

RECAST ENERGY LOUISVILLE FUEL SWITCH FROM COAL TO BIOMASS



Document Prepared By

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Project Title	Recast Energy Louisville Fuel Switch From Coal to Biomass for Thermal Energy
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PROJECT DETAILS

1.1 Summary Description 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.

1.2 Sectoral Scope and Project Type

Sectoral Scope: 01 Energy (renewable/non-renewable)

UNFCCC Clean Development Mechanism AMS-I.C. for Small Scale Thermal Energy Projection without Electricity – Version 19

This project is not grouped.

1.3 Project Proponent

Organization name	Recast Energy Louisville, LLC
Role in the project	Energy Producing Facility
Contact person	Larry Dowell
Title	Plant Manager
Address	4200 Bells Lane, Louisville, KY 40211
Telephone	502-772-4135
Email	ldowell@recastenergy.com

Organization name	Recast Energy Louisville LLC
Contact person	Donna L Wirick c/o Recast Energy, LLC
Title	EHS Manager
Address	8730 Stony Point Pkwy, Ste 100, Richmond, VA 23235
Telephone	804-212-3181
Email	dwirick@recastenergy.com

1.4 Other Entities Involved in the Project

There are no other entities involved in the development of the Project.

1.5 Project Start Date

December 10, 2012 is the project start date.

1.6 Project Crediting Period

As a non-AFOLU project focusing on the reduction of CO₂ from fossil fuels, the Project Crediting Period is 10 years, with the possibility to renew twice.

The projected start date for the initial 10 year crediting period is April 1, 2013 and ending March 31, 2023.

1.7 Project Scale and Estimated GHG Emission Reductions or Removals

Project Scale	
Project	X
Large project	

Year	Estimated GHG emission reductions or removals (tCO ₂ e)
2013	40,207
2014	53,610

2015	53,610
2016	53,610
2017	53,610
2018	53,610
2019	53,610
2020	53,610
2021	53,610
2022	53,610
2023	13,402
Total estimated ERs	536,100
Total number of crediting years	10
Average annual ERs	53,610

1.8 Description of the Project Activity

The Recast Energy Louisville biomass project (hereafter, the “project activity”) is a thermal energy generation project fuelled with locally available urban, forestry, and agricultural cellulosic residues (i.e. primary mill residues, logging residues, clean pallets, tree care and landscape trimmings, right-of-way maintenance, driftwood, and crop residues). The thermal energy from the biomass system displaces thermal energy previously generated for the customers (Lubrizol and Zeon) by OxyVinyls, L.P., and subsequently by Recast Energy Louisville, LLC, after the purchase of the thermal energy plant from OxyVinyls by way of Lubrizol.

The Project Activity consists of converting an existing coal fired boiler built in 1981 to a biomass fired boiler that will continue to provide thermal energy to the project customers. The biomass boiler will be the predominant thermal energy source for the customers. Supplemental thermal energy will be provided by natural gas boilers during periods when the biomass boiler cannot meet full demand load.

The biomass is generated generally within a wood basket that has an abundant supply of biomass feedstock potential. The wood basket encompasses a one hour drive time from the project site (the “Target Feedstock Area”). On a case by case basis, some biomass may be sourced up to two hour drive time. Within the Target Feedstock Area, an estimated 2.743,000 million short tons of green (wet) biomass is generated annually. The project is expected to consume between 75,000 and 100,000 green tons per year based on historical thermal energy demand.

Aside from displacing greenhouse gases from fossil fuels, the project activity also has an economic benefit for the local community. A large portion of the biomass fuel used in the project activity was previously unused and unsellable material, which generally remained in the field and forest to decay or was landfilled. As a result of the project activity, the economy of the entire area has benefitted through job creation in the collecting, processing and transport of materials. The project activity creates roughly 30 permanent green collar jobs: 14 in plant and approximately 12 to 20 upstream in the fuel supply chain.

Although the project activity has the capacity to supply the project customer’s typical annual steam load, the project proponent elects to maintain a natural gas boiler system as redundant backup. When the biomass system is not able to meet the real-time full load, additional load is

met by combusting natural gas. The generation of steam from the biomass boiler and natural gas boilers are metered separately, allowing for detailed accounting of the generation of steam from each fuel resource.

The project was implemented under a long term energy agreement with the steam customers which extends beyond the 10 year crediting period. However, since similar boilers have been operating in the US for up to 90 years (see data supporting the remaining lifetime of the legacy boiler in the additionality assessment), the project lifetime is expected to be over 30 years.

1.9 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 Fuelled Boiler and emission controls
 - (6) Ash and blowdown handling systems
 - (7) Control rooms
 - (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.

1.10 Conditions Prior to Project Initiation

The project site is part of an industrial complex built by B.F. Goodrich during WWII in conjunction with the U.S. Office of War Production. Since then, a central steam plant has used fossil fuels (coal, natural gas and fuel oil) to produce the thermal energy needed for the various chemical manufacturing companies that have since occupied the site.

Prior to the project activity, the project customers received steam that was generated by coal supplemented with natural gas when needed. The steam was generated by a third chemical company that has since ceased operations at the site (OxyVinyls L.P). Prior to and leading up to the acquisition by Recast Energy Louisville in July 2010, the coal unit Boiler #4 served as the primary steam generation unit while the natural gas boiler #5 served as backup. .

On July 9, 2010, OxyVinyls sold the boiler assets to Lubrizol Advanced Materials, who in turn sold them to Recast Energy Louisville, LLC (d/b/a IN Louisville, LLC at the time) on the same day.

Commencing on the acquisition date, Recast Energy seamlessly continued operations providing steam to the customers. In preparation for converting Boiler #4 to biomass, upon acquisition Recast Energy laid up Boiler #4, thus marking the end of Boiler #4's use as a coal combustion unit. To supply steam during the construction period from coal to biomass, Recast Energy fired the backup natural gas unit #5 as the primary steam generation unit. A second temporary trailer-mounted natural gas boiler was installed to provide supplemental steam as needed. Concurrent with its acquisition of the facility, Recast immediately began the preconstruction and permitting activities to convert coal Boiler #4 to exclusively use biomass. The Louisville Air Pollution Control District issued the Air Emission Permit to Construct in June 2011. This permit allowed the conversion and operation of Boiler #4 using wood (biomass) fuels.

Prior to the project activity, much of the candidate biomass residues generated in the region were burned openly or piled to decay slowly over many years or landfilled. The primary candidate fuel is urban residuals from right-of-way maintenance, landscaping, and tree care, broken shipping pallets, and nuisance driftwood that become entrained in water intake structures. Since the project is located in an urban area, maintenance trimmings from the utility companies and county maintenance departments will be used as fuel, diverting material that was previously landfilled. Secondary supply sources include mill residuals, land clearing for construction and logging slash. Typically, logging crews create large piles of slash (tree limbs, tops, broken pieces and undersized trees) when they harvest the round wood (large diameter tree trucks) for saw, pole and pulp and paper mills. Slash piles hinder forest regeneration by blocking sunlight penetration to the ground and by encouraging wildfires.

1.11 Compliance with Laws, Statutes and Other Regulatory Frameworks

The project complies with applicable local, state and federal laws and regulations. Specifically, the project operates under permits as outlined in the **Table 1.11**

Table 1.11 Permits Issued to Project

Permitted Activities	Law and/or Regulation	Compliance
Air Emissions	Kentucky Revised Statutes Chapter 77 Air Pollution Control, Louisville Metro Air Pollution Control District Regulation 2.16 for Title V Sources	Facility operates under Title V Permit No. 27652-14-TV
Storm Water Discharge	KPDES Regulations (401 KAR Chapter 5)	Facility operates under a four-company combined KPDES permit KY0001457
Industrial Waste Water Discharge		Facility operates under a four-company combined Louisville Metropolitan Sewer District Discharge Permit #7109

Beneficial Ash Use	Kentucky Revised Statutes 224 and 401 KAR Chapters 30 and 47 – Beneficial Reuse of Solid Waste in Kentucky	Facility will comply with Permit by Rule for Beneficial Reuse of Solid Waste for ash is used in Kentucky.
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1.12 Ownership and Other Programs

1.12.1 Right of Use

Recast Energy Louisville, LLC has title and ownership to claim the environmental attributes associated with the project, as further evidenced by:

- Recast Energy Louisville, LLC is the sole owner of the project building and equipment.
- Under each of the energy supply contracts with Lubrizol and Zeon, Recast Energy Louisville, LLC is granted ownership of the environmental attributes associated with the thermal energy sold to each customer.
- Under the fuel procurement contracts with its suppliers, Recast Energy Louisville, LLC is granted ownership of the environmental attributes associated with the biomass fuels.

1.12.2 Emissions Trading Programs and Other Binding Limits

The project is not being used for compliance with an emissions trading program or to meet binding limits on GHG emissions.

1.12.3 Other Forms of Environmental Credit

The project has not sought, nor is it seeking at this time, registration under other GHG programs.

1.12.4 Participation under Other GHG Programs

The project is not registered, nor is it seeking at this time to register under any other form of GHG program.

1.12.5 Projects Rejected by Other GHG Programs

The project has not been rejected by any other GHG programs.

1.13 Additional Information Relevant to the Project

Eligibility Criteria

Not applicable.

Leakage Management

The leakage for this project is not an overall significant source of emissions. The leakage management for the Project is approached in a systematic manner that includes:

- Following the prescribed methodology in AMS-I.C. for identifying leakage sources
- Accounting for all sources of leakage
- Monitoring leakage parameters such as distance transported and volume processed (see section 3.3 Leakage)

Commercially Sensitive Information

No commercially sensitive information is excluded from this project description.

Recast has provided both commercially sensitive customer contracts and commercially sensitive biomass supply contracts to the reviewing body under separate cover.

Further Information

Not applicable.

2 APPLICATION OF METHODOLOGY

2.1 Title and Reference of Methodology

Title: Indicative simplified baseline and monitoring methodology for selected small-scale CDM project activities.

Reference of VCS methodology: Appendix B of the simplified modalities and procedures for small-scale CDM project activities.

Type I: Renewable Energy Projects

Type I.C. Thermal energy with or without electricity (Version 19)

Tools Applied:

“Tool to calculate project or leakage CO₂ emissions from fossil fuel combustion”, Version 02

“Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Version 01

“Tool to calculate the emission factor for an electricity system”, V4 and the

Guidance Applied:

“General guidelines for SSC CDM methodologies”, v20.

“Indicative Simplified Baseline and Monitoring Methodologies for Selected Small-Scale CDM Project Activity Categories, General guidance on leakage in biomass project activities” Version 03

“Annex 18, Definition of Renewable Biomass”

“Guidelines of the Demonstration of Additionality of Small-Scale Project Activities” Version 09

2.2 Applicability of Methodology

This project falls under the “Type I: Renewable Energy Projects,” and sub-category “I.C: Thermal energy production with or without electricity” (Version 19).

This project involves the switch from a fossil fuel (coal) based thermal generation system to a biomass fuelled thermal generation system. The energy produced by the project activities from biomass is used for thermal steam generation and consumed by the project customers in adjacent facilities. No electricity is generated by the steam produced by the project at this time, but the generation capacity qualifies the project as small scale methodology.

Therefore, the applicable category for this project is Appendix B, AMS-I.C. – “Thermal energy production with or without electricity” under “Type I. Renewable Energy Projects” as mentioned in appendix B of the simplified modalities and procedures for small-scale CDM Project activities.

The choice of the methodology is accurate for this project and is justifiable since the project activity meets the applicability conditions as summarized in Table 2.2.

Table 2.2: Applicability

Condition	Description of Project Activity	Conclusion
As per the Technology/Measure specification, this category comprises renewable energy technologies that supply individual households or users with thermal energy that displaces fossil fuels or non-renewable sources of biomass	The project activity generates thermal energy that displaces a fossil fuel (coal) with a renewable source of biomass (forestry, milling, and agricultural residues, urban wood, clean pallets)	Satisfied
The total installed/rated thermal energy generation capacity of the project equipment is equal to or less than 45 MW thermal	The rated thermal energy generation capacity of the post-converted project equipment is 144 MMBtu steam per hour* (42.2 MW), which is below the 45 MW thermal threshold.	Satisfied
In case electricity and/or steam/heat produced by the project activity is delivered to another facility or facilities within the	The supplier has entered into an agreement with each consumer that transfers responsibility for monetizing	Satisfied

project boundary, a contract between the supplier and consumer(s) of the energy will have to be entered into specifying that only the facility generating the energy can claim emission reductions from the energy displaced.	the emissions reductions to the supplier, the net cash proceeds of which are shared between the supplier and the customers as set forth in each agreement.	
In case of gasification, the process shall ensure that all the syngas produced, which may contain non-CO2 GHG, will be combusted and not released unburned to the atmosphere. Measure to avoid physical leakage of the syngas between the gasification and combustion sites shall also be adopted.	The project activity does not deliver syngas to its customers. Using overfire air, the project activity completely combusts the gases in the same furnace where they are produced, avoiding any material release or leakage of non-CO2 GHG.	Satisfied
In the case of project activities using biomass, emission reductions may only be accounted for the combustion of "renewable biomass as defined in "Definition of Renewable Biomass"	The biomass used in this project is a biomass residue, defined as biomass by-products, residues and waste streams from forestry and related industries. These sources include utility and municipal tree maintenance, wood residue from mill, manufacturing, and construction activities and land clearing activities that would occur in the absence of this project, such as home and road construction. Definition 5 of Annex 18	Satisfied

* Rated capacity of 120,000 lbs/hr @ 1198.65 Btu/lb, per equipment contract specifications

2.3 Project Boundary

Table 2.3 identifies the project boundary and relevant GHG sources, sinks and reservoirs for the project and baseline scenarios, including applicable leakage.

Table 2.3 Project Boundary

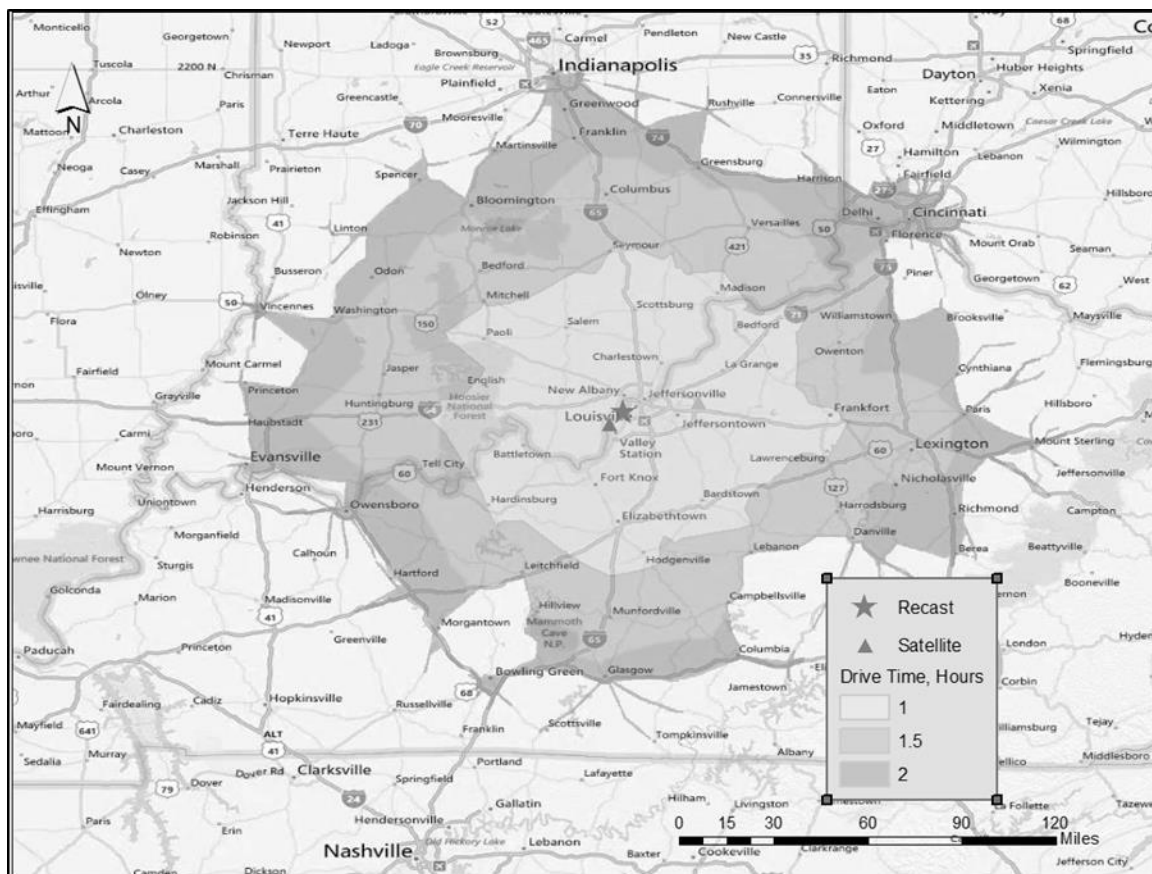
Source		Gas	Included?	Justification/Explanation
Baseline	Emission from coal combustion	CO ₂	Yes	Main emission source
		CH ₄	No	Excluded for simplification; this is conservative
		N ₂ O	No	Excluded for simplification; this is conservative
		Other	NA	NA
Project	Emissions from grid electricity	CO ₂	Yes	Emissions from combusting fossil fuels to generate electricity purchased from the Kentucky power grid to operate the biomass boiler.

Source		Gas	Included?	Justification/Explanation
	purchases powering the biomass boiler system	CH ₄	No	Excluded for simplification
		N ₂ O	No	Excluded for simplification
		Other	NA	NA
	Emissions from onsite vehicle use	CO ₂	Yes	Emissions from combusting fossil fuels while managing biomass fuel yard with the front-end loader
		CH ₄	No	Excluded for simplification
		N ₂ O	No	Excluded for simplification
		Other	NA	NA
Leakage	Emissions from offsite collecting, processing and over-the-road vehicle use	CO ₂	Yes	Emissions from combusting fossil fuels while collecting, processing and transporting biomass to the facility; Emissions from transporting ash for offsite beneficial use or disposal.
		CH ₄	No	Excluded for simplification
		N ₂ O	No	Excluded for simplification
		Other	NA	NA

Project Boundary Map:

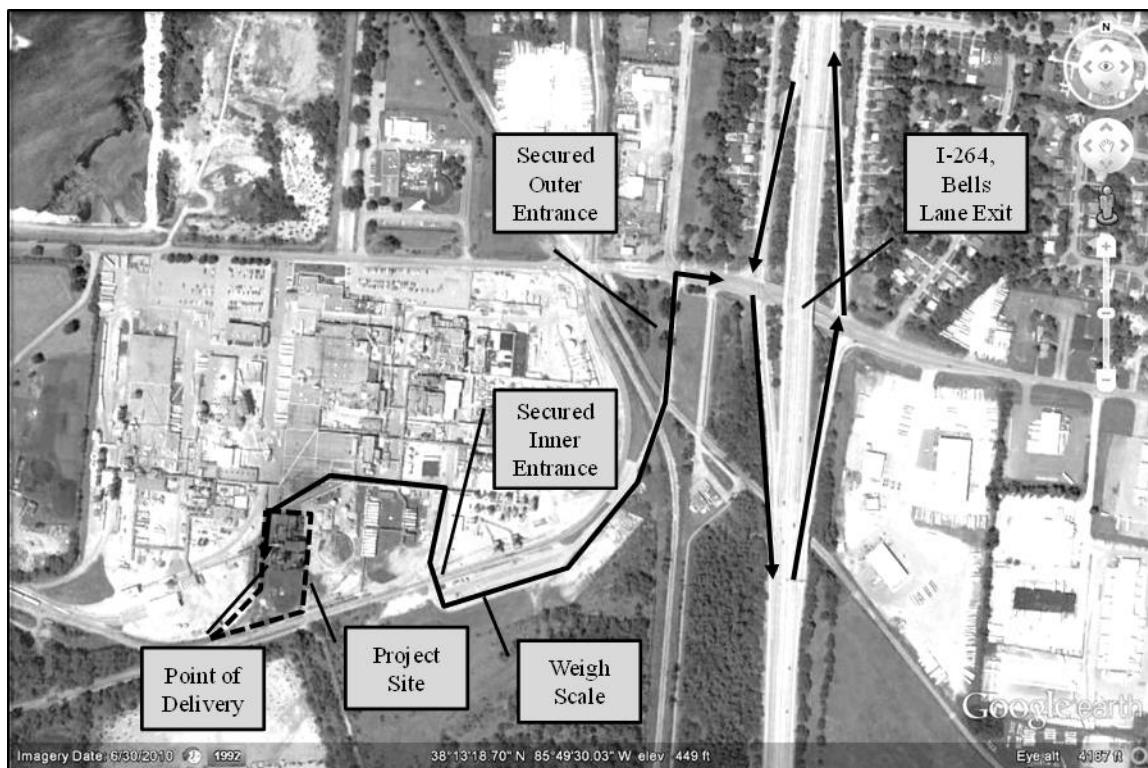
The map below (Figure 2.3-1) identifies the target feedstock area for the project, and identifies various drive time locations from the project biomass boiler located in Louisville.

Figure 2.3-1: Project Boundary Map - Target Feedstock Area



The photograph below (Figure 2.3-2) shows the Project Facility within the Project Boundary.

Figure 2.3-2: Project Boundary – Project Facility



The diagram below (Figure 2.3-3) identifies the systems and flows of mass and energy.

Figure 2.3-3: Project Boundary – Project Flows

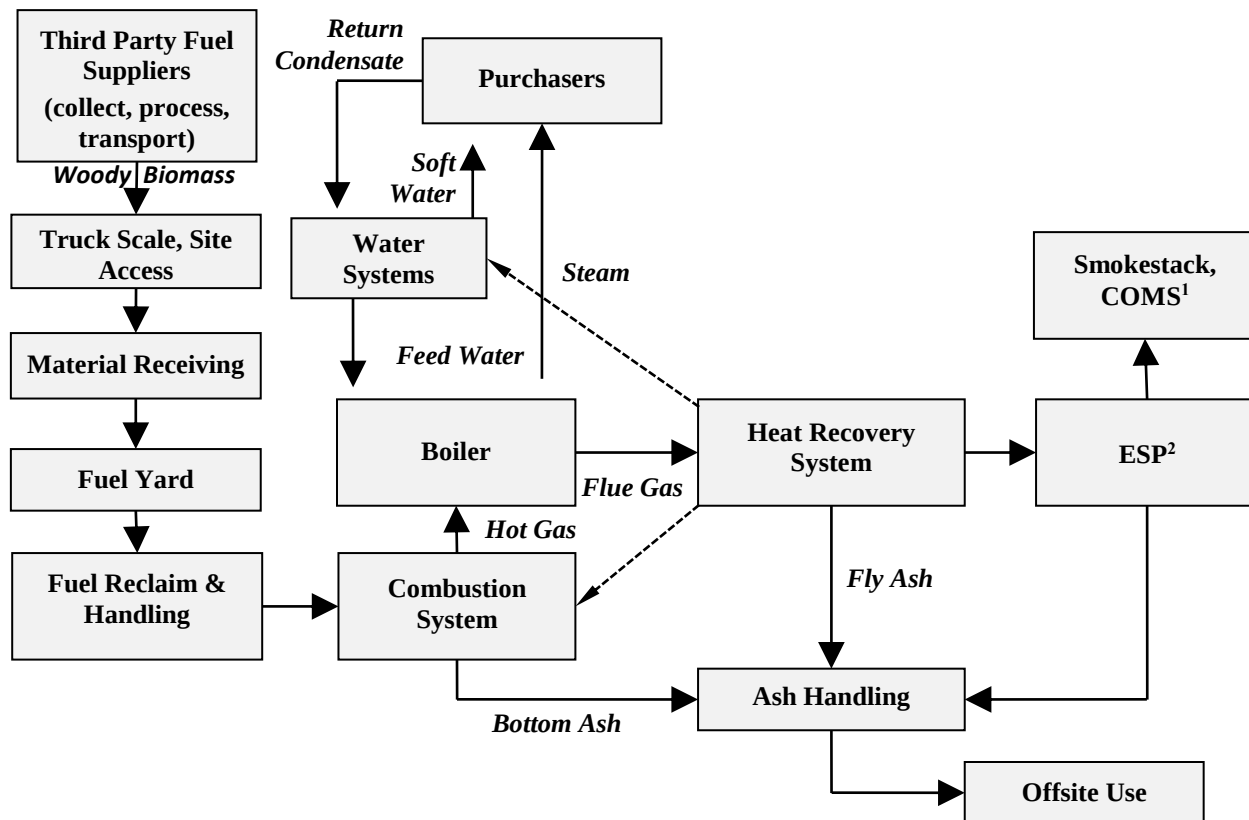
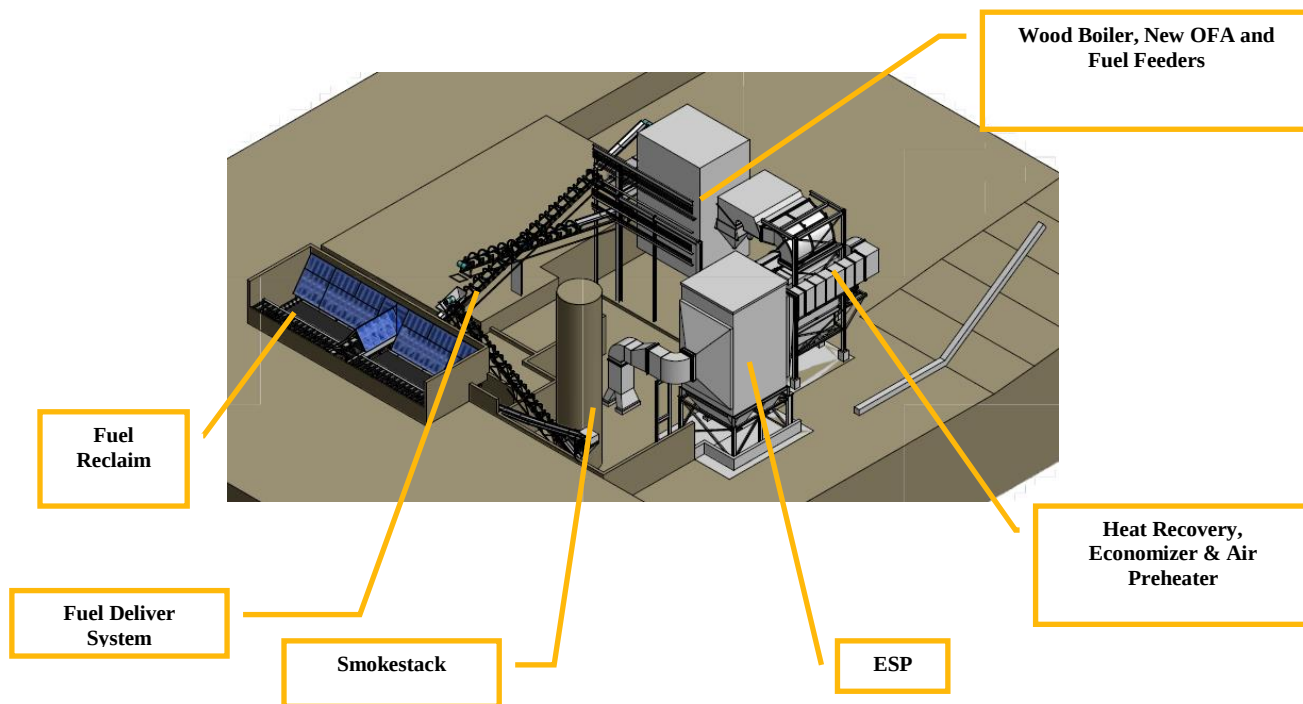


Figure 2.3-4: Project Boundary – Project Facility Major Equipment Configuration



2.4 Baseline Scenario

The baseline scenario is the continued use of the legacy coal boiler system. The legacy coal system was operated since 1981 (by the previous owner) until June 11, 2010, less than 30 days before the equipment was sold. The coal unit was shut down and laid-up for the biomass conversion by the previous owner in accordance with the instructions of Recast Energy Louisville, LLC as a prerequisite for purchasing the plant. The equipment stopped operating once the existing coal supplies were depleted in anticipation of the sale. The equipment was in a state of good repair such that it could continue to operate as a coal boiler with an economic life in excess of ten years without extraordinary capital investment. Therefore, there was no need to replace, reinvest or overhaul the legacy system at the time the project activity was commenced. This is supported by the fact that Boiler #4 was converted to biomass fuel and continues to operate as the basis for this project.

This baseline scenario was selected in accordance with paragraph 16 of CDM “AMS-I.C. Thermal energy production with or without electricity.”

“16. For renewable energy technologies that displace technologies using fossil fuels, the simplified baseline is the fuel consumption of the technologies that would have been used in the absence of the project activity, times an emission factor for the fossil fuel displaced.”

2.5 Additionality

In accordance with AMS-I.C methodology (Version 19), the additionality is demonstrated by applying the CDM Annex 27 Guidelines on the Demonstration of Additionality of Small-Scale Project Activities, Version 09.

Several barriers existed prior to initiating the project activity, including outsourced energy supply, technological barriers and prevailing practice barriers. The expected revenue from VCU's allowed all parties – Recast Energy and the customers – to overcome these barriers and implement the project activity. Without implementing the activity, the customers would have continued to use coal to fulfil their manufacturing energy requirements, resulting in higher emissions equivalent to approximately 50,000 tons of CO₂e annually.

1. These barriers included: Outsourced Energy Supply for Manufacturing: The project faced implementation barriers associated with negotiating terms for outsourced energy supply that were overcome through the expectation of revenue from VCU's, both direct and indirect. These barriers created significant unknowns about the future that required negotiation and concessions over risk factors that the project's customers were unwilling to accept without additional compensation. As evidenced in correspondence during negotiation, concerns over construction capitol, steam price structure, construction deadlines, termination schedules and carbon credit revenues all became roadblocks that stood in the way of executing the energy supply agreement in 2010. Ultimately, these roadblocks were overcome when the parties agreed to concessions that included sharing the net benefits of revenue from VCU's as documented in the energy supply agreements. VCU revenues directly earned by the thermal energy users provides financial incentives in the form of additional steam price discounts that helped the customers overcome the implementation barriers described below. VCU revenues retained by Recast Energy also benefit the project customers indirectly through a lower baseline steam price due to Recast Energy's expectations of receiving VCU revenue alongside steam revenue as part of the project's total revenue stream.

2. Risk of Technology and Prevailing Practice: Continuing to operate the existing coal boiler (Boiler #4) was a less risky technology alternative to the project activity. Conversely, biomass combustion with its low market share and performance uncertainty presented significant risks.
 The existing coal boiler had been operated successfully since 1981, and no changes were needed to continue operation using coal. It had an active Air Emission Permit and industrial coal boilers are demonstrated to operate for over 70 years, per data compiled by the USEPA (a). After operating continuously since 1981, the coal boiler had proven reliability, an established and abundant fuel supply and trained operators in place.
 The project required a revised Title V/PSD air permit, complete replacement of the fuel handling/feeding systems, new combustion management/ air handling systems, and new pollution control equipment to accommodate biomass combustion. While these technologies are not new, biomass applications are not as well demonstrated, as they represent a very small share of the energy production in the US and other industrialized countries, demonstrating that biomass combustion is not yet a prevailing practice in the chemical industry.

Data compiled in 2010 by the USEPA (a) show only 6.3% (594 of the 9384) of the identified industrial boilers use biomass as a primary or secondary fuel. Furthermore, of that 6.3%, the majority of the facilities use or process biomass as a core business (ie lumber, paper, furniture), and thus have a strong incentive to overcome any technology barriers to use a captive fuel supply, which is not the case for the project customers.

The actual utilization of biomass is estimated to be even lower. According to a publication of the International Energy Agency, The Handbook of Biomass Combustion and Co-firing, (b), Section 10.2.1, it is estimated that in 2006, only 1.8% of the energy generated in the US came from woody biomass:

“In the US, biomass currently delivers some 3 per cent to the primary energy mix. An estimated 10GWe of biomass power generation is in operation, of which about 60 per cent is derived from forest products (wood residues, black liquor, etc.) and agricultural residues, 35 per cent from municipal solid waste, and the remainder from other options such as landfill gas”

This information demonstrates that at the time this project was actively discussed and negotiated, this technology was not a common practice to implement in manufacturing, especially where fossil fuels and existing equipment were readily available.

- (a) <http://www.epa.gov/ttn/atw/boiler/boilerpg.html>;

Technical Information

Final Major Source Reconsideration Technical Support Documents

May 2012 Boiler MACT Draft Emissions and Survey Results Databases (zip file)

(DRAFT Survey Database containing Results of the 2008 Questionnaire for Boilers, Process Heaters, & Other Combustion Units (ICR No. 2286.01) (version 4))

- (b) The Handbook of Biomass Combustion and Co-firing, Edited by Sjaak van Loo and Jaap Koppejan, Copyright © Sjaak van Loo and Jaap Koppejan, 2008

2.6 Methodology Deviations

1. **Parameter:** Q_{steam} , :

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 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, h_{steam} and

$h_{\text{feedwater}}$ 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:** EC_y ,
AMS-I.C Requirement: Use “Tool to calculate baseline, project and/or leakage emissions from electricity consumption”
Deviation from Requirement: 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:** $EF_{\text{grid}, \text{CM}, y}$
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:** $FC_{\text{Diesel}, \text{loader}, y}$
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.

3 QUANTIFICATION OF GHG EMISSION REDUCTIONS AND REMOVALS

3.1 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, times the emission factor for the fossil fuel displaced.

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-fuelled boiler will be measured, corrected for efficiency of the coal-fuelled 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:

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

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)
$EF_{\text{FF, CO}_2}$	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.

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

Q_{steam}	The quantity of steam generated by the project activity
$*(h_{\text{steam}} - h_{\text{feedwater}})$	The difference in enthalpy of the steam and feedwater

3.2 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.
- 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:

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

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 CO₂ emissions coefficient for diesel fuel during the year y; tCO₂e/gal

$$COEF_{\text{Diesel}, y} = NCV_{\text{Diesel}, y} * EF_{CO_2, \text{Diesel}, y}$$

$NCV_{\text{Diesel}, y}$ = is the weighted average net calorific value of the fuel type (diesel) in year y

$EF_{CO_2, \text{Diesel}, y}$ = is the weighted average CO₂ 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).

The assets operated by Recast Energy are within the boundaries of a legacy industrial facility that has been subdivided over time into separate companies and various operations within those companies. The previous owners of the Recast Energy boiler-house (OxyVinyls) also operated equipment associated with manufacturing that also used electricity. In order to establish a baseline for electricity usage of the boiler house while running Boiler #4 on coal, meter readings would have to be available that could be traced exclusively to the boiler house equipment. After exhaustive research into existing records, interviews with employees and discussions with the property owner (Lubrizol), it has been determined that establishing a reliable baseline for electricity usage would be unlikely.

Alternatively, using the current facility electricity usage in the project emissions calculation would introduce a grossly overstated emissions value, as the majority of the electricity usage is associated with the legacy systems.

For example, the soft water and brine water systems, boiler feed water, return condensate, instrumentation and controls systems operate regardless of which fuel is generating thermal energy.

In addition, prior to the project, the coal-fuelled boiler used electricity to operate conveyors, fans, motors, bucket elevators, instrumentation and control systems, and a bag house to generate thermal energy. The wood-fuelled boiler also uses electricity for many of the same activities, but some of the equipment has been replaced with wood-compatible versions

Therefore, Recast proposes an alternative approach to arriving at the value for EC_y by comparing the electricity demand of Boiler #4 and the associated pollution control equipment before and after the biomass conversion based on the *specifications of the power consuming equipment*. All other electricity uses within the facility existed prior to the conversion, and would have continued

at the same rate had the conversion not occurred. The only differences in electricity usage for the project are related directly to the changes in equipment on the boiler and pollution control equipment to combust biomass.

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

Where:

$EF_{EL,y}$ = the CO₂ emission factor for the grid-purchased electricity; tCO₂e/MWh

And under Scenario A:, Option A1:

$EFL_y = EF_{grid, CM,y}$ = 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

Project Emissions Estimation

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

$FC_{Diesel, loader,y}$	=	15,000	Gallons
$COEF_{Diesel,y}$	=	1.015E-02	tCO ₂ e/gal
$PE_{FC, loader,y}$	=	152.30	tCO₂e
EC_y	=	1757	MWh
$EF_{Grid, CM,y}$	=	0.0.63	tCO ₂ e/MWh
TDL_y		0.0582	
$PE_{EC,y}$	=	1171	tCO₂e

$$PE_y = PE_{FC, loader,y} + PE_{EC,y} = 1323.6 \text{ tCO}_2\text{e}$$

3.3 Leakage

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 residues. Emissions outside the project boundary are estimated as the project leakage. The following equation is used to determine the annual project leakage:

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

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

The ability to utilize biomass fuels by this project activity is a new capability for the energy users situated at the chemical complex. Therefore, the project activity does not cause leakage as a result of replacing biomass energy capacity elsewhere; this parameter is not included in the project leakage formula.

Project leakage from biomass collecting and processing

In-woods and in-field collection and processing are necessary for project use of some residues from forestry or land management activities and crop residues. This collection and processing may not otherwise occur but for the project activity and require heavy machinery running on diesel, thus producing project leakage. This machinery may include feller/bunchers, skidders, loaders and chippers/grinders. Emissions from collecting and processing biomass residues are determined with the following formula:

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

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

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 $LE_{\text{process},y}$ calculations.

Project leakage from biomass transportation:

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

The project leakage estimate for the transportation of biomass fuel will be compiled by evaluating each delivery using the following criteria:

- (a) Using delivery tickets, record data for each load including distance travelled, source and weight of wood delivered.
- (b) Calculate driving distance from source to plant – either point source or distributed source.
- (c) Identify each load traveling a distance greater than 200 km radius to the plant and include in $DAF_{\text{biomass delivery}}$

The distances calculated in (b) above will be derived from the incremental transportation for the fuel based on the pre-project destination of the material.

- Material Aggregating Facilities: These facilities are pre-project (existing) collection areas for a variety of wood sources. When material is obtained from these facilities, the actual distance to the Recast facility will be used. These facilities include both commercial and municipal operations.
- In place disposal: Material obtained from these categories will be counted in the transportation accrual as either a point distance (specific facility) or for variable distance (distributed distances) by distance from the geographic center of the county of origin.
- Any deliveries that do not fit into these categories will be identified and evaluated based on the previous destination of the material in relation to the project site.

The emissions from transporting the biomass from offsite collection points to the project activity are determined using the following formula:

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

$DAF_{\text{biomass delivery}}$	=	The roundtrip distance of each delivery; km
$COEF_{\text{Diesel},y}$	=	The CO2 emissions coefficient for diesel fuel during the year y; tCO2e/gal
$EFF_{\text{tt},y}$	=	The fuel efficiency of a typical tractor trailer during the year y; km/gal

Project leakage from ash transportation

Biomass residues transported over a distance of more than 200 kilometres due to the implementation of the project activity must be considered a leakage source attributed to the transportation. While the methodology does not specifically discuss leakage for the ash transport, this criteria will also be applied to the ash transport from the project to locations for beneficial use.

Ash from the electrostatic precipitator and bottom ash from the boilers is delivered to locations for beneficial use. Because contractors are used to transport the ash, the project leakage estimate for the ash transportation follows the same methodology employed to calculate the project leakage estimate for the transportation of biomass residues and for the same reasons. The emissions from transporting the ash to offsite locations for final disposition are determined using the following formula:

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

Where:

DAF _{ash delivery}	=	The roundtrip distance of each delivery; km
COEF _{Diesel,y}	=	The CO ₂ emissions coefficient for diesel fuel during the year y; tCO ₂ e/gal
EFF _{tt,y}	=	The fuel efficiency of a typical tractor trailer during the year y; km/gal

Project leakage of type L2 – Competing Uses for the Biomass

Leakage of type L2 is defined as competing uses for the biomass that might have occurred in the absence of the project. However, if it is demonstrated at the beginning of the crediting period that the quantity of available biomass in the region is at least 25% larger than what will be used including the project, then this source of leakage can be neglected.

Pursuant to the report “Wood Fuel Supply Study Prepared for Recast Energy Louisville, LLC” dated June 12, 2012, no leakage of type L2 occurs as a result of the project activity. The report concludes that the project activity consumes less than 4% of the total surplus biomass forestry and mill residues generated annually within the wood basket, and therefore does not need to be included in the leakage calculations.

Project Leakage Forecast

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

Q _{biomass j,y}	=	2,500	tons
EFF _{Diesel,process j,y}	=	1.54	gal/ton

COEF _{Diesel,y}	=	1.015E-02	tCO ₂ e/gal
LE _{process,y}	=	38.99	tCO₂e
Σ(DAF _{biomass deliveries})	=	25,000	km
COEF _{Diesel, y}	=	1.015E-02	tCO ₂ e/gal
EFF _{tt, y}	=	9.66	km/gal
LE _{biomass transp,y}	=	26.73	tCO₂e
Σ(DAF _{ash delivery})	=	0	km
COEF _{Diesel, y}	=	1.015E-02	tCO ₂ e/gal
EFF _{tt,y}	=	9.66	km/gal
LE _{ash transp,y}	=	0	tCO₂e
LE _{L2,y}	=	0	tCO ₂ e
LE _y	=	LE _{biomass transp,y} + LE _{biomass process,y} + LE _{L2,y} + LE _{ash transp,y} + LE _{L2,y}	65.72 tCO₂e

3.4 Net GHG Emission Reductions and Removals

The estimated emissions reductions (ER_y) are calculated as the difference between the baseline emissions and the project emissions and project leakage. The table below shows the net emissions reductions estimated during the project crediting period; actual annual emissions reductions are expected to be within 25% of these estimates, varying primarily as the project customer's demand for steam varies. The start of each year commences on January 1.

$$ER_y = BE_y - PE_y - LE_y$$

Years	Estimated baseline emissions or removals (tCO ₂ e)	Estimated project emissions or removals (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated net GHG emission reductions or removals (tCO ₂ e)
2013	41,250	993	50	40,207
2014	55,000	1324	66	53,610
2015	55,000	1324	66	53,610
2016	55,000	1324	66	53,610
2017	55,000	1324	66	53,610

2018	55,000	1324	66	53,610
2019	55,000	1324	66	53,610
2020	55,000	1324	66	53,610
2021	55,000	1324	66	53,610
2022	55,000	1324	66	53,610
2023	13,750	331	17	13,402
Total				536,100

4 MONITORING

4.1 Data and Parameters Available at Validation

Data / Parameter	NCV _{Diesel, 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 31, published by Oak Ridge National Labs on July 31, 2014 (http://cta.ornl.gov/data/index.shtml) http://cta.ornl.gov/data/appendix_b.shtml , Table B04
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	No comments

Data Unit / 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. http://www.eia.doe.gov/oiaf/1605/coefficients.html
Value applied:	0.06928
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
Any comment:	No comments

Data Unit / 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
Any comment:	No comments

Data Unit / 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. http://www.eia.doe.gov/oiaf/1605/coefficients.html
Value applied:	88.42 (GCV Basis) tCO2/TJ
Justification of choice of data or description of measurement	Data source selected as reliable national value from the US Department of Energy. To be reviewed annually for

methods and procedures applied:	updates.
Purpose of Data	Calculation of baseline emissions
Any comment:	No comments

Data Unit / 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
Any comment:	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 applied:	525 per year
Monitoring equipment	NA
QA/QC procedures to be applied	Not Applicable.
Purpose of data	Calculation of baseline emissions
Calculation method	$EG_{thermal,y} = Q_{steam,y} * (h_{steam} - h_{feedwater}) * 1.055E-9$
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 http://www.epa.gov/cleanenergy/documents/egridzips/eGRID_9th_edition_V1-0_year_2010_Summary_Tables.pdf . Page1, 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 applied:	For 2010, 0.630 tCO ₂ e/MWh
Monitoring equipment	Not Applicable
QA/QC procedures to be applied	Not Applicable
Purpose of 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 http://www.epa.gov/cleanenergy/documents/egridzips/eGRID_9th_edition_V1-0_year_2010_Summary_Tables.pdf . Page9, Eastern Region
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 applied:	0.0582
Monitoring equipment	Not Applicable
QA/QC procedures to be applied	Not Applicable
Purpose of data	Calculation of project emissions
Calculation method	Not Applicable
Comments	No comments

Data Unit / 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 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 applied:	500,000,000
Monitoring equipment:	ABB Vortex Flowmeter FV4000 (see manufacturer specification sheet)
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.
Purpose of Data	Calculation of baseline emissions
Calculation method:	Addition of daily totalized readings
Any comment:	No comments

Data Unit / Parameter:	h_{steam}
Data unit:	Btu/lb
Description:	The enthalpy of steam as it leaves the biomass boiler.
Source of data:	Temperature or pressure monitoring assembly located to measure steam exiting Boiler #4. Temperature will be the primary data used, and pressure data will be used as a secondary source if needed.
Description of measurement methods and procedures to be applied:	Manual or automated reading and recording of the temperature or pressure is used to calculate enthalpy using standard thermodynamic tables
Frequency of monitoring/recording:	Temperature or pressure values are determined at least hourly and recorded at least daily. The average temperature or pressure is translated into enthalpy using standard thermodynamic tables, assuming saturated steam conditions.
Value applied:	1192 based on avg 350 degree F and 180 psig steam
Monitoring equipment:	Temperature monitoring assembly consisting of RTD (Resistance Temperature Detectors) and thermo well with appropriate operating range. . Steam pressure is monitored by a separate pressure meter.
QA/QC procedures to be applied:	The meters are calibrated in accordance with the manufacturers' 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.
Purpose of 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.
Any comment:	No comments

Data Unit / 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:	Manual or automated reading and recording of the temperature is used to calculate enthalpy using standard thermodynamic tables.
Frequency of monitoring/recording:	Temperature value is determined at least hourly and recorded at least daily. The average temperature is translated into enthalpy using standard thermodynamic tables.
Value applied:	195 estimated value based on 225 degree F feedwater))
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.
Purpose of 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 .
Any comment:	No comments

Data Unit / Parameter:	$FC_{\text{Diesel, loader, y}}$
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 are summed over the entire reporting period, assuming all diesel fuel delivered is consumed by the loader.

Frequency of monitoring/recording:	Each invoice will be recorded
Value applied:	15,000 gallons
Monitoring equipment:	NA
QA/QC procedures to be applied:	Purchase fuel invoices are identified, recorded at least monthly and archived
Purpose of Data:	Calculation of project emissions
Calculation method:	Addition
Any comment:	No comments

Data Unit / 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 will be 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 will be applied as the power consumed by the project activity.
Frequency of monitoring/recording:	Once per verification period, the engineering study will be reviewed and updated as needed. The list of equipment used to calculate the net change in electricity will be reviewed for any equipment and usage updates. The net change in electricity will be recalculated for inclusion in the project emissions calculations.
Value applied:	1757
Monitoring equipment:	Not applicable
QA/QC procedures to be applied:	The master list of plant equipment will be compared to the equipment listed in the study, including visual confirmation of the presence and specifications of major equipment components.
Purpose of 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: $EC_{total,y} = \text{maximum electricity capacity for Boiler \#4 in year } y; \text{ MWh}$ $EC_{avg(pre-project)} = \text{maximum electricity capacity for Boiler \#4 prior to project; MWh}$

Any comment:	No comments

Data Unit / 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 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 applied:	$[\Sigma(\text{DAF})]$ Biomass: 25,000
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.
Purpose of Data:	Calculation of leakage
Calculation method:	Summation
Any comment:	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 slash processing), the round-trip distance is calculated to the center of the county from which the delivery originated. For each monitoring period, a table will be developed listing roundtrip distances for primary mill 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.

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Data Unit / 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 applied:	[Σ(DAF)] Ash: 0
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.
Purpose of Data:	Calculation of leakage
Calculation method:	Summation
Any comment:	For ash deliveries the actual delivery round-trip distance is calculated. For each monitoring period, a table will be 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 Unit / Parameter:	EFF _{tt,y}
Data unit:	Km/gal
Description:	Fuel efficiency for tractor trailers
Source of data:	Transportation Energy Data Book, Edition 31, published by Oak Ridge National Labs on July 31, 2014

	(http://cta.ornl.gov/data/index.shtml)
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 applied:	9.50 (5.9 miles/gal)
Monitoring equipment:	Not applicable
QA/QC procedures to be applied:	Not applicable
Purpose of Data:	Calculation of leakage
Calculation method:	Not applicable
Any comment:	No comments

Data Unit / 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 applied:	<table> <tr> <td>All Biomass Delivered</td><td>72,500 tons</td></tr> <tr> <td>Biomass Not Processed for Project</td><td>70,000 tons</td></tr> <tr> <td>Biomass Processed for Project</td><td>2500 tons</td></tr> </table>	All Biomass Delivered	72,500 tons	Biomass Not Processed for Project	70,000 tons	Biomass Processed for Project	2500 tons
All Biomass Delivered	72,500 tons						
Biomass Not Processed for Project	70,000 tons						
Biomass Processed for Project	2500 tons						
Monitoring equipment:	Truck scale						
QA/QC procedures to be applied:	Truck scale is 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 Data:	Calculation of leakage
Calculation method:	Aggregation of the tons of wood identified or tagged as wood processed for the project
Any comment:	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.

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.

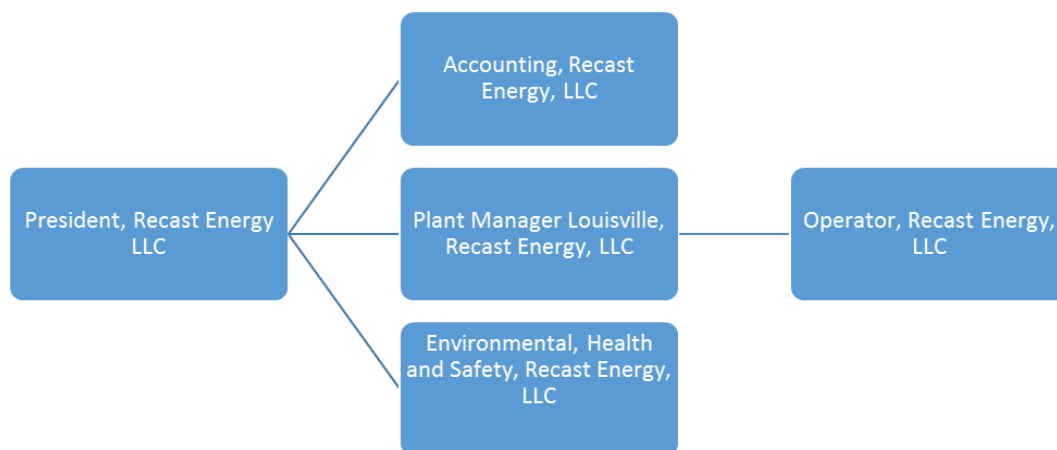
The reference manual “Louisville Operating Procedures” details the project’s general operating procedures, including data monitoring and reporting. A copy is stored onsite and revised from time to time.

Table 4.3 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 4.3 Project-specific Parameters Monitored Under Monitoring Plan

Data Parameter	Units	Frequency	Measured, Estimated, Reported	Party Responsible for Recording Data
Steam	Lbs	Monthly	Measured	Recast Operator
Steam Pressure	Psi	Daily	Measured	Recast Operator
Steam Temperature	°F	Daily	Measured	Recast Operator
Feed water Temperature	°F	Daily	Measured	Recast Operator
Feed water Flow	Gal/hr	Daily	Measured	Recast Operator
Electricity consumption	KWh	Once per monitoring period	Engineering Study	Recast EHS
Diesel fuel consumption (at project)	Gallons	Monthly	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 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 Accounting is responsible for Accounts Payable, Accounts Receivable and all associated record keeping for financial audits.

Recast 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 part authorities. Project-specific parameters include those listed in **Table 4.3**.

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, as needed 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, pressure and temperature 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.

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(s) 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.

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 ENVIRONMENTAL IMPACT

Not applicable.

6 STAKEHOLDER COMMENTS

. Not Applicable

APPENDIX X: