1 Implementation Status of the Project Activity

The implementation status of the project is as follows:

- For the initial verification period (2013, 2014), the project operated continuously during the verification period supplying steam to the project customers as needed for their manufacturing operations. The normal demand for steam fluctuates with operational needs as well as the need for building heat during cold weather. However, on 11/4/2013, the biomass boiler was shut down when the de-aeration (DA) tank serving the boiler house failed and had to be replaced. A smaller temporary tank was installed, which resulted in a lower feedwater temperature until the full-sized permanent tank was installed on 6/24/2014. The lower temperature of the feedwater resulted in lower feedwater enthalpy and increased fuel usage for the period. This DA tank that failed was a part of the original boiler house and not installed or modified for the biomass boiler conversion project.
- For the current verification period (January 2022 - March 2023), the project operated continuously supplying steam to the project customers as needed for their manufacturing operations. The normal demand for steam fluctuates with operational needs as well as the need for building heat during cold weather. Increases and

decreases from year to year are primarily the result of fluctuations in demand for building heat for the manufacturing complex, as demonstrated by the customer invoices.

- There were no changes to the project activity, proponents, or other entities.

3.2 Deviations

3.2.1 Methodology Deviations

1) Parameter: Qsteam, AMS-I.C

Requirement: In case the project is exporting heat to other facilities, the metering shall be carried out at the recipient's end.

Deviation: Measure thermal energy produced directly from the steam and feed water meters on the biomass boiler, not at the customer's meters.

Justification: Steam for delivery to two separate customers is generated by one biomass boiler and up to 4 natural gas boilers. If steam is measured at the customer's meters, steam and feed water measurements will comingle mass and energy from all boilers will be used to calculate thermal energy generated by the biomass boiler alone. Recast proposes simply measuring the steam and feed water only at the biomass boiler to eliminate the inaccuracy introduced by deriving the thermal energy using 12 measuring points instead of 2 direct measuring points. Accordingly, the enthalpy values, hsteam and hfeedwater will be determined at the biomass boiler. This deviation will result in increased accuracy of the baseline by directly measuring the energy produced from biomass.

2) Parameter: ECy, AMS-I.C

Requirement: Use "Tool to calculate baseline, project and/or leakage emissions from electricity consumption"

Deviation: Electricity consumption is measured based on the difference in equipment (motor ratings) on Boiler #4 before and after conversion.

Justification: Reliable data is not available for electricity consumption of the boiler house prior to conversion. The converted boiler is one part of a complex boiler house system consisting of other boilers, water pumps, water treatment systems, etc. that did not change with the project. A study will be prepared that identifies the changes in equipment for Boiler #4 and the maximum capacity for electricity usage before and after the project. Once per verification period, the list of equipment used to calculate the net change in electricity will be reviewed for any equipment and usage updates, and the net change in electricity recalculated for inclusion in the project emissions calculations. This deviation is conservative, as it measures the maximum potential electricity usage for Boiler #4 pre and post project, which will be larger than the actual usage of the boiler. The deviation is also more accurate, as it is very difficult to isolate the electrical usage of Boiler #4 and the boiler house in general both pre and post project.

3) Parameter: EFgrid, CM,y, AMS-I.C

Requirement: Use “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”

Deviation: Data from the US Environmental Protection Agency eGRID tables is used in place of calculating a combined margin emission factor per the Tool.

Justification: The Emissions & Generation Resource Integrated Database (eGRID) is a comprehensive source of data on the environmental characteristics of almost all electric power generated in the United States. Emission factors are generated for the US based on the electricity generation in each sub-region. This deviation is more accurate than a default factor (Option A2) and is more accurate than using Option A1 to calculate a combined margin emission factor based on the closest power producers. The project is connected to a large power grid that will pool electricity from many sources over the project life, so a regional average will include the full range of fuels producing GHG's in the region of the project.

4) Parameter: FCDiesel, loader, y, AMS-I.C

Requirement: Use “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”

Deviation: Purchased fuel invoices are used to monitor the quantity of diesel fuel used to calculate the project CO₂ emissions from fossil fuel.

Justification: The diesel fuel is metered into the onsite storage tank by the fuel supplier and recorded on the invoices, and this deviation assumes all fuel purchased during the monitoring period is used in the onsite fuel moving equipment. This deviation is conservative by assigning all purchased fuel at the facility to the project emissions calculations.

Note: These deviations were approved in the Validation and Initial Verification by VCS and have not changed for this reporting period

3.2.2 Project Description Deviations

There were no Project Description Deviations for this monitoring report.

3.3 Grouped Projects

This project is not grouped.

3.4 Baseline Reassessment

Did the project undergo baseline reassessment during the monitoring period?

☐ Yes

☒ No

4 DATA AND PARAMETERS

4.1 Data and Parameters Available at Validation

Data/Parameter	NCVDiesel, y
Data Unit	GJ/gallon
Description	Weighted average net calorific value of fuel (diesel) in year y
Source of Data	Transportation Energy Data Book, Edition 39, Table B.4, published by Oak Ridge National Labs updated August 2021. https://cta.ornl.gov/data/appendix_b.shtml Table B.4.
Value Applied	0.1464
Justification of Choice of Data or Description of Measurement Methods and Procedures Applied	Data source (c) selected as national default value since preferred source (a) is not available. To be reviewed annually.
Purpose of Data	Calculation of project emissions Calculation of leakage
Comments	Values reviewed for verification period. No change to parameter value for verification period.

Data/Parameter	EF _{CO2,Diesel, y}
Data Unit	tCO ₂ e/GJ
Description	Weighted average CO ₂ emission factor of fuel type (diesel) in year y
Source of Data	DOE Voluntary Reporting of Greenhouse Gases Program: Fuel and Energy Source Codes and Emission Coefficients. https://www.eia.gov/environment/emissions/co2_vol_mass.php
Value Applied	0.06935
Justification of Choice of Data or Description of Measurement Methods and Procedures Applied	Data source (c) selected as national default value since preferred source (a) is not available. To be reviewed annually.

Purpose of Data	Calculation of project emissions and leakage
Comments	DOE program discontinued in 2014. Values published by DOE from program data in 2016 were used (see link in Source of Data). Value continues to be used in most EIA publications. No change from previous verification period.

Data/Parameter	Eff _{Diesel,process j,y}
Data Unit	gal/ton
Description	The diesel fuel consumed to collect and process biomass of type j
Source of Data	Estimate based on manufacturer specification for particular operating conditions. Sum of worst-case fuel economy specified by the manufacturer for typical pieces of collecting /processing equipment.
Value Applied	Mill residues = 0 Forestry residues = 1.54 Crop residues = n/a
Justification of Choice of Data or Description of Measurement Methods and Procedures Applied	For forestry residues, calculated value was compared against published study by University of Georgia and compared with estimates provided by equipment manufacturers.
Purpose of Data	Calculation of project leakage
Comments	No comments

Data/Parameter	EF _{CO2, Coal}
Data Unit	tCO2/TJ
Description	CO2 Emission Factor for Bituminous Coal, calculated on a Gross Calorific Value (GCV) basis
Source of Data	DOE Voluntary Reporting of Greenhouse Gases Program: Fuel and Energy Source Codes and Emission Coefficients. https://www.eia.gov/environment/emissions/co2_vol_mass.php
Value Applied	88.44 (GCV Basis) tCO2/TJ
Justification of Choice of Data or Description of Measurement Methods and Procedures Applied	Data source selected as reliable national value from the US Department of Energy. To be reviewed annually for updates.
Purpose of Data	Calculation of baseline emissions

Comments	DOE program discontinued in 2014. Values published by DOE from program data in 2016 were used (see link in Source of Data). Value continues to be used in most EIA publications. No change from previous verification period.
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Data/Parameter	$\eta_{BL, Thermal}$
Data Unit	%
Description	Efficiency of project legacy boiler system, Gross Calorific Value (GCV) basis
Source of Data	Value taken from EPA-600/7-81-111a July 1981, "Emissions and Efficiency Performance of Industrial Coal Stoker Fired Boilers", table 1-2.
Value Applied	83.43%
Justification of Choice of Data or Description of Measurement Methods and Procedures Applied	Value selected using option 30(a) for efficiency of baseline units per methodology. Value extracted from 1981 EPA publication of test results for boilers with similar specifications using coal. The highest measured value from the study was selected, and equipment efficiency is expected to have degraded over time, making this efficiency a conservative value.
Purpose of Data	Calculation of baseline emissions
Comments	No comments

4.2 Data and Parameters Monitored

Data/Parameter	$EG_{thermal,y}$
Data Unit	Tj
Description	The net quantity of steam/heat supplied by the project activity during the year y
Source of Data	Calculation

Description of Measurement Methods and Procedures to Be Applied	The net quantity of steam calculated from the quantity of steam (Q _{steam}) and enthalpy (h) during the verification period
Frequency of Monitoring/Recording	At least annually.
Value Monitored	For 2022: 448.85 For 2023: 113.65
Monitoring Equipment	NA
QA/QC Procedures to Be Applied	NA
Purpose of the Data	Calculation of baseline emissions
Calculation Method	$EG_{thermal,y} = Q_{steam,y} \cdot (h_{steam} - h_{feedwater}) \cdot 1.055E-9$
Comments	No comments

Data/Parameter	EF _{grid, CM,y}
Data Unit	tCO ₂ e/MWh
Description	Combined margin emission factor for the grid in year y
Source of Data	USEPA eGrid eGrid2022 Summary Table (https://www.epa.gov/egrid/download-data) Table 1, Region SRTV (Tennessee Valley)
Description of Measurement Methods and Procedures to Be Applied	Annual update using most recent data
Frequency of Monitoring/Recording	At least once per verification period

Value Monitored	For 2022 and 2023: 0.427 tCO ₂ e/MWh (from 2022 report which is the most recent data available)
Monitoring Equipment	Not Applicable
QA/QC Procedures to Be Applied	Not Applicable
Purpose of the Data	Calculation of project emissions
Calculation Method	Not Applicable
Comments	No comments

Data/Parameter	TDL _y
Data Unit	Not Applicable
Description	Average technical transmission and distribution losses for providing electricity to the project in year y
Source of Data	USEPA eGrid <u>eGrid2022 Summary Table (https://www.epa.gov/egrid/download-data</u> Table 1, Region SRTV (Tennessee Valley)
Description of Measurement Methods and Procedures to Be Applied	Annual review of data source for most recent published value appropriate for the verification period.
Frequency of Monitoring/Recording	Annual Review
Value Monitored	For 2022 and 2023: 0.051 (from 2022 report which is the most recent data available)

Monitoring Equipment	Not Applicable
QA/QC Procedures to Be Applied	Not Applicable
Purpose of the Data	Calculation of project emissions
Calculation Method	Not Applicable
Comments	No comments

Data/Parameter	$Q_{\text{steam},y}$
Data Unit	Lbs
Description	The quantity of steam generated by the project activity (Boiler #4) in year y
Source of Data	Steam meter reading for Boiler #4
Description of Measurement Methods and Procedures to Be Applied	The steam meter sends continuous readings to the automated process control system. A daily sum of the steam produced is recorded by the process control computer and transcribed daily to operator logs and spreadsheets. The monthly totals are added over the monitoring period.
Frequency of Monitoring/Recording	Continuous monitoring with at least monthly recording of total steam produced by Boiler
Value Monitored	For 2022: 429,088,200 For 2023: 108,292,600
Monitoring Equipment	ABB Vortex Flowmeter FV4000
QA/QC Procedures to Be Applied	The meter was calibrated at start-up in accordance with the manufacturer's specifications. Per the manufacturer Operating Instructions, there is no recommended recalibration schedule. The meter will be serviced by a qualified technician at least once every three years to verify proper installation and operating parameters. In

	addition, the sum total of all boiler steam meters is reconciled with the customer delivery steam meters for fuel-based billing. Meter was serviced in 2021.
Purpose of the Data	Calculation of baseline emissions
Calculation Method	Addition of daily totalized readings
Comments	No comments

Data/Parameter	h_{steam}
Data Unit	Btu/lb
Description	The enthalpy of steam as it leaves the biomass boiler.
Source of Data	Pressure monitoring assembly located to measure steam exiting Boiler #4.
Description of Measurement Methods and Procedures to Be Applied	Automated reading and recording of the pressure was used to calculate enthalpy using standard thermodynamic tables
Frequency of Monitoring/Recording	Pressure values were determined at least hourly and recorded at least daily. The average daily pressure was translated into enthalpy using standard thermodynamic tables, assuming saturated steam conditions.
Value Monitored	For 2022: 1197.46 For 2023: 1197.55
Monitoring Equipment	Steam pressure is monitored by a pressure meter (transducer)
QA/QC Procedures to Be Applied	The meters are calibrated in accordance with the manufacturers' specifications. The manufacturer of the pressure monitoring equipment does not recommend a calibration. The equipment will be evaluated by a qualified technician at least once every three years during the project to verify proper installation and operating parameters. The equipment was evaluated in 2021.

Purpose of the Data	Calculation of baseline emissions
Calculation Method	Microsoft Excel calculations based on IAPWS IF-97 (see www.iapws.org) using code provided by Mangus Homgren at http://www.mathworks.com/matlabcentral/fileexchange/9817-x-steam-thermodynamic-properties-of-water-and-steam-or-equivalent .
Comments	No comments

Data/Parameter	$h_{\text{feedwater}}$	
Data Unit	btu/lbs	
Description	The enthalpy of boiler feed water as it enters the biomass boiler (Boiler #4).	
Source of Data	Temperature monitoring assembly located on feed water line entering Boiler #4	
Description of Measurement Methods and Procedures to Be Applied	Automated reading and recording of the temperature was used to calculate enthalpy using standard thermodynamic tables.	
Frequency of Monitoring/Recording	Temperature value was determined at least hourly and recorded at least daily. The average daily temperature was translated into enthalpy using standard thermodynamic tables.	
Value Monitored	For 2022: 205.9 For 2023: 202.8	
Monitoring Equipment	Temperature monitoring assembly consisting of RTD (Resistance Temperature Detectors) and thermo well with appropriate operating range.	
QA/QC Procedures to Be Applied	The sensors are calibrated in accordance with manufacturer specifications. The manufacturer of the temperature monitoring equipment does not recommend a calibration frequency. The equipment will be evaluated by a qualified technician at least once	

	every three years to verify proper installation and operating parameters. Equipment was evaluated in 2021.	
Purpose of the Data	Calculation of baseline emissions	
Calculation Method	Microsoft Excel calculations based on IAPWS IF-97 (see www.iapws.org) using code provided by Mangus Homgren at http://www.mathworks.com/matlabcentral/fileexchange/9817-x-steam-thermodynamic-properties-of-water-and-steam or equivalent.	
Comments	No comments	

Data/Parameter	FC _{Diesel, loader, y}	
Data Unit	Gal	
Description	Quantity of diesel fuel used by the front-end loader and any other on-site fuel moving equipment	
Source of Data	Invoices from the fuel supplier	
Description of Measurement Methods and Procedures to Be Applied	Individual fuel invoices from the fuel supplier were summed over the entire reporting period, assuming all diesel fuel delivered is consumed by the loader.	
Frequency of Monitoring/Recording	Each invoice was recorded	
Value Monitored	For 2022: 10,505.30 For 2023: 2,717.00	
Monitoring Equipment	NA	
QA/QC Procedures to Be Applied	Purchased fuel invoices were identified, recorded at least monthly and archived	
Purpose of the Data	Calculation of project emissions	

Calculation Method	Addition
Comments	No comments

Data/Parameter	EC _y
Data Unit	MWh
Description	Power consumed by the project activity
Source of Data	Engineering study
Description of Measurement Methods and Procedures to Be Applied	A study was prepared that identifies the changes in equipment for Boiler #4 and the maximum capacity for electricity usage before and after the project. The difference in usage was applied as the power consumed by the project activity.
Frequency of Monitoring/Recording	During this initial verification period, the engineering study was created, and then reviewed and updated as needed after the end of this verification period. The list of equipment used to calculate the net change in electricity was reviewed for any equipment and usage updates. The net change in electricity was recalculated for inclusion in the project emissions calculations.
Value Monitored	For 2022: 1,957 For 2023: 489
Monitoring Equipment	Not applicable
QA/QC Procedures to Be Applied	The master list of plant equipment was compared to the equipment listed in the study, including visual confirmation of the presence and specifications of major equipment components. The list of plant equipment was verified as correct for the current verification period.

Purpose of the Data	Calculation of project emissions
Calculation Method	The difference in maximum capacity for electricity usage by Boiler #4 pre and post project. $EC_y = EC_{total,y} - EC_{avg,(pre-project)}$ Where: $EC_{total,y}$ = maximum electricity capacity for Boiler #4 in year y; MWh $EC_{avg,(pre-project)}$ = maximum electricity capacity for Boiler #4 prior to project; MWh
Comments	No comments

Data/Parameter	DAF _{biomass delivery}
Data Unit	Km
Description	Estimated round-trip delivery distance
Source of Data	Delivery tickets; Yahoo Maps
Description of Measurement Methods and Procedures to Be Applied	The one-way driving distance from the project site to a biomass source was determined using Yahoo Maps and is doubled to arrive at the round-trip distance. The round trip distance is summed over all delivery tickets received for each source or destination during the reporting period.
Frequency of Monitoring/Recording	Each delivery ticket
Value Monitored	[Σ(DAF)] Biomass: For 2022: 17,979 For 2023: 922

Monitoring Equipment	Not applicable
QA/QC Procedures to Be Applied	Each delivery ticket or electronic record is reviewed and verified by a project employee, reviewed periodically during invoice matching and then archived.
Calculation of Leakage	Calculation of leakage
Calculation Method	Summation
Comments	For all deliveries from biomass source, the round-trip distance to the source is used (truck scales are on the project site). For deliveries from an industrial point source, (e.g. sawdust from a sawmill), the round-trip distance is calculated to the mill. For deliveries from a distributed source (e.g. in-woods or unidentified mill), the round-trip distance is calculated to the center of the county from which the delivery originated. For the monitoring period, a table was developed listing roundtrip distances for primary industrial locations and surrounding counties used during the monitoring period. For biomass deliveries, all round trip distances less than 400km (200 km radius) are excluded from the summation.

Data/Parameter	DAF, ash delivery
Data Unit	Km
Description	Estimated round-trip delivery distance
Source of Data	Delivery tickets; Yahoo Maps
Description of Measurement Methods and Procedures to Be Applied	The one-way driving distance from the project site to an ash destination is determined using Yahoo Maps and is doubled to arrive at the round-trip distance. The round trip distance is summed over all delivery tickets received for each source or destination during the reporting period.

Frequency of Monitoring/Recording	Each delivery ticket
Value Monitored	[Σ(DAF)] Ash: For 2022: 0 For 2023: 0
Monitoring Equipment	Not applicable
QA/QC Procedures to Be Applied	Each delivery ticket or electronic record was reviewed and verified by a project employee, reviewed periodically during invoice matching and then archived.
Purpose of the Data	Calculation of leakage
Calculation Method	Summation
Comments	For ash deliveries the actual delivery round-trip distance is calculated. For the monitoring period, a table was developed listing roundtrip distances for deliver points used during the monitoring period. For ash deliveries, all round trip distances less than 400km (200 km radius) are excluded from the summation.

Data/Parameter	$EFF_{tt,y}$
Data Unit	Km/gal
Description	Fuel efficiency for tractor trailers
Source of Data	TRANSPORTATION ENERGY DATA BOOK: EDITION 40 —2022, Table 5.2, 2020 Data. https://cta.ornl.gov/data/tedbfiles/Edition39_Chapter05.pdf

Description of Measurement Methods and Procedures to Be Applied	The latest published version of the Transportation Energy Data Book is reviewed and the parameter is updated with the most recent value.
Frequency of Monitoring/Recording	Annual during verification process for verification period.
Value Monitored	9.98 (6.2 miles/gal) is the value for 2020 as published in the June 2022 update of the TEDB.
Monitoring Equipment	Not applicable
QA/QC Procedures to Be Applied	Not applicable
Purpose of the Data	Calculation of leakage
Calculation Method	Not applicable
Comments	No comments

Data/Parameter	$Q_{\text{biomass},j,y}$
Data Unit	Tons, as received (wet)
Description	Quantity of biomass residues of type j delivered to the project activity, as received.
Source of Data	Delivery ticket; truck weigh scale
Description of Measurement Methods and Procedures to Be Applied	Truck scale weighs the net biomass delivered from each load; delivery ticket records the net weight and origin. Each load of biomass received for the project will be identified by the source then tagged with an identifier indicating whether processing would have occurred pre-project, or whether the material was processed specifically for the project. All biomass processed specifically for the project will be included in the calculations. Any delivery which cannot be clearly identified and tagged indicating the source processing status will be assumed to be processed for the project.

Frequency of Monitoring/Recording	Each truckload
Value Monitored	For 2022: All Biomass Delivered: 66,067 tons Biomass Not Processed for Project 66,067 tons Biomass Processed for Project 0 tons For 2023: All Biomass Delivered: 13,502 tons Biomass Not Processed for Project 13,502 tons Biomass Processed for Project 0 tons
Monitoring Equipment	Truck scales
QA/QC Procedures to Be Applied	Truck scales are calibrated at least once per year in accordance with manufacturer recommendation. Each delivery ticket is reviewed and signed by a project employee upon receipt from the truck driver, reviewed during invoice matching and then archived.
Purpose of the Data	Calculation of leakage
Calculation Method	Aggregation of the tons of wood identified or tagged as wood processed for the project
Comments	The Louisville area has previously developed the following consolidation and distribution activities that are considered “not processed for the project”: • Mulch distribution • Landfilling or other disposal • Commercial aggregating facilities The following activities did not require processing prior to the project: • In place open-burning or decomposition

Therefore, of the above categories, only in place open-burning or decomposition require any additional processing/sizing for use by the project and will be included in the aggregation of biomass processed for the project.

For this verification period, no biomass was processed exclusively for the project.

4.3 Monitoring Plan

Recast Energy applies a disciplined approach to managing the real-time operations and performance of its facilities. This includes detailed operational guidelines and procedures as well as an array of management reporting metrics and tools. The purpose of monitoring is to:

- Ensure accurate and timely communications,
- Facilitate operational decision making,
- Retain records for mandatory reporting to government regulators, and
- Verify GHG emission reductions. The reference manual “Louisville Operating Procedures” details the project’s general operating procedures, including data monitoring and reporting. A copy is stored onsite and revised from time to time.

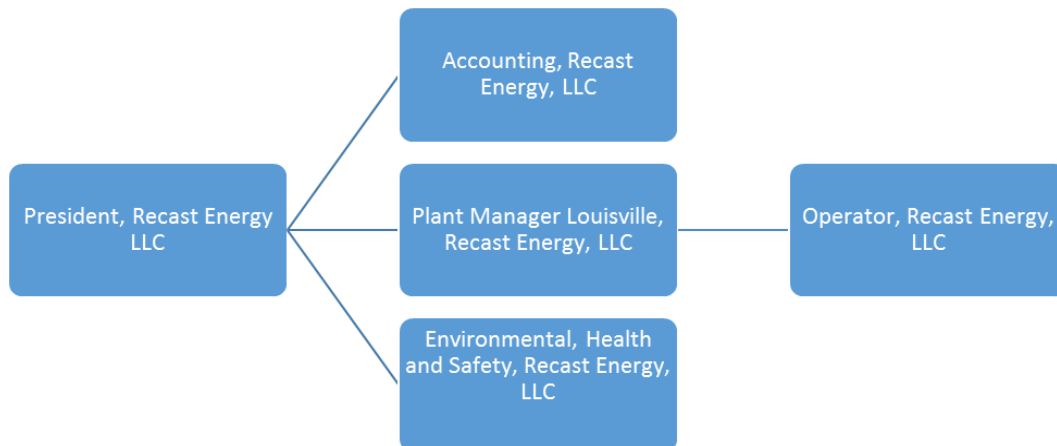
Table 2 lists the project-specific parameters monitored for the purposes of verifying GHG emission reductions. Additional parameters generated from third-party sources are monitored as needed and specified in later sections of this document.

Table 2 Project-Specific Parameters Monitored under Monitoring Plan

Data Parameter	Units	Frequency	Measured, Estimated, Reported	Party Responsible for Recording Data
Steam	Lbs	Continuous with At Least Monthly Recording	Measured	Recast Operator
Steam Pressure	Psi	At least Hourly and Recorded At Least Daily	Measured	Recast Operator
Feed Water Temperature	°F	At Least Hourly and Recorded At Least Daily	Measured	Recast Operator
Feed Water Flow	Gal/hr	At least Hourly and Recorded At Least Daily	Measured	Recast Operator

Electricity Consumption	KWh	Once Per Monitoring Period	Engineering Study	Recast EHS
Diesel Fuel Consumption (at Project)	Gallons	Each Delivery	Reported by Supplier	Recast Accounting
Diesel Fuel Consumption for Biomass Processing	Gallons	Annually	Estimated	Recast EHS
Biomass Delivery Weight	Lbs	Each Delivery	Measured	Recast Accounting
Biomass Origin		Each Delivery	Reported by Supplier	Recast Accounting
Distance to Origin	Km	Each Delivery	Estimated	Recast EHS
Ash Transportation Weights	Loads	Each Delivery	Measured	Recast Accounting
Ash Destinations		Each Delivery	Estimated	Recast EHS

Recast Energy operators are located at the facility in Louisville, KY. Recast Energy Accounting and EHS are located at the corporate headquarters in Richmond, VA. The organization structure is as follows:



Recast Energy operators are trained in boiler house operations, equipment maintenance, and process record keeping. The boiler house is staffed at all times by at least two operators who are responsible for monitoring operations and delivery of steam to the project customers.

Recast Energy Accounting is responsible for Accounts Payable, Accounts Receivable, and all associated record keeping for financial audits. Recast Energy EHS is responsible for maintaining all environmental permits, monitoring environmental data, and submitting required reports to designated agencies.

The project emissions are monitored with a combination of project-specific parameters and data published by third-party authorities. Project-specific parameters include those listed in Table 2.

The parameters used to calculate baseline emissions are monitored using a continuous steam mass flow rate meter and the integrated digital display; flow, temperature and pressure readings are computer-logged. The boiler system is configured to operate at pre-set conditions to deliver required steam loads to the project customer's steam tie-in point using primarily the biomass boiler supplemented by the natural gas boilers as needed. The instrumentation is calibrated on a schedule that is consistent with the manufacturer recommendations.

Steam mass flow and pressure are measured as it leaves the biomass boiler and prior to combining with steam from other boilers, conditions at which the legacy baseline boiler system would also have delivered steam. Condensate return and make-up water temperature is also measured as feed water entering the biomass boiler. These measurements and standard thermodynamic reference tables are used to calculate the net enthalpy rise in the fluid, thereby determining the useful energy generated. These parameters are monitored and recorded using either: 1) direct visual measuring and manual recording or 2) automated telemetric meter reading.

Process data from the automated telemetric meter reading used to calculate the baseline emissions is recorded in raw form by the process control computer system in daily data files. From this data, cumulative data (e.g., daily steam flow) is recorded manually by operators onto daily log sheets and in various spreadsheets.

Procedures have been implemented to prevent data loss. All data used to calculate the baseline is recorded in the daily operators log sheet and transferred to spreadsheets after quality review. Data summaries are also transferred electronically into spreadsheets stored within the data system. And finally, all process data files and spreadsheets are backed up to a second off-site location at least daily.

Electricity consumption from the grid is determined from an engineering study that will be reviewed during each monitoring period for updated equipment information. With the exception of the front-end loader, all major pieces of equipment at the project site are powered with electricity supplied by the grid. Diesel fuel consumption by the onsite front-end loader used in the biomass fuel yard is reported with each invoice/statement from the diesel fuel supplier. The

net weight of biomass is monitored by the truck scale and recorded either on the delivery ticket issued and signed for each delivery or by an automated system. The biomass origin is used to calculate the transportation and account for the diesel fuel consumed for processing of certain biomass residues. Note that due to the use of contractors who collect and process fuels and their use of subcontractors to haul the fuels, exact mileage from in-woods or in-field job sites is not tracked. Instead, the county of origin is tracked and all deliveries from a specific county are assumed to have originated from the center of the county for the purpose of calculating distance.

The procedures used for handling any internal auditing performed and any non-conformities identified are as follows:

For information collected and recorded by operators, the data is transferred daily to a master spreadsheet (dashboard) by a supervisor, and any anomalies or suspected errors are investigated and corrected immediately. This data is reviewed and used for multiple purposes in operations.

For information collected by the accounting department, invoices are reviewed when received and approved by the plant manager. Any suspected errors are investigated and corrected prior to payment. Wood tickets are reviewed and recorded daily at the plant and the accounting department compares the list to the invoices from vendors. Anomalies and suspected errors are investigated and corrected.

The EHS group reviews the information recorded on each wood ticket and works with the wood manager to confirm the origin location and type of material based on knowledge of the vendor and source locations associated with the vendor. Any corrections to source location and type of material is documented on the wood log used to calculate distances the fuel travels to the project.

All documents and records used in this monitoring plan shall be stored in a secure and retrievable manner for at least two years after the end of the project crediting period.

5 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

5.1 Baseline Emissions

For this project, the simplified baseline is the fuel consumption of the technology that would have been used in the absence of the project activity multiplied by the emission factor for the displaced fossil fuel.

The conversion of the boiler to wood-burning is displacing the use of coal in the same boiler. Therefore, the net quantity of steam/heat generated by the wood-fueled boiler will be measured, corrected for efficiency of the coal-fueled boiler, and multiplied by the CO₂ emission factor of the coal.

Baseline emissions for this project will be calculated using equation (2) from paragraph 22 “Baseline emissions for power and heat production” of the methodology:

$$BE_{\text{thermal, CO}_2, y} = (EG_{\text{thermal, y}} / \eta_{\text{BL, thermal}}) * E_{\text{FF, CO}_2}$$

Where:

$BE_{\text{thermal, CO}_2, y}$	=	The baseline emissions from steam/heat displaced by the project activity during the year y (tCO ₂)
$EG_{\text{thermal, y}}$	=	The net quantity of steam/heat supplied by the project activity during the year y (TJ)
$E_{\text{FF, CO}_2}$	=	The CO ₂ emission factor of the fossil fuel that would have been used in the baseline plant (coal)
$\eta_{\text{BL, thermal}}$	=	The efficiency of the plant using fossil fuel that would have been used in the absence of the project activity

Calculation of EG_{thermal} :

EG_{thermal} represents the thermal energy produced by combusting biomass fuel in Boiler #4. It is calculated from the quantity of steam produced and the difference in heat content (enthalpy) between the boiler feedwater and steam produced.

$$EG_{\text{thermal, y}} = Q_{\text{steam, y}} * (h_{\text{steam}} - h_{\text{feedwater}}) * 1.055\text{E-9}$$

Where:

Q_{steam}	=	The quantity of steam generated by the project activity
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$(h_{\text{steam}} - h_{\text{feedwater}})$	=	The difference in enthalpy of the steam and feedwater
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Monitoring Period Baseline Emissions Calculation Results:

		<u>2022</u>	<u>2023</u>	<u>Units</u>
$EG_{\text{thermal},y}$	=	448.85	113.65	TJ
$\eta_{\text{BL,thermal}}$	=	83.43	83.43	%
$EF_{\text{FF},\text{CO}_2}$	=	88.44	88.44	tCO ₂ e/TJ
BE_{thermal}	=	47,578	12,047	tCO ₂ e

5.2 Project Emissions

Project emissions are in accordance with paragraph 45 of CDM AMS-I.C and include:

- CO₂ emissions from on-site consumption of diesel fuel in equipment used to move wood fuel within the facility, and
- CO₂ emissions from electricity consumption by the project activity that is in excess of the electricity used by the boiler prior to the activity.

Project Emissions from Diesel Fuel:

The CO₂ emissions from on-site consumption of diesel fuel will be measured in accordance with CDM “Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion.” The emissions will be calculated by multiplying the quantity of fuel purchased in the reporting period (from fuel supplier invoices) by the emission factor for diesel fuel:

$$PE_{\text{FC,loader},y} = FC_{\text{Diesel, loader}, y} * COEF_{\text{Diesel},y}$$

Where:

$FC_{\text{Diesel,loader},y}$	=	The quantity of diesel fuel combusted to operate the fuel moving equipment during the year
$COEF_{\text{Diesel},y}$	=	The CO ₂ emissions coefficient for diesel fuel during the year y; tCO ₂ e/gal
$COEF_{\text{Diesel}, y}$	=	$NCV_{\text{Diesel}, y} * EF_{\text{CO}_2,\text{Diesel},y}$
$NCV_{\text{Diesel},y}$	=	The weighted average net calorific value of the fuel type (diesel) in year y
$EF_{\text{CO}_2,\text{Diesel}, y}$	=	The weighted average CO ₂ emission factor of the fuel type (diesel) in year y

Project Emissions from Power Consumption:

No electricity is generated by the project activity and no captive power plant supplies any of the electricity consumed by the project activity; all electric power is purchased from the local utility, Louisville Gas and Electric (LG&E).

$$PE_{EC,y} = EC_y * EF_{EL,y} * (1 + TDL_y)$$

Where:

$EF_{EL,y}$	=	The CO ₂ emission factor for the grid purchased electricity; tCO ₂ e/MWh
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And under Scenario A, Option A1:

$EF_{EL,y}$	=	$EF_{grid, CM,y}$ = Combined margin emission factor for the grid in year y
EC_y	=	The electricity consumed by the project activity during year y; MWh
TDL_y	=	Average technical transmission and distribution losses for providing electricity to project in year y

Monitoring Period Project Emission Calculation Results:

The following estimates the annual project emissions for the project activity:

$$PE_y = PE_{FC,loader,y} + PE_{EC,y}$$

		<u>2022</u>	<u>2023</u>	<u>Units</u>
$PE_{FC,loader,y}$	=	106.66	27.59	tCO ₂ e
$PE_{EC,y}$	=	877.37	219.34	tCO ₂ e
PE_y		984.03	246.93	tCO ₂ e

5.3 Leakage Emissions

The project boundary includes the immediate site leased by Recast Energy. Activities relating to the project outside this boundary include: the collecting, processing, and transporting of biomass. Emissions outside the project boundary are estimated as the project leakage. The following equation is used to determine the annual project leakage:

$$LE_y = LE_{biomass\ process,y} + LE_{biomass\ transp,y} + LE_{ash\ transp,y} + LE_{L2,y}$$

Where:

LE_y	=	The project leakage during the year y; tCO ₂ e
$LE_{\text{biomass process},y}$	=	The emissions from off-site consumption of diesel fuel during the collecting and processing of biomass residues into a transport-ready fuel format; tCO ₂ e
$LE_{\text{biomass transp},y}$	=	The emissions from off-site consumption of diesel fuel during the transporting of biomass residues from more than 200km to the project site; tCO ₂ e
$LE_{\text{ash transp}}$	=	The emissions from off-site consumption of diesel fuel during the transportation of ash (combustion residuals) from the project to beneficial use outlets or other final destination; tCO ₂ e
$LE_{L2,y}$	=	The emissions from type L2, if applicable; tCO ₂ e

Project Leakage from Biomass Collecting and Processing:

$LE_{\text{process},y}$	=	$\sum_j (Q_{\text{biomass } j,y} * EFF_{\text{Diesel, process } j,y}) * COEF_{\text{Diesel},y}$
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Where:

$Q_{\text{biomass } j,y}$	=	The quantity of biomass residues of type j during the year y; tons
$EFF_{\text{Diesel, process } j,y}$	=	The diesel fuel efficiency of processing biomass of type j during the year y; gal/ton
$COEF_{\text{Diesel},y}$	=	The CO ₂ emissions coefficient for diesel fuel during the year y; tCO ₂ e/gal

Project Leakage from Biomass Transportation:

Biomass residues transported over a distance of more than 200 kilometers due to the implementation of the project activity must be considered a leakage source attributed to the transportation.

$LE_{\text{biomass transp},y}$	=	$\sum_{\text{deliveries}} (DAF_{\text{biomass delivery}}) * COEF_{\text{Diesel},y} / EFF_{\text{tt},y}$
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Where:

$DAF_{\text{biomass delivery}}$	=	The roundtrip distance of each delivery; km
$COEF_{\text{Diesel},y}$	=	The CO ₂ emissions coefficient for diesel fuel during the year y; tCO ₂ e/gal
$Eff_{\text{tt},y}$	=	The fuel efficiency of a typical tractor trailer during the year y; km/gal

Project Leakage from Ash Transportation:

Ash residues transported over a distance of more than 200 kilometers due to the implementation of the project activity are considered a leakage source attributed to the transportation.

$LE_{\text{ash transp},y}$	=	$\sum \text{deliveries (DAF}_{\text{ash delivery}}) * COEF_{\text{Diesel},y} / EFF_{\text{tt},y}$
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Where:

DAF _{ash delivery}	=	The roundtrip distance of each delivery; km
COEF _{Diesel,y}	=	The CO2 emissions coefficient for diesel fuel during the year y; tCO2e/gal
EFF _{tt,y}	=	The fuel efficiency of a typical tractor trailer during the year y; km/gal

Project Leakage Forecast:

The following estimates the annual project leakage for the project activity:

$$LE_y = LE_{\text{biomass transp},y} + LE_{\text{biomass process},y} + LE_{L2,y} + LE_{\text{ash transp},y} + LE_{L2,y}$$

Where:

		<u>2022</u>	<u>2023</u>	<u>Units</u>
$LE_{\text{process},y}$	=	0	0	tCO2e
$LE_{\text{biomass transp},y}$	=	18.29	0.94	tCO2e
$LE_{\text{ash transp},y}$	=	0	0	tCO2e
LE_y	=	18.29	0.94	tCO2e

5.4 GHG Emission Reductions and Carbon Dioxide Removals

This project is not required to assess permanence risk.

The estimated emissions reductions (ERy) are calculated as the difference between the baseline emissions and the project emissions and project leakage.

$$ERy = BEy - PEy - LEy$$

Vintage Year	Baseline Emissions or Removals (tCO ₂ e)	Project Emissions or Removals (tCO ₂ e)	Leakage Emissions (tCO ₂ e)	Reduction VCU's (tCO ₂ e)	Removal VCU's (tCO ₂ e)	Total VCU's (tCO ₂ e)
01-Jan-2022 to 31-Dec-2022	47578.5	984	18.3	46,576.1	0	46,576.1
01-Jan-2023 to 31-Mar-2023	12,047.3	246.9	0.94	11,799.5	0	11,799.5
Total	59,625.8	1,230.9	19.24	58,375.6	0	58,375.6

Vintage period	Ex-ante estimated reductions/removals	Achieved reductions/removals	Percent difference	Explanation for the difference
01-Jan-2022 to 31-Dec-2022	53,610	46,576.1	13.12	Reduced and variable steam demand from customers.
01-Jan-2023 to 31-Mar-2023	13,402	11,799.5	11.96	Reduced and variable steam demand from customers.
Total	67,012	58,375.6	12.89	Reduced and variable steam demand from customers.

APPENDIX 1: COMMERCIALY SENSITIVE INFORMATION

There is no commercially sensitive information included in the monitoring report to be excluded in the public version.