Application of the United Nations Framework Classification for Resources (UNFC) to Bioenergy Resources – Case studies

Prepared by the Bioenergy Sub-group to support the Public Comment on Draft Bioenergy Specifications (24 May–23 July 2017)

Draft case studies

Case study 1: Cyclone Corn Ethanol, United States
Case study 2: Project Magnus Viriditas (Miscanthus Cellulosic Ethanol Case Study), United States
Case study 3: Soo Power (biomass), Canada
Case study 4: Usina BioSucro (sugarcane ethanol case study), Brazil
Case study 5: XYZ Renewable Diesel, the Netherlands

Cyclone Corn Ethanol

Project Location: Des Moines, Iowa, U.S.A.

Data date: 2014, Historical Data to 2005

Date of evaluation: January 1, 2015

Quantification method: Simulation based on business operating plan, technical data, historical feedstock and product pricing, and future forecast from government agency

Estimate type (deterministic/probabilistic): Deterministic (scenario)

1. Project Summary and Background

This is a hypothetical case-study/example produced with the purposes of demonstrating the application of the Bioenergy Specifications. The specific objectives are to provide a biofuel case study that demonstrates the treatment of an energy source (biomass in the form of corn) sourced via a system of purchase agreements, the accounting for potentially commercial projects, and policy/regulatory support uncertainty. Please note that the case study has been abbreviated for clarity, accordingly it does not include the full range of documentary evidence to support the classification and underlying assumptions.

Cyclone Ethanol ("Cyclone") has a corn-ethanol production facility in the State of Iowa that entered commercial service January 1, 2015. The operator has retained a 3rd party to classify the Renewable Energy Resources.

The Project includes a new ethanol production facility (the "Facility") as the renewable energy extraction process, with which the operator Cyclone intends to produce 55 million gallons per year ("MGPY") of denatured ethanol. The operator of the Project has executed contracts for the part of the supply of feedstock corn, offtake of the ethanol produced, and has obtained the necessary permits to construct and operate the Facility.

The Facility utilizes a design from an established technology provider that is employed at approximately 100 other corn ethanol production facilities. The conversion (extraction) process at the Facility produces; anhydrous ethanol, wet or dry distillers grains with solubles ("WDGS" or "DDGS" respectively), and inedible corn oil from yellow dent number 2 corn. Corn is supplied via conveyor from a grain elevator located adjacent to the facility. Cyclone permitted the Facility as a minor source of air emissions, allowing the operator to produce ethanol at a maximum production rate of 60 MGPY.

Renewable Energy Source biomass is available as yellow dent number 2 corn, the majority of which is grown by farmers within a 50-mile radius of the new facility. Corn is traditionally sold in bushels, with 1 bushel equal to 56 pounds of corn. Corn can be stored for long periods in grain bins, allowing year round delivery of feedstock.

The principal Energy Product is denatured anhydrous ethanol meeting the specifications within the American Society of Testing and Materials ("ASTM") standard specification *D4806 – 14 Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-*

Ignition Engine Fuel. Cyclone has sanctioned the installation of a biodiesel production system to produce biodiesel from the co-product corn oil, and it is currently in construction. Upon its completion on January 1, 2016, the Facility will be capable of producing biodiesel compliant with ASTM D6751 *Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels* which is eligible for a biodiesel production tax credit of $1 per gallon produced. The biodiesel production tax credit is scheduled to expire on December 31, 2018 unless renewed by the US Congress, and biodiesel production is uneconomic without the aforementioned tax credit. Cyclone is also examining the potential to produce cellulosic ethanol from the corn fiber. This cellulosic ethanol utilizes ASTM D4806 for the product quality specification but is eligible for certain tax credits and other policy supports via the U.S. Renewable Fuel Standard ("RFS") due to the greenhouse gas reductions compared to fossil derived fuels. The cellulosic fuel production process is at the pilot testing phase, installation at the Facility would be the first commercial installation.

2. Project Definition

2.1 Bioenergy Source(s)

- U.S. Yellow Dent Number 2 Corn per U.S. Department of Agriculture Federal Grain Inspection Service, *Grain Inspection Handbook*

The Yellow Dent Number 2 Corn is considered to be a Bioenergy Source within the definition set out in the Bioenergy Specification on the basis that is biogenic, and via the agricultural cropping, harvesting and re-cropping of the corn the rate of extraction does not exceed the rate of replenishment and the replenishment is via biomass of the same type.

2.2 Bioenergy Product(s) & Reference Point(s)

Energy Product	Reference Point	Specification	Reporting Units	Supplemental Information
Anhydrous Ethanol	Rail Car Loading Meter	ASTM D4806	Mill Gals	RFS "Renewable Fuel" Category D6
Biodiesel	Truck Loading Meter	ASTM D6751	Mill Gals	RFS "Biomass Based Diesel" Category D4
Anhydrous Cellulosic Ethanol	Rail Car Loading Meter	ASTM D4806	Mill Gals	RFS "Cellulosic Biofuel" Category D3

2.3 Non-Energy Product(s)

- DDGS
- Inedible Corn Oil

2.4 Authorisation and Commitment

The facility was constructed by Cyclone and its performance testing was completed prior to commercial handover from the Engineering, Procurement, and Construction contractor to Cyclone on December 31, 2014. The facility has all the environmental permits and licenses necessary for commercial operation.

Product Approvals: Cyclone has registered the facility under the U.S. Environmental Protection Agency as a renewable fuel producer of D6 Renewable Fuel and is filing the documentation to register as a producer of D4 Biomass Based Diesel.

3. Quantification

Operating Plan / Performance: The multi- year operating plan is based on the nameplate capacity of the Facility, 55 MGPY, which is considered to be the best estimate of future production levels. The highest confidence estimate was considered to be the EPC Contractor guaranteed production rate of 50 MGPY (91 percent of the nameplate capacity). The low confidence production level has been assessed at 60 MGPY based on test runs and the maximum throughput under the existing permitting.

Grind margins are stable and have historically been positive. As a proxy for future economics, the operator collected local pricing information from January 2005 to December 2014 to calculate the operating margin per gallon of ethanol that the Facility would have enjoyed had it been in operation at that time.

Ethanol Margin Based on Historical Pricing (January 2005 to December 2014)	Ethanol Price ($/gal)	DDGS ($/ton)	Corn ($/ton)	Natural Gas ($/MMBTU)	Margin ($/gal)
Current (December 2014)	**$2.02**	**$138**	**$3.77**	**$6.97**	**$0.60**
Average	$2.06	$149	$4.37	$7.11	$0.46
Median	$2.11	$129	$3.82	$6.97	$0.36
Standard Deviation	$0.42	$60.20	$1.82	$2.06	$0.40
Maximum	$3.15	$299	$8.15	$12.42	$2.17
Minimum	$1.06	$68	$1.48	$3.30	$(0.06)
Probability that Grind Margin is Positive					96.7%
50% Exceedance Grind Margin					$0.36
90% Exceedance Grind Margin					$0.07
Number of Months Evaluated					120
Number of Months where Margin is greater than $0.00					116
Number of Months where Margin was equal to or less than $0.00					4

Project Lifetime: The Facility was designed for a 20-year service life and Cyclone has prepared a long term operating plan that includes both (1) major maintenance to renew or replace those capital equipment items that have a service life shorter than that of the Facility and (2) preventative and corrective maintenance spend to repair or replace equipment as necessary to support continued operation of the Facility. Provided that the Facility is operated and maintained consistent with generally accepted engineering practices and all required renewals and replacements are made on a timely basis, the high confidence level confidence estimate of the Facility technical lifetime is 20 years, moderate confidence level estimate is 25 years and a low confidence level estimate is 30 years. There

is at this stage no proposal to re-invest in the Facility to significantly extend its operating life beyond 30 years.

Feedstock Access and Entitlement: The operator has executed a feedstock supply contract with a large privately held commodity trader in which the trader guaranteed to supply 50% of the feedstock corn required to operate the plant, with liquidated damages equal to the cost to acquire alternative feedstock or lost revenues in the event of the trader's non-performance. The Term of the agreement is for 10 years following the commercial operation date of January 1, 2015. Corn sourced under this agreement is assumed to be of the highest confidence.

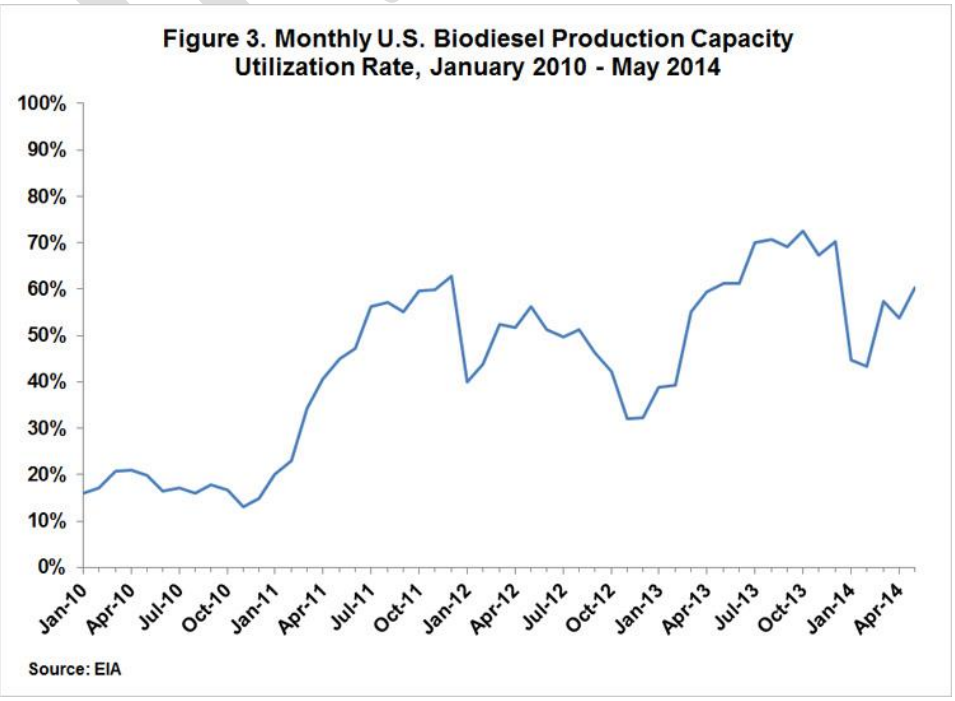
The remaining 50% of the feedstock corn is to be supplied by the local farmers on a spot basis at the grain elevator adjacent to the Facility. Cyclone has retained experienced grain origination personnel to schedule grain deliveries with local farmers as well as determine the daily grain pricing. The grain origination manager's prior employment was at an operating ethanol facility in Ames, Iowa, approximately 20 miles north of the Cyclone facility. Given the historical performance of the grain origination personnel in the local market, the aggregate quantities from contract and spot is assumed to be the best estimate.

Cyclone has obtained the 10-year feedstock pricing forecast from the United States Department of Agriculture ("USDA"), and feedstock yields and pricing are both anticipated to be stable with minimal increases due to inflation and productivity gains.

Facility Access and Entitlement: Cyclone has 100% equity ownership of the Facility, and intends to continue as the owner/operator of the Facility for the foreseeable future.

Monetization of Energy Products: The operator has entered into an ethanol marketing agreement for offtake of 100% of the ethanol produced at the Facility. The Term of the agreement is to be for 10 years, with automatic 1 year renewal periods. Offtake of biodiesel is to be to the same marketer based on the terms within the ethanol marketing agreement.

In addition to revenues from the sale of biodiesel, the US Treasury provides a $1 per gallon biodiesel production credit. Cyclone is reliant on this credit for their biodiesel production to be economically viable. This credit comes in the form of a direct payment to Cyclone from the US Government. While the biodiesel production credit has been extended annually since 2005, the tax credit is scheduled to



lapse December 31, 2018 unless extended by future legislation. Prior lapses in the tax credit have had a significant impact on utilization in the biodiesel industry, with reductions in utilization in January prior to the credit's retroactive extension as indicated in the following chart from the United States Energy Information Administration (EIA).

Policy Framework: The US Renewable Fuel Standard (RFS) establishes a blending mandate for the inclusion of renewable fuels within the US fuel pool. Ethanol produced at the Facility qualifies as ("Renewable Fuel") under the RFS with a 20% greenhouse gas reduction, and biodiesel qualifies as "Biomass Based Diesel") with a 50% greenhouse gas reduction. The RFS blending requirements are set to increase through the end of 2022, after which the blend levels are to be adjusted annually by the EPA. The RFS is not subject to a sunset provision at this time. The $1 per gallon biodiesel production tax credit is independent of the RFS, and it is currently scheduled to sunset on December 31, 2018. The biodiesel tax credit has been extended a number of times in the past, however its extension is not guaranteed.

While the RFS provides an incentive to blend ethanol, sales of ethanol are not wholly dependent on the RFS as ethanol producers discount their product as necessary to incentivize retail gasoline outlets to blend ethanol. If the RFS was abandoned, the resulting corn glut would likely reduce the cost to produce ethanol to the level required to incentivize the retailers to blend. In the event the price of corn drops below the cost of production; the USDA has a number of subsidy programs that would enable the farmers to continue to produce corn.

Current Expansion: Cyclone has sanctioned and is constructing a biodiesel production unit to convert the inedible corn oil co-product into biodiesel.
Biodiesel production is economic at current commodity pricing levels with the $1 per gallon biodiesel production credit. Annual production for biodiesel production unit is anticipated to be 1 million gallons of biodiesel, and is adjusted according to the Facility's ethanol throughput rate. Accordingly, the high confidence level production is 900,000 gallons per year, moderate confidence production level is 1,000,000 gallons per year, and low confidence production level is 1,100,000 gallons per year.

Cyclone intends to use the inedible corn oil co-product to produce biodiesel, no other source of feedstock has been identified in the event ethanol production is halted.

Future Expansion: The operator is evaluating a cellulosic ethanol technology for inclusion within the Facility. The technology is a bolt on cellulosic ethanol production unit which uses enzymes to break down corn fiber which is then fermented into ethanol.
Cellulosic ethanol is forecast to cost $5 per gallon of ethanol to produce, however prices are falling such that production is expected to be economically feasible in 2 years. Approximately 35 percent of the DDGS coproduct is corn kernel fiber in the form of glucan or xylan which can be converted to sugars and fermented. The cellulosic ethanol technology provider guarantees a yield of 70 gallons of cellulosic ethanol per ton of corn kernel fiber fed, while tests at Facility indicated that the yield of cellulosic ethanol is expected to be 80 gallons per ton of corn kernel fiber fed. The theoretical maximum conversion of the corn kernel fiber is 168 gallons per ton. Based on these yields, the guaranteed capacity is expected to be (high confidence level) 3,900,000 gallons per year, best estimate of yield based on testing (moderate confidence level) 4,500,000 gallons per year, and the theoretical conversion (low confidence level) 9,500,000 gallons per year.

4. UNFC-2009-Classification and Quantification

Class	Sub Class	Classification	Energy Products	Quantity	Units
Commercial Project	On Production	E1 F1.1 G1	Ethanol	250	Mil gals
		E1 F1.1 G1+G2	Ethanol	1,375	
		E1 F1.1 G1+G2+G3	Ethanol	1,800	
	Approved for Development	E1.2 F1.2 G1	Biodiesel	1.8	
		E1.2 F1.2 G1 + G2	Biodiesel	24	
		E1.2 F1.2 G1 + G2 + G3	Biodiesel	31.9	
Potentially Commercial Project		E2 F2 G1	Cellulosic Ethanol	31.2	
		E2 F2 G1 + G2	Cellulosic Ethanol	103.5	
		E2 F2 G1 + G2 + G3	Cellulosic Ethanol	292.6	

5. E Category Classification and Sub Classification

Project	Category	UNFC-2009 Definition	Reasoning for classification
On Production Ethanol Plant	**E1**	Extraction and sale has been confirmed to be economically viable	The plant is an operating viable concern, with all necessary approvals, authorisations and commercial contracts in place to produce ethanol.
	Sub-category	**UNFC-2009 Definition**	
Corn Oil Biodiesel Expansion	**E1.2**	Extraction and sale is not economic on the basis of current market conditions and realistic assumptions of future market conditions, but is made viable through government subsidies and/or other considerations.	Economic viability of biodiesel is dependent on regulatory support, specifically the $1 production tax credit. The uncertainty on future evolution (post 2018) of this legislation is considered in the G Axis categorisation.
	Category	UNFC-2009 Definition	Reasoning for classification
Cellulosic Ethanol from DDGS	**E2**	Extraction and sale is expected to become economically viable in the foreseeable future.	Cellulosic ethanol is anticipated to be economic within 2 years

6. F Category Classification and Sub classification

Project	Category	UNFC-2009 Definition	Reasoning for classification
On Production Ethanol Plant	**F1**	Feasibility of extraction by a defined development project or mining operation has been confirmed	A current operational unit.
	Sub-category	**UNFC-2009 Definition**	
	F1.1	Extraction is currently taking place	
	Sub-category	**UNFC-2009 Definition**	**Reasoning for classification**
Corn Oil Biodiesel Expansion	**F1.2**	Capital Funds have been committed and implementation of the development project is underway.	Biodiesel unit is in construction.
	Category	**UNFC-2009 Definition**	**Reasoning for classification**
Cellulosic Ethanol from DDGS	**F2**	Feasibility of extraction by a defined development Project or mining operation is subject to further evaluation.	Project has access to Bioenergy Source, further development work at pilot scale is required prior to final sanction.

7. G Category Classification and Sub-classification

	Reasoning for classification		
UNFC-2009 Definition	**G1**	**G1 + G2**	**G1 + G2 + G3**
	Quantities associated with a known deposit that can be estimated to a high level of confidence.	Quantities associated with a known deposit that can be estimated to a moderate level of confidence.	Quantities associated with a known deposit that can be estimated to a low level of confidence.
Project			
On Production Ethanol Plant	Annual ethanol production at 25 MGPY (high confidence level estimate of performance) for a period of 10 years. The period of 10 years is the aggregate high confidence level estimate based on 50 percent of the biomass under contract for 10 years. The high confidence level estimates the technical life of the asset (20 yrs) is not a constraining factor.	Annual production at 100% of operating plan (moderate confidence level estimate) for a period of 25 years for ethanol based on the moderate confidence level technical life of the Facility.	Annual production at 110% of operating plan (high confidence level estimate) for 30 years.
Corn Oil Biodiesel Expansion	Annual biodiesel production of 900,000 gallons for 2 years, the current expiry of the biodiesel tax credit.	Biodiesel annual production at 1,000,000 gallons per year for 24 years (is not to enter service until beginning of 2nd year). Assumes spot contracts are available to the Project for the technical life of the Facility.	Biodiesel annual production at 110% of operating plan (1,100,000 gallons per year) for 29 years (is not to enter service until beginning of 2nd year). Assumes spot contracts are available to the Project for the technical life of the Facility.

Cellulosic Ethanol from DDGS	Annual cellulosic ethanol production of 3,900,000 gallons for 8 years, assuming start-up of the unit in 2 years following the date of the assessment and prior to the expiration of the long term feedstock contracts.	Annual cellulosic ethanol production of 4,500,000 gallons for 23 years, assuming start-up of the unit in 2 years following the date of the assessment and the Facility operating at the best estimate production rate for the moderate confidence level technical life of the Facility.	Annual cellulosic ethanol production at 10,450,000 gallons per year for 28 years, assuming start-up of the unit in 2 years following the date of the assessment based on the low confidence level technical life of the Facility. The production rate is based on the theoretical conversion rate of 9,500,000 gallons per year increased by 110% to allow for the increased DDGS fibre supply due to the increased operating rate of the corn ethanol operations.

8. Glossary (Units)

Volume	
MGPY	Million Gallons (US) Per Year
Mill Gals	Million Gallons (US)

Project Magnus Viriditas (Miscanthus Cellulosic Ethanol Case Study)

Project Location: North Tennessee, US

Data date: 2015

Date of evaluation: 1 Jan 2016

Quantification method: Simulation based on Miscanthus yield modelling and indicative performance data for a cellulosic ethanol process from a technology licensor.

Estimate type (deterministic/probabilistic): Deterministic (scenario)

1. Project Summary and Background

This is a hypothetical case-study/example to demonstrate a potential application of the Potential Resource category.

Company ACME is carrying out an initial screening / desktop study on for the location of a possible 50 mill gal cellulosic ethanol plant using Miscanthus as a feedstock. ACME has identified a potential location in North Tennessee, US. Miscanthus yield estimates are based on modelling, using University of Illinois work on yield mapping of Miscanthus and Switchgrass yields. Estimates for cellulosic plant performance based on indicative data proved by a cellulosic ethanol technology licensor.

2. Project Definition

2.1 Bioenergy Source(s)

Miscanthus Giganteus. Miscanthus is a fast growing energy grass. It is a perennial crop, that regrows after harvesting from rhizomes (rootstalks) over harvest cycles for up to 20 years, after which replanting can occur.

The Miscanthus accessed by the project has been assessed to be a Bioenergy Source within the definition set out in the Bioenergy Specification on the basis that: -

1.) It is biogenic.
2.) The intended rate of extraction will not exceed the rate of replenishment. The project includes the agricultural activities necessary for the on-going cultivation and harvesting of the crop.
3.) The harvested Miscanthus will be replaced by Miscanthus either from regrowth or replanting, or replanting with a similar species of energy grass.

2.2 Bioenergy Product(s) & Reference Point(s)

Energy Product	Reference Point	Specification	Reporting Units	Supplemental Information
Cellulosic Ethanol	Road/Rail Car Gantry Meter	Specification ASTM D 4806 (water 1.0%vol max)	US gals	

2.3 Non-Energy Product(s)

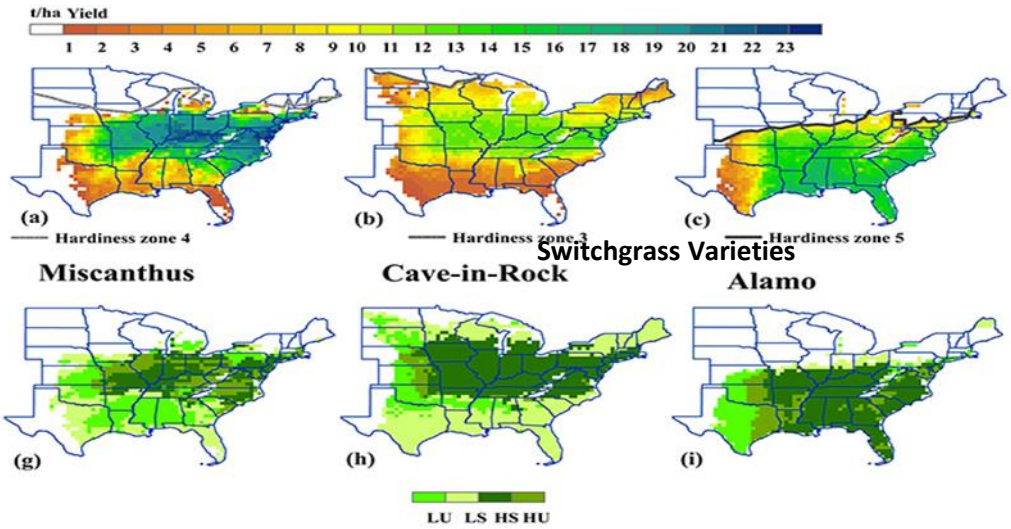
Nil

2.4 Authorisation and Commitment:

The basis of this evaluation is ACME's initial screening (appraise) study. No regulatory approval has been sought or is required at this stage of project evaluation. No commercial contracts, e.g. land options, have yet been entered into.

3. Quantification

Miscanthus Yield Data : Based on the Miscanthus and Switchgrass yield modelling work carried out by the University of Illinois Estimates of Biomass Yield for Perennial Bioenergy Grasses in the USA, Yang Song, Atul K. Jain, William Landuyt, Haroon S. Kheshgi, Madhu Khanna 2014 http://rd.springer.com/article/10.1007%2Fs12155-014-9546-1



Conversion Performance: Based on indicative data (no performance guarantees, not project specific) provided by the cellulosic ethanol technology licensor, the evaluation is assuming an ethanol conversion of 80 gal ethanol / oven dry tonne of Miscanthus. The plant is energy (steam & power) sufficient due to firing of the stillage and a proportion of the Miscanthus feedstock. There are no power exports for sales.

Since both the estimates for Miscanthus yields and conversion plant performance are based on indirect evidence they are classified as G4 estimates, that is estimates based primarily on indirect evidence.

Project Lifetime: A best estimate assumption of 30 years based on guidance from the potential technology licensor.

Feedstock Supply Access and Entitlement: ACME has carried out a preliminary review of the potential land availability in a potential supply envelope around the plant's proposed location. The review has considered the feasibility of leasing sufficient land for various landowners / farmers in a ~50 km radius of the location to supply the plant with sufficient feedstock (~625 kodte pa) to support a production of 50 mill gal. The review has also considered the possibility of alternative feedstocks

such as corn stover, to provide a supplemental supply. The review indicates that the best estimate is that sufficient feedstock can be secured for 20 years that is for two crop planting cycles.

No land optioning has yet occurred.

Conversion Plant Access and Entitlement: ACME is assumed to have 100% equity of the plant.

Monetisation of Energy Products: ACME's preliminary discussions with the US EPA and CARB indicate that the cellulosic ethanol will respectively qualify as a cellulosic biofuel under the Federal Renewable Fuels Standard cellulosic Renewable Volume Obligation (RVO), and will additionally qualify for a carbon intensity of ~20 g CO2eq/MJ under the California Low Carbon Fuels Standard. Moreover, the data from the technology provider indicates that advances in the cellulosic biotechnology package will enable cellulosic ethanol's production cost to become competitive with gasoline in the next 10 years. ACME preliminary discussions with a number of US fuel suppliers demonstrate that there would be interest in overtake agreements for the plant's production for durations of up to 10 years. Based on the above ACME has determined that there is sufficient evidence that the plant's production of cellulosic ethanol can be economically monetised.

4. UNFC-2009-Classification and Quantification

Class	Class	Classification	Energy Products	Quantity	Units
Potential Resource	Exploratory Project	E3.2 F3 G4.1+4.2	Ethanol	1000	Million US Gals
	Additional quantities in place associate with a potential resource	E3.3 F4 G4.1+4.2	Ethanol	3179.4	

5. E Category Classification and Sub-classification

Category	UNFC-2009 Definition	Reasoning for classification
E3	Extraction and sale is not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability.	Project is at its early initial screening/appraise stage.
Sub-category	**UNFC-2009 Definition**	
E3.2	Economic viability of extraction cannot yet be determine due to insufficient information (e.g. during the exploration phase).	
Sub-category	**UNFC-2009 Definition**	
E3.3	On the basis of realistic assumptions of future market conditions, it is currently considered that there are	Considers the difference of the total energy supplied to the plant as defined by the cumulative lower heating value of Miscanthus vs. the

	not reasonable prospects for economic extraction and sale in the foreseeable future.	cumulative energy (lower heating value) of the cellulosic ethanol extracted assuming an ethanol conversion of 80 gal ethanol / oven dry te of Miscanthus. Potential for improvements in conversion efficiency not considered at this stage.

6. F Category Classification and Sub-classification

Category	UNFC-2009 Definition	Reasoning for classification
F3	Feasibility of extraction by a defined development project or mining operation cannot be evaluated due to limited technical data.	Assessment based on Miscanthus yield modelling data and indicative cellulosic ethanol performance data.
F4	No development project or mining operation has been identified.	No feasible technical option assumed to be available to increase either Miscanthus yields and subsequent conversion beyond 80 gal ethanol / oven dry te of Miscanthus.

7. G Category Classification and Sub-classification

	Reasoning for classification	
UNFC-2009 Definition	**G4**	**G4.1 + G4.2**
	Estimated quantities associated with a potential resource based on indirect evidence	Best estimate of the quantities
Project		
Exploratory Project	Assessment based on indirect evidence in the form of Miscanthus yield modelling (c.f. crop trials at the proposed location) and indicative cellulosic ethanol process performance (c.f. pilot plant data and/or process guarantees).	Assessment based on the following best estimates assessments: Miscanthus yield: 20 dry te/ha/yr Land required: 31.3 K ha Total Miscanthus supplied: 625 Kodte/yr Ethanol Conversion: 80 gal / odte /yr Plant Lifetime & Feedstock Supply: 20 years
Additional quantities in place associated with a potential resource		Assessment based on the un-extracted energy in the Miscanthus represented by the difference of its lower heating value (17.95 GJ/dry te) and the energy of the ethanol recovered (Lower Heating Value 21.28 GJ/m3).

8. Glossary (Units)

Volume	
Mill gal	Million US gallons

Mass	
Kodte pa	Thousand oven dry metric tonnes per annum

Soo Power

Project Location: Sault Ste. Marie, Ontario, Canada

Data date: 2016, Historical Data to 2000

Date of evaluation: July 1, 2017

Quantification method: Simulation based on business operating plan, technical data, forecast feedstock pricing, and fixed product pricing based on government contract

Estimate type (deterministic/probabilistic): Deterministic (scenario)

1. Project Summary and Background

This is a hypothetical case-study/example produced with the purposes of demonstrating the application of the Bioenergy Specifications. The specific objectives are to provide a biopower case study that demonstrates the treatment of an energy source (biomass in the form of wood pellets) sourced via a long term contract. Please note that the case study has been abbreviated for clarity, accordingly it does not include the full range of documentary evidence to support the classification and underlying assumptions.

Soo Power ("Soo") is currently constructing a biomass power generation facility in the Canadian Province of Ontario that is scheduled to enter service on January 1, 2018. The operator has retained a 3rd party to classify the Renewable Energy Resources.

The Project includes a new biomass power facility (the "Facility") of 60 megawatts ("MW") capacity for the renewable energy extraction process, with which Soo intends to produce 417,000 megawatt-hours ("MWh") per year of renewable power. The operator of the Project has executed contracts for the long term supply of wood pellets, has secured a 20 year Feed-In-Tariff contract for power offtake with the Independent Electricity System Operator ("IESO") of Ontario, and has obtained the necessary permits to construct and operate the Facility.

The Facility utilizes a bubbling-fluidized-bed ("BFB") boiler and steam-turbine-generator ("STG") from established technology providers that are commercially established in the power generation market. The conversion (extraction) process at the Facility produces renewable power and a co-product ash stream which is sold for de minimis value as a fertilizer. Wood pellets are supplied via barge from a third party pellet production facility located on the west side of Lake Superior in Thunder Bay, Ontario. Soo permitted the Facility with the Ontario Ministry of the Environment and Climate Change ("MOE"), allowing the operator to produce power at a 60 MW nominal capacity.

Renewable Energy Source biomass is available from Lakehead Pellet Company ("Lakehead") in a commodity grade produced for sale to Canadian and European clients. Lakehead's renewable biomass pellet production plant is a 500,000 metric ton per year ("tpy") plant using yellow pine as its principal feedstock. Pellets can be stored for long periods in bins, allowing year round delivery of feedstock.

The principal Energy Product is renewable electrical power, the Facility is directly connected to the IESO grid using a 115 kilovolt ("kV") substation according to the requirements of the Interconnection Agreement ("IA") with IESO.

2. Project Definition

2.1 Bioenergy Source(s)

- Lakehead "Standard" grade pellet - pellet specification: a minimum net caloric value of 16.5 megajoules per kilogram, total moisture between 5 and 10 percent, a maximum ash content of 1.5 percent, and a tamped bulk density of 650 to 750 kilograms per cubic meter ("kg/m3").

The wood pellets are considered to be a Bioenergy Source within the definition set out in the Bioenergy Specification on the basis that they are biogenic, and via the forestry operations of harvesting and re-cropping that the rate of extraction does not exceed the rate of replenishment and the replenishment is via biomass of the same type.

2.2 Bioenergy Product(s) & Reference Point(s)

Energy Product	Reference Point	Specification	Reporting Units	Supplemental Information
Renewable Electricity	IESO Utility Meter at Substation	N/a	kWh	Renewable Biomass required to comply with FIT 2.0 Exhibit A

2.3 Non-Energy Product(s)

- Ash

2.4 Authorisation and Commitment

The Facility is currently in construction, and is schedule to reach commercial operation on January 1, 2018 (the "COD"). The facility has all the environmental permits and licenses necessary for commercial operation.

Product Approvals: Soo is to file paperwork with the IESO indicating that the biomass is from a renewable source and that Soo has complied with the various provisions of the IA, metering plan, and has achieved COD.

3. Quantification

Operating Plan / Performance: The multi- year operating plan is based on an availability factor of 89 percent, an annual net capacity of 53.5 MW, yielding 417,000 MWh/year based on a net heat rate of 12,400 British Thermal Units per kWh ("Btu/kWh). The highest confidence estimate was estimated to be at a reduced availability case of 84 percent, yielding 394,000 MWh/yr and the low confidence level case has been estimated with an availability factor of 94 percent, yielding 440,000 MWH/yr. The high and low availability cases are Soo's estimates based on operations at their other biomass power operations.

The Facility does have the potential to increase the efficiency of the conversion from wood pellets (reduce the heat rate); although the costs to do so are not expected to be economically viable within the foreseeable future nor the methodology by which it could be done been identified. The design efficiency of the Facility is 27.5 percent (3,412/12,400), as an early estimate, Soo considers the high confidence level case to be a 5 percent reduction in the heat rate to 11,780 Btu/kWh (29.0 percent efficiency), the moderate confidence level case to be a 10 percent reduction in the heat rate to 11,160

Btu/kWh (30.5 percent efficiency), and the low confidence level case to be the theoretical heat rate of 7,260 Btu/kWh (efficiency of 47 percent).

Project Lifetime: The Facility was designed for a 20-year service life, and provided that the Facility is operated and maintained consistent with generally accepted engineering practices and all required renewals and replacements are made on a timely basis, the high confidence level confidence estimate of the Facility technical lifetime is 20 years, moderate confidence level case estimate is 25 years and a low confidence level estimate is 30 years. There is at this stage no proposal to re-invest in the Facility to significantly extend its operating life beyond 30 years. The FIT contract term is for 20 years from COD, this term cannot be extended under the existing FIT program. Biomass power would not be economic selling into the wholesale electricity markets at this time.

Feedstock Access and Entitlement: Soo has executed a 10-year pellet supply contract with Lakehead, the pellet supply contract includes successive 1 year renewal terms unless one of the parties terminates the agreement via written notice 6 months prior to the end of the term or a renewal term. Lakehead has signaled their intent to supply pellets for the full 20 year term as Soo's FIT contract allows them to pay higher prices for pellets than Lakehead can obtain via other outlets (the European spot market). Lakehead has assigned any rights they might have to classify reserves to Soo as a condition of the pellet supply contract.

Facility Access and Entitlement: Soo has 100% equity ownership of the Facility, and intends to continue as the owner/operator of the Facility for the foreseeable future.

Monetization of Energy Products: Soo is to receive CAD$0.156 per kWh of electricity under the FIT 2.0 pricing Schedule in effect at the time of execution of the FIT contract. Soo is an IESO Market Participant so direct payments are made from the IESO to Soo on a monthly basis based on the kWh reading at the IESO controlled meter in the 115 kV substation that services the Facility. Transmission losses from the substation to the high voltage lines are borne by IESO. Soo's FIT contract is for a term of 20 years following COD, the FIT term cannot be extended.

Policy Framework: The Ontario Feed-In-Tariff was developed as a result of the Ontario Green Energy Act ("GEA") to promote the greater use of renewable energy resources by establishing a standard method to contract for renewable energy generation, offering stable prices and long term contracts. Funds to pay the FIT electricity rates are generated via the Global Adjustment, a cost added to the market price of electricity within Ontario.

Future Expansion: The FIT contract does not permit an increase in the contract capacity, so Soo does not have any plans for expansion at this time.

4. UNFC-2009-Classification and Quantification

Class	Sub Class	Classification	Energy Products	Quantity	Units
Commercial Project	Approved for Development	E1.2 F1.2 G1	Electricity	7,880	thousand MWh
		E1.2 F1.2 G1 + G2	Electricity	8,340	
		E1.2 F1.2 G1 + G2 + G3	Electricity	8,800	
Non Sales Production		E3.1 F1.2 G1	Electricity	957	thousand MWh
		E3.1 F1.2 G1 + G2	Electricity	1,014	
		E3.1 F1.2 G1 + G2 + G3	Electricity	1,070	
Additional Quantities in Place		E3.3 F4 G1	Electricity	23,296	thousand MWh
		E3.3 F4 G1 + G2	Electricity	24,659	
		E3.3 F4 G1 + G2 + G3	Electricity	26,022	

5. E Category Classification and Sub Classification

Category	UNFC-2009 Definition	Reasoning for classification
E1	Extraction and sale has been confirmed to be economically viable	Power plant investment sanctioned and construction underway. Investment case demonstrates economic viability under the project economic and commercial assumptions, including the provision of a 20 Feed in Tariff (FIT).
Sub-category	**UNFC-2009 Definition**	
E1.2	Extraction and sale is not economic on the basis of current market conditions and realistic assumptions of future market conditions, but is made viable through government subsidies and/or other considerations.	Economic viability of renewable biomass power production in Ontario is made possible via the subsidized FIT rate due to the GEA for a period of 20 years.
E3.1	Quantities that are forecast to be extracted, but which will not be available for sale	The parasitic loss between the gross power output of 60MW and the net power output of 53.5MW, at a capacity factors of 84%, 89%, and 94% for G1, G1+G2, and G1+G2+G3 respectively.

E3.3	On the basis of realistic assumptions of future market conditions it is currently considered that there are not reasonable prospects for economic extraction and sale in the Foreseeable Future	Efficiency improvements have not been identified nor are there prospects for the improvements to be economically viable in the foreseeable future. Additional quantities in place estimated based on design efficiency.

6. F Category Classification and Sub classification

Category	UNFC-2009 Definition	Reasoning for classification
Sub-category	**UNFC-2009 Definition**	
F1.2	Capital Funds have been committed and implementation of the development project is underway.	Facility is in construction, but is not anticipated to enter service until 6 months following the date of the classification.
F4	In situ quantities that will not be extracted by a currently defined development project	Improvements necessary to increase the efficiency have not been identified.

7. G Category Classification and Sub-classification

	Reasoning for classification[1]		
UNFC-2009 Definition	**G1**	**G1 + G2**	**G1 + G2 + G3**
	Quantities associated with a known deposit that can be estimated to a high level of confidence.	Quantities associated with a known deposit that can be estimated to a moderate level of confidence.	Quantities associated with a known deposit that can be estimated to a low level of confidence.
Project			
Commercial Project	Annual electrical production at 84 percent availability (high confidence level estimate of performance) for a period of 20 years. The period of 20 years is based on the term of the FIT contract (from COD). Biomass supply contract is for 10 years, and renewable for successive years under common commercial terms. The high confidence level estimates the technical life of the asset (20 yrs) is not a constraining factor.	Annual production at 100% of operating plan (moderate confidence level estimate) with production at 89 percent availability for a period of 20 years. The period of 20 years is based on the term of the FIT contract (from COD). Biomass supply contract is for 10 years, and renewable for successive years under common commercial terms. The moderate confidence level estimates the technical life of the asset (25 yrs) is not a constraining factor.	Annual electrical production at 94 percent availability (low confidence level estimate of performance) for a period of 20 years. The period of 20 years is based on the term of the FIT contract (from COD). Biomass supply contract is for 10 years, and renewable for successive years under common commercial terms. The low confidence level estimates the technical life of the asset (30 yrs) is not a constraining factor.
Non Sales Production	The parasitic loss of 6.5 MW under the respective G1,G1+G2, and G1+G2+G3 operating conditions as follows:-		
	84% availability for a period of 20 years.	89% availability for a period of 20 years.	94 % availability for a period of 20 years.
Additional Quantities in Place	An estimate of the energy (expressed in MWh) not recovered from the wood chip after net power output (sales) and parasitic load, for the G1, G1+G2, and G1+G2+G3 case respectively. Calculated as (Net Power Output+ Parasitic Load)/ (1/efficiency -1), where efficiency is taken as the design efficiency of 27.5%.		

(1) We note that all cases assume a Project Lifetime of 20 years determined by the length of the FIT contract, and that a second Project based on an extension and or new FIT contract may be possible provided that additional investments are planned to extend the physical lifetime of the Facility

8. Glossary (Units)

Power / Energy	
BTU	British Thermal Units
MW	Megawatts
MWh	Megawatt Hours
KWh	Kilowatt Hours

Usina BioSucro (sugarcane ethanol case study)

Project Location: San Paulo State, Brazil

Data date: 2015

Date of evaluation: 1 Jan 2016

Quantification method: Simulation based on businesses operating plan and supporting commercial and technical data.

Estimate type (deterministic/probabilistic): Deterministic (scenario)

1. Project Summary and Background

This is a hypothetical case-study/example produced with the purposes of demonstrating the application of the Bioenergy Specifications. The specific objectives are to provide an exemplar treatment of project maturity, project life uncertainty within G Axis, additional quantities in place, non-energy product and non-sales quantities, access and entitlement. Given the breath of the case-study and the number of projects involved it by necessity is abbreviated and does not present the full range of supporting information that would be required in a full classification, and to support the underlying assumptions. In particular it does not present the documentary evidence that would be required to support E1, F1 classifications.

Usina BioSucro is Brazilian sugarcane ethanol plant based in San Paulo state (near Ribeirao Preto). It has an existing capacity of 5 million tonnes pa of cane crushing, with an ethanol equivalent capacity of 102 mill gal. It produces two grades of ethanol, hydrous and anhydrous and two grades of sugar VHP (international raw sugar grade for the export market) and Crystal (semi refined sugar for the domestic market). It has the ability to flex 60:40 either way between ethanol and sugar, and can produce anhydrous ethanol to a max 30:70 anhydrous: hydrous ethanol split.

It has cogen consisting of high pressure (60 bar) boilers fired using bagasse, and 2x 20 MW turbo alternators. It currently produces all its internal steam and power requirements, but does not have sufficient cogen capacity to export power to the grid. However, a cogen expansion project is under construction. Currently the surplus bagasse is being sold as a low value component into animal feed rations.

The mill accesses its cane from a portfolio of land leases (65%), long-term cane supply contracts (35%) and very small (balancing) volume of spot (annual) cane contracts. The cane is a semi-perennial crop grown on 4 - 6 year ratoons (planting cycles). Mechanical harvesting is used for all its cane.

2. Project Definition

2.1 Bioenergy Source(s)

Sugarcane (*Saccharum*) – multiple varieties.

The sugarcane accessed by Usina BioSucro is assessed to be a Bioenergy Source within the definition set out in the Bioenergy Specification on the following basis:-

1.) It is biogenic.
2.) The rate of extraction does not exceed the rate of replenishment.
3.) The cane that is harvested for processing is replaced with cane.

Specifically, with regards to points 2, and 3, the mill has a clearly defined agricultural planting plan that ensures the continued supply of cane for the mill, and by optimising ratoon (planting) cycle optimises the cane yield and sugar content of the cane. In addition, the cultivation plan also optimises the cane yield and sugar content both on an in-year and multi-year perspective through the optimisation of the various agricultural inputs (e.g. fertilizer, vinasse (nutrient rich waste water recycle from the mill), supplemental irrigation, soil conditioning inputs and herbicide and pesticide inputs. The replacement of the cane occurs both within the ratoon (planting) cycle via re-growth of the cane, and via the re-planting of the cane on a field by field (harvest area basis) at the end of each ratoon as defined in the planting plan.

2.2 Bioenergy Product(s) & Reference Point(s)

Energy Product	Reference Point	Specification	Reporting Units	Supplemental Information
Hydrous Ethanol	Road Gantry Meter	ANP No. 7 AEHC (water 4.9%vol max)	KM^3	
Anhydrous Ethanol	Road Gantry Meter	ANP No. 7 AEAC (water 0.4%vol max)	KM^3	
Cellulosic Ethanol	Road Gantry Meter	ASTM D 4806 (water 1.0%vol max)	KM^3	
Electricity	Export Meter	230kV	GWhe	

2.3 Non-Energy Product(s)

Product	Reference Point	Specification	Reporting Units	Supplemental Information
VHP Sugar (very high polarization)	Mill Weighbridge	ICUMSA 1200	Kte	Export grade
Crystal Sugar	Mill Weighbridge	ICUMSA 150	Kte	Domestic grade
Bagasse	Mill Weighbridge	NA	Kte	Local animal feed rations

2.4 Authorisation and Commitment

The mill is a currently operating asset, and assessed by its auditors in its last statement of annual accounts as a viable going concern. It has all the necessary licences and permits to operate from the Brazil Federal San Paulo State authorities. This includes water extraction and waste water discharge permits both for the agricultural and industrial activities.

In addition there are a number of projects, detailed below, at various stages of development/sanction.

Project	Status	Description

Cogen Expansion	In Construction	Expansion of existing boiler capacity with an additional 20MW TA to enable the incremental firing of bagasse and export power sales.
Debottleneck (0.25 mtpa crush)	Developed, Awaiting Sanction	Debottleneck of existing capacity 0.25 mpta additional crush capacity developed and awaiting sanction. Additional cane already secured to a high level of confidence estimate of 5 years.
Expansion (1.25 mpta crush)	Under Development	Expansion project of an additional 1.25 mpta crush project being developed. 60:40 Ethanol:Sugar. Economic life estimates: High level of confidence 30 yrs, Moderate level of confidence 35 yrs Low level of confidence 45 yrs. Land origination underway. Moderate level of confidence in securing cane for 35 yrs.
Cellulosic Ethanol Project	On Hold	A project to convert the additional bagasse produced from the two expansion projects, combined with additional trash/cane straw recovery from the existing cane to cellulosic ethanol. Production capacity is 20 mill gal pa.
100% Ethanol Production	Conceptual / Early Stage Development	A conceptual project considering the installation of additional fermentation capacity to produce 100% ethanol.

3. Quantification

3.1 Operating Plan / Performance: Usina BioSucro's Financial team prepares and maintains a long-term operating plan. This plan covers the existing asset and potential upgrades / expansions that are in the development pipeline. The plan assumes a 50:50 ethanol: sugar production ratio, and a 70:30 hydrous: anhydrous split. The Operating Plan production profile is Usina BioSucro's "Best Estimate" (G1 + G2) of its future productive capacity. The high confidence level (G1) of is future production is considered to be 90% of its current Operating Plan volumes.

Performance Summary				
		High Confidence	Best Estimate (Operating Plan)	Low Confidence
Annual Cane Crush	Ktpa	4500	5000	5000
% of Operating Plan	%	90%	100%	100%[1]

Ethanol : Sugar Ratio		50:50	50:50	50:50
Aggregate Recoverable Sugar (TRS)	Kg/te cane	130	135	140
Ethanol Hydrous	KM^3 pa	131.3	151.4	157.1
Ethanol Anhydrous	KM^3 pa	54.4	62.7	65.1
Sugar (VHP + Crystal)	Ktpa	278	321	333

1: For simplicity in this case study, harvest / seasonal constraints assumed to limit mill annual cane crush rates to operating plan rates from a multi-year planning perspective.

3.2 Project Lifetime: The high confidence level estimate of the mill's current economic life is 25 years (G1), based on a technical assessment of the mill's engineering team, and in consideration of the projected sustain capex spend contained in the mill's operating plan. The engineering team best estimate of the mill's economic life is 35 yrs (G1 + G2). Based on typical mill lifetimes elsewhere in the Brazilian cane sector there is a high confidence level (G1 + G2 + G3) that the mill will achieve an economic lifetime of 45 years.

3.3 Feedstock Supply Access and Entitlement: The cane supply consists of a mix of land leases (65%), long-term cane supply contracts (~35%), and a very small (balancing) volume of spot (annual) cane contracts. The typical duration of the land leases is 5 years, with the option (at the mill's discretion) to extend by 1 year. The cane supply contracts are for 4 years. In aggregate the mill (including the 1 year extension provisions) has in place legal contracts that secure cane for the next 5 years.

Under the land leases the mill is responsible for the entirety of the agricultural operations, consisting of the initial cane planting, cultivation, harvesting, and subsequent transport to the mill. The land leases price on a formula that is linked to the Consecana cane formula price (which in turn is linked to ethanol and sugar prices), and a defined base sugar content. The mill is therefore exposed to the costs of the agricultural operations, the Consecana price, and the actual recovered yield of cane from the fields and the differential in actual cane sugar content and the base sugar content.

Under the cane supply contracts, the grower is generally responsible for all the agricultural operations. However in some instances the mill carries out some or all of the agricultural operations with the costs charged back to the grower. The cane prices on a per tonne basis, linked to the Consecana price, based on an assumed cane sugar content, but the mill has the right to all the cane from the stipulated area of land. Therefore, the mill is primarily exposed to the Consecana price, and the differential in actual cane sugar content and the assumed sugar content.

3.4 Conversion Plant Access and Entitlement: Usina Biosucro is the 100% equity owner and operator of the mill and associated agricultural operations

3.5 Monetisation of Energy Products:

Hydrous / Anhydrous Ethanol: Sold through a combination of spot and annual term contracts priced off the ELSAQ quotation. A proportion of the Anhydrous grade is sold in tank in Port Santos

and subsequently exported typically to the US / California. There is reasonable expectation that the mill can continue to monetise its ethanol production in this manner for the foreseeable future.

Power (sales): ~90% of power sales from the cogen facility that is under construction have been contracted under a Capacity Tender Auction for 10 years at price of 140 R$/MWh. The remaining 10% will be sold in the spot power market. There is a reasonable expectation that at the end of the 10 yr contract that the mill will either be able to re-tender for another power supply contract or receive equivalent remuneration via the spot market.

Sugar Sales: The sugar production is sold via an annual term supply arrangement at a price indexed to the New York No.11 Sugar contract. There is a reasonable expectation that the sugar production can be monetised in this manner for the foreseeable future.

Cellulosic Ethanol: The intention would be sell volumes via annual or longer term contracts to fuel supplier in tank in Port Santos for export into the US or EU.

4. UNFC-2009-Classification and Quantification

Class	Project Name	Sub Class	E & F Classification	Energy Products	G Axis Categorisation / Quantity			Units
					G1	G1 + G2	G1 + G2 + G3	
Commercial Projects	Current Project	On Production	E1.1 F1.1	Hydrous Ethanol	657	5299	7070	KM^3
				Anhydrous Ethanol	272	2195	2930	KM^3
	Cogen Expansion	Approved for Development	E1.1 F1.2	Power	889	6664	8150	GWh_e
	Debottleneck Project	Justified for Development	E1.1 F1.3	Hydrous Ethanol	33	265	353	KM^3
				Anhydrous Ethanol	14	110	146	KM^3
				Power	45	333	407	GWh_e
Potentially Commercial Projects	New 1.25 mtpa Crush Train	Development Pending	E2 F2.1	Hydrous Ethanol	164	1325	1767	KM^3
				Anhydrous Ethanol	68	549	732	KM^3
				Power	225	1666	2037	GWh_e
	Cellulosic Ethanol from Bagasse	Development on Hold	E2 F2.2	Anhydrous Ethanol	340	2646	3402	KM^3
				Power	-380	-2955	-3800	GWh_e
Non-Commercial Projects	100% Ethanol Production	Development Unclarified	E3.2 F2.2	Hydrous Ethanol	853	6894	9183	KM^3
				Anhydrous Ethanol	499	4041	5375	KM^3
				Power	122	986	1313	GWh_e
		Development not Viable	E 3.3 F 2.3					
Additional Quantities in Place Associated with Resource			E3.3 F 4	Total Energy	122	935	1183	PJ
Non Sales Production	From current Production		E3.1 F1	Power	1607	12495	16065	GWh_e
				Steam	6690	52052	66924	GWh_s
	From New Projects (exc. Cellulosic		E3.1 F2	Power	482	3749	4820	GWh_e

	Ethanol Project)			Steam	2007	15616	20077	GWh_s
	From Cellulosic Ethanol Plant Project		E3.1 F2	Power	380	2955	3800	GWh_e

5. E Category Classification and Sub Classification

Projects	Category	UNFC-2009 Definition	Reasoning for classification
Current Project / Cogen Expansion /Debottle-neck Project	**E1**	Extraction and sale has been confirmed to be economically viable	**Access and Entitlement:** The mill has a demonstrated portfolio of land leases and long-term supply contracts that demonstrate that it has the right and entitlement to access the necessary supplies of cane to supply the mill at its rated capacity. The additional cane required for the debottleneck project will be supplied in part by already delivered productivity/yield improvements, with the mill currently selling out the surplus cane rather than reducing its lease/contract portfolio. The supply sources for the additional cane requirements have been identified by the land origination team with options taken out. These options will be exercised on sanction of the debottleneck project. The operating entity is the sole owner of the mill. **Market and Sales Connectivity:** The mill has in place the necessary physical logistical infrastructure required to transport/ transfer the ethanol, power and associated non-energy products to their respective markets. The capacity is sufficient either sufficient to handle the increased volumes arising from the additional projects, or the inclusion of additional required capacity is included within the associated project itself. As per 3.5 the mill has all the necessary commercial contracts in place to monetise both the energy and non-energy production and there are reasonable expectations for this to continue for the foreseeable future. **Authorization:** The existing sugarcane mill and associated agricultural operations have all the necessary approvals, permits authorisations in place. These regulatory approvals extend to the Cogen Expansion and Debottleneck Project. For the US ethanol exports the mill has successful registered with both CARB and the EPA, and hence the mill's ethanol production is approved and recognised both under the US Federal Renewable Energy Directive, and the Californian Low Carbon Fuels Standard. The mill is also certified under the Bonsucro sugarcane sustainability standard covering its ethanol and sugar production. As Bonsucro is a recognised and approved standard under the EU Renewable Energy Directive, this enable the mill's ethanol to qualify as a recognised biofuel under the biofuel regulations / targets of any of the EU28 member states. **Economic Case Validation:** The mill and the associated agricultural operations is a viable operating concern and the 10 year operating plan demonstrates economic operations under the operational and market assumptions. **Social and Environmental Considerations:** There are no known social or environmental contingences that would impact the operation

			of the Project, or impact/prevent the Cogen Expansion or Debottleneck Projects. In addition to all necessary authorisations being in place, the mill has an active social engagement plan with the local community and is regarded as a responsible and valued business, source of employment and wealth generation within the local community.
	Sub-category	**UNFC-2009 Definition**	The ethanol and power (for sales) production is economic without the need for regulatory support currently and the forward assumption on the price environment. Brazil does not have any ethanol targets or mandates and hydrous competes at the pump against gasoline on an un-subsided basis. The proportion of ethanol that is exported to California does receive regulatory support under the Californian Low Carbon Fuels Standard (LCFS) and the US Federal Renewable Fuels Standard (RFS). However it is accretive in value terms and not fundamental to either the project as a whole or to the production of the volumes concerned.
	E1.1	Extraction and sale is economic on the basis of current market conditions and realistic assumptions of future market conditions.	
Projects	**Category**	**UNFC-2009 Definition**	**Reasoning for classification**
New 1.25 mtpa Crush Train / Cellulosic Ethanol from Bagasse	**E2**	Extraction and sale has not yet been confirmed to be economic, but on the basis of realistic assumptions of future market conditions, there are reasonable prospects for economic extraction and sale in the *Foreseeable Future*.	**Access and Entitlement:** Additional Cane Requirement – the land origination required to access the additional cane required to support the new 1.25 mpta crush train is way under way, with some land options already taken out. The site selection of the existing mill and the subsequent land access strategy was determined with such a possible expansion in mind. The existing land leases and cane supply contracts have been executed in a manner to "protect" the mill's cane supply envelope and hence facilitating future expansion. Therefore there are reasonable expectations that the mill will be able to access the sufficient additional supplies of cane. Additional bagasse/trash requirement- the additional bagasse/trash requirement to support the proposed lignocellulosic ethanol project will be accessed by additional trash collection from the fields as part of the cane harvesting operations through the adjustment of the harvester "blower settings". The project team has determined the appropriate levels of trash collection consistent with maintaining soil condition, moisture content etc. The mill would remain the sole operating entity of both the new crush train and the cellulosic ethanol plant. **Market and Sales Connectivity:** As per the E1 classification the mill has in place all the necessary physical infrastructure necessary to transport/transfer the additional production to market. The additional ethanol and sugar production will be sold via the existing commercial frameworks. The mill has reasonable expectations that it will be able to monetise the additional power production via a long term power supply contract at a similar price to the contract recently agreed. The cellulosic ethanol production will be sold via long-term supply contract for export to a US fuel supplier. The mill has had initial conversations with potential US off-takers that confirm their interest in accessing such volumes and indicative price levels. **Authorization:** The mill has reasonable expectations that the existing regulatory and permitting framework can be expanded to cover the new crush train. This includes the additional water extraction permits required for the additional supplemental irrigation requirements.

			The cellulosic ethanol project will require an addition regulatory approval necessary to enable the use of and disposal of genetically modified yeasts, and the use of certain pre-treatment chemicals. Conversations are already underway with the appropriate regulatory authorities and there is currently no indication that approval will not be granted. In addition in order for the cellulosic ethanol to receive US regulatory support under the Federal Renewable Fuels Standard and the California Low Carbon Fuels standard the cellulosic ethanol plant must be registered together with support information with both the EPA and CARB. This has yet to occur, but based on similar 3rd party projects the mill has reasonable expectations that approval will be granted in this case. **Economic Case Validation:** New 1.25 mtpa Crush Train – based on the existing market assumptions this project is economic with a demonstrated payback and internal rate of return that meets the mills internal hurdle requirements. Cellulosic Ethanol - under current assumptions this project is economic, but only marginally so. Given the plant's additional power requirements and the subsequent reduction in power sales, there are questions on the project's sensitivity to future power prices. **Social and Environmental Considerations:** For the new 1.25 mtpa Crush Train project there are some local concerns on the increased number of truck traffic and the suitability of some of the local road infrastructure, in particular some weak bridges. The project is working with the local community to allay these concerns in terms of demonstrating truck traffic management, a program of road water spraying on key road to minimise dust, and a program to strengthen certain bridges. At this time, the mill has reasonable expectations that these concerns can be effectively addressed and they will not impede the execution of the project. Given its smaller size there are no known issues that would impact the execution of the cellulosic ethanol project.
Projects	**Category**	**UNFC-2009 Definition**	**Reasoning for classification**
100% Ethanol Production	**E3**	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic extraction and sale in the foreseeable future.	**Access and Entitlement:** This project would utilise the existing cane supply base required to support the existing mill, the debottleneck project and the new 1.25 mtpa expansion. **Market and Sales Connectivity:** The project would use the existing logistical infrastructure, but would require additional onsite ethanol tankage and road loading gantry capacity in order handle the increased volumes. **Authorization:** No additional permitting or regulatory approvals required. **Economic Case Validation:** Under the current existing market and future assumptions investing in additional ethanol production at the expense of current sugar production/capacity would not be economic. In addition the loss of loss of optionality to swing between ethanol and sugar production would potentially be significant and a major change to the mill's business model. However, there may be future ethanol, sugar demand & supply scenarios where this would be economic. **Social and Environmental Considerations:** No additional social or environmental contingencies identified.
	Sub-category	**UNFC-2009 Definition**	Project would only be economic under certain ethanol, sugar demand & supply scenarios. The likelihood of these scenarios is still being investigated.

	E3.2	Economic viability of extraction cannot yet be determined due to insufficient information (e.g., during the exploration phase).	
Non Sales Production	**E3.1**	Quantities that are forecast to be extracted, but which will not be available for sale.	Steam and power produced from the mill's cogen facility fuelled by bagasse (cane residue) for internal consumption by the mill.
Additional Quantities in Place Associated with Resource	**E3.3**	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic extraction and sale in the foreseeable future.	Non-extractable energy in the cane.

6. F Category Classification and Sub-classification

Projects	**Category**	**UNFC-2009 Definition**	**Reasoning for classification**
	F1	Feasibility of extraction by a defined development Project or mining operation has been confirmed.	
	Sub-category	**UNFC-2009 Definition**	
Current Project	**F1.1**	Extraction is currently taking place.	The existing mill and associated agricultural operations are already underway.

Cogen Expansion	**F1.2**	Capital funds have been committed and implementation of the development Project or mining operation is underway.	The cogen expansion project has been sanctioned and construction is underway
Debottle-neck Project	**F1.3**	Sufficiently detailed studies have been completed to demonstrate the feasibility of extraction by implementing a defined development Project or mining operation.	All the engineering, agricultural development, land origination and economics and commercial evaluation has been carried out. A financial memorandum requesting sanction for the project has been prepared and is awaiting sanction.
Projects	**Category**	**UNFC-2009 Definition**	**Reasoning for classification**
	F2	Feasibility of extraction by a defined development Project or mining operation is subject to further evaluation.	
	Sub-category	**UNFC-2009 Definition**	
New 1.25 mtpa Crush Train	**F 2.1**	Project activities are ongoing to justify development in the Foreseeable Future.	Work is actively underway to develop the project and prepare a case for financial sanction.
Cellulosic Ethanol from Bagasse	**F 2.2**	Project activities are on hold and/or where justification as a commercial development may be subject to significant delay.	Initial development work has been carried out, but given the marginal economics, the capital requirements, the uncertainties on impact of the project economics on future power prices, the exposure to the project on US regulatory support for advanced biofuels and some associated uncertainties, the mills management as decided to put the project on hold and devote business development resources to more attractive opportunities.
100% Ethanol Production	**F 2.2**	Project activities are on hold and/or where justification as a commercial development may be subject to significant delay.	The project is not deemed to be economically viable under current or future market conditions, but may be economic under some ethanol and sugar supply & demand scenarios, but these are currently assessed to be unlikely to occur within the foreseeable future.
Additional Quantities in Place Associated with Resource	**F4**	In situ (in-place) quantities that will not be extracted by any currently defined development project or mining operation.	Non-extractable energy in the cane.

7. G Category Classification and Sub-classification

	Reasoning for classification		
UNFC-2009 Definition	**G1**	**G1 + G2**	**G1 + G2 + G3**
	Quantities associated with a known deposit that can be estimated to a high level of confidence.	Quantities associated with a known deposit that can be estimated to a moderate level of confidence.	Quantities associated with a known deposit that can be estimated to a low level of confidence.
Project			
Current Project	The production profile is based on the high confidence level estimates set out in the performance summary table in section 3, for a period of 5 years. The period of 5 years is the aggregate high confidence level estimate of the confidence in securing cane supply based on the aggregate length of land lease and cane supply contracts (including the 1 year extension provisions) that are currently in place. N.B. the high confidence level estimate of the technical life of the asset (30 years) is not constraining.	The production profile is based on the best estimate (Operating Plan) set out in the performance summary table in section 3 for a period of 35 years. The period of 35 years is based on the mill's cane origination's team reasonable expectations to maintain cane supplies to the mill for a period of at least 35 years. In aggregate this would comprise 7 further ratoons, cane growing cycles. This view is supported by the selection of cane fields to protect the mill's cane supply envelop to minimise competitive from other mills, the strategic relationships developed with the landowners and cane growers and their limited alterative options, coupled with demonstrated practice elsewhere in Brazil. In addition, the agricultural team has demonstrated agricultural improvement plan with the objective of increasing cane productivity, both yield and total recoverable sugar content, maintaining soil condition, and protecting against pest and pathogens. The plan targets a 1% pa yield improvement which is consistent with historical performance both by the mill and within the entire sector. The increased cane yield will support in part the	The production profile is based on the low level confidence level estimate set out in the performance summary table in section 3 for a period of 45 years The period of 45 years is based on the low level of confidence estimate of the technical life of the asset and a low level of confidence estimate of the extension of the cane supply also to 45 years. N.B. Upside views on increased cane yields resulting from the agricultural improvement plan assumed to result in lower land utilisation rather than increased production.

		debottleneck and expansion projects, but will also progressively reduce the land area requirement to support the mill's processing capacity. The moderate level of confidence estimate for the technical life of the asset (35 yrs) also constraints the production profile to a limit of 35 years.	
Cogen Expansion	An annual power export of 100 GWh_e consistent with the high confidence level production profile as per section 3, for a period of 5 years, again consistent with the cane supply assessment for the high confidence level estimate for the current project.	An annual power export of 190 GWh_e consistent with the best estimate production profile as per section 3, for a period of 35 years, again consistent with the cane supply assessment for the moderate confidence level estimate for the current project.	An annual power export of 181 GWh_e consistent with the high confidence level production profile as per section 3, for a period of 45 years, again consistent with the cane supply assessment for the high confidence level estimate for the current project. N.B, the reduced power export from the G1+G2 estimate is due to the higher cane sugar content/ hence higher ethanol production and hence higher mill energy requirements.
Debottle-neck Project	An additional 0.25 mpta of annual cane crush capacity operating to the same performance as per the high confidence level production profile in section 3 (e.g. 90% of operating plan) for a period of 5 years, consistent with the cane supply assessment for the high confidence level estimate for the current project.	An additional 0.25 mpta of annual cane crush capacity operating to the same performance as per the best estimate level production profile in section 3 (e.g. operating plan) for a period of 35 years, consistent with the cane supply assessment for the moderate confidence level estimate for the current project.	An additional 0.25 mpta of annual cane crush capacity operating to the same performance as per the high confidence level production profile in section 3 for a period of 45 years, consistent with the cane supply assessment for the high confidence level estimate for the current project.
New 1.25 mtpa Crush Train	An additional 1.25 mpta of annual cane crush capacity operating to the same performance as per the high confidence level production profile in section 3 (e.g. 90% of operating plan) for a period of 5 years, consistent with the cane supply assessment for the high confidence level estimate for the current project.	An additional 1.25 mpta of annual cane crush capacity operating to the same performance as per the best estimate level production profile in section 3 (e.g. operating plan) for a period of 35 years, consistent with the cane supply assessment for the moderate confidence level estimate for the current project.	An additional 1.25 mpta of annual cane crush capacity operating to the same performance as per the high confidence level production profile in section 3 for a period of 45 years, consistent with the cane supply assessment for the high confidence level estimate for the current project.

Cellulosic Ethanol from Bagasse	Cellulosic ethanol production from a 20 mil gal (76 km^3) annual capacity unit operating at 90% capacity for a period of 5 years consistent with the high level confidence case assumptions.	Cellulosic ethanol production from a 20 mil gal (76 km^3) annual capacity unit operating at 100% of capacity for a period of 35 years consistent with the best estimate case assumptions.	Cellulosic ethanol production from a 20 mil gal (76 km3) annual capacity unit operating at 100% of capacity for a period of 45 years consistent with the low confidence case assumptions.
	In each case the operating assumptions of the cellulosic ethanol plant are linked to the confidence case of the current project due to the interdependences of the plant on the bagasse/trash supply from the cane, and energy integration. The cellulosic ethanol plant is a net energy (power) importer and so reduces the power available for sales.		
100% Ethanol Production	The additional ethanol production represented by the swing from a 50:50 ethanol: sugar ratio to 100% ethanol enabled by investment in additional fermentation capacity from the total cane crush capacity including the current, debottleneck and expansion projects (6.5 mtpa).		
	100% ethanol production operating as per the high confidence level production profile in section 3 (e.g. 90% of operating plan) for a period of 5 years, consistent with the high confidence level cane supply assumptions	100% ethanol production operating as per the best estimate level production profile in section 3 (e.g. operating plan) for a period of 35 years, consistent with the best estimate cane supply assumptions	100% ethanol production operating as per the Low confidence level production profile in section 3 for a period of 45 years with the low confidence level cane supply assumptions
Non Sales Production	Mill Steam and Power consumption consistent with the high confidence level production profile in section 3 (e.g. 90% of operating plan) for a period of 5 years, consistent with the high confidence level cane supply assumptions.	Mill Steam and Power consumption consistent with the best estimate level production profile in section 3 (e.g. operating plan) for a period of 35 years, consistent with the moderate confidence level cane supply assumptions.	Mill Steam and Power consumption consistent with the low confidence level production profile in section 3 for a period of 45 years, consistent with the low confidence level cane supply assumptions.
Additional Quantities in Place Associated with the Resource	The un-extracted energy in the cane represented the difference of its lower heating value (15 GJ/ dry te) and the sum of the energy extracted in the form of ethanol, power (sales and non-sales), steam from all the projects consistent with the respective G1, G1 +G2, G1+G2+G3 assumptions as below:-		
	5850 mtpa cane crush consistent with the high confidence level production profile in section 3 (e.g. 90% of operating plan) for a period of 5 years, consistent with the high confidence level cane supply assumptions.	6500 mtpa cane crush consistent with the best estimate level production profile in section 3 (e.g. operating plan) for a period of 35 years, consistent with the moderate confidence level cane supply assumptions.	6500 mtpa cane crush consistent with the high level production profile in section 3 for a period of 45 years, consistent with the high level cane supply assumptions.

8. Glossary (Units)

Volume	
KM^3	Thousand cubic meters
Mill gal	Million US gallons
Mass	
Kte	Thousand metric tonnes
Ktpa	Thousand metric tonnes per annum
Mtpa	Million metric tonnes per annum
Energy	
GWhe	Gigawatt hours of electricity
GWhs	Gigawatt hours of steam
PJ	Peta Joules, 10^{15} Joules

XYZ Renewable Diesel

Project Location: Rotterdam, NL

Data date: 2015

Date of evaluation: 1 Jan 2016

Quantification method: Simulation based on businesses operating plan and supporting commercial and technical data.

Estimate type (deterministic/probabilistic): Deterministic (scenario)

1. Project Summary and Background

This is a hypothetical case-study/example produced with the purposes of demonstrating the application of the Bioenergy Specification. The specific objectives are to provide a biodiesel case study that demonstrates the treatment of multiple feedstock / bioenergy sources, the treatment of energy sources sourced via a system of purchase agreements, the accounting for a non-biogenic feedstock, policy/regulatory support uncertainty, and regulatory sustainability requirements. This is an abbreviated case study and does not present the full range of supporting information that would be required in a full classification and to support the underlying assumptions.

N.B. this case study was first developed before the release of the European Commission's proposal for the EU biofuel targets post 2020, and therefore does not consider the implications of the draft proposal for further restrictions on food based biofuels post 2020. In a real world situation, the release of such a legislative proposal that may have material implications on the project's economic viability would be a potential trigger point for a revaluation of the classification.

XYZ Renewable Diesel is an existing 100 ktpa hydrogenation plant located at Rotterdam, NL that has been operating for 3 years (start-up 2013). It processes fatty acid oils (palm oil and animal tallow) into renewable diesel (a biodiesel that is essentially chemically indistinguishable to diesel derived from fossil sources), via a hydrogenation process (technology licensed by XYZ).

The plant sources its non-renewable hydrogen from a neighbouring oil refinery (~ 2%wt of the feedstock). Overall conversion is 90% (the remaining 10% is water), of which 5% is (bio)propane, 5% Bio Naphtha and 80% Renewable Diesel. The Renewable Diesel is supplied into the Dutch and German markets. The plant purchases process steam across the fence from the neighbouring refinery, and power from the grid. It also purchases natural gas ex grid to fire its process heater. The propane is sold to the refinery via a connecting pipeline.

Given that the Renewable Diesel's production cost is higher than conventional diesel under most price environments, the plant's economic viability is highly dependent on regulatory support. The relevant legislation is the EU Renewable Energy Directive which sets out biofuel targets out to 2020. This has been promulgated into EU member state legislation, including the Dutch, and German markets that the plant supplies, that have in each introduced biofuel mandates/targets out to 2020. However, policy post 2020 is currently unclear and yet to be determined both at an EU and a member state level. In addition the EU has recently introduced a 7% (energy) cap on biofuels produced from food crops.

The plant's production from palm oil falls into this category and would be limited by this cap. The production from the tallow is excluded.

A requirement of the Renewable Energy Directive is that qualifying biofuels meet certain sustainability criteria and are certified under EU recognized sustainability scheme. XYZ Renewable Diesel corresponding sources RSPO certified Palm Oil and ISCC certified animal tallow to comply with these requirements.

2. Project Definition

2.1 Bioenergy Source(s)

Palm Oil - 50% of feedstock requirements.
Animal Tallow (category 1) – 50% of feedstock requirements.

Both the palm oil and animal tallow are considered to be Bioenergy Sources within the definition set out in the Bioenergy Specification on the basis that both are biogenic, and in both cases their rate of extraction does not exceed the rate of replenishment , and both are replenished by biomass of a substantially similar form. In the case of palm oil, this occurs via agricultural cropping and subsequent processing of palm fruit. In the case of animal tallow this is sourced as a waste as from the meat processing sector whose economic activity is considered to continue for at least as long as the lifetime of the project.

There are significant concerns relating to the sustainability of palm oil both as a biofuel feedstock and for other applications. This aspect is considered under the regulatory treatment of palm oil as a biofuel feedstock within European legislation, specifically the need to comply with sustainability standards and the cap on food based biofuel targets.

The project also sources hydrogen derived from non-bioenergy from a neighbouring refinery for use in the hydrogenation process. A proportion of the hydrogen is chemically combined with the energy products. Since the hydrogen is a not a bioenergy source, its proportion is factored out of the reported energy products volumes.

2.2 Bioenergy Product(s) & Reference Point(s)

Energy Product	Reference Point	Specification	Reporting Units	Supplemental Information
Renewable Diesel	Road/Rail Car Gantry Meter	EN590 (EU Diesel Specification)	Kte	The proportion of non-renewable hydrogen factored out of the reported volumes.
Bio Naphtha	Road/Rail Car Gantry Meter	*Bio Naphtha x.x 1.01.2013* (XYZ Renewable Diesel Manufacturing Specification)	Kte	
Bio Propane	Pipeline meter	Propane *x.x 1.01.2013* (XYZ Renewable Diesel Manufacturing Specification)	Kte	

2.3 Non-Energy Product(s)

Nil

2.4 Authorisation and Commitment

The plant is a currently operating asset, and assessed by its auditors in its last statement of annual accounts as a viable going concern.

The plant has all necessary permits and operating licences from the Dutch Government and Rotterdam Port Authority to allow operations. This includes water extraction and waste water discharge permits.

Product approvals: The plant and its renewable diesel and bio naphtha production is registered and approved as qualifying biofuels under the relevant Dutch, German, French, and UK legislation. As part of this approval, the Palm Oil sourced by the plant is certified under the Roundtable of Sustainable Palm Oil (RSPO) scheme, and the Animal Tallow under the International Sustainability and Carbon Certification Scheme. Both schemes are recognised and approved schemes by the European Commission as meeting the requirements of the EU Renewable Energy Directive.

3. Quantification

Operating Plan / Performance: The multi- year operating plan is based on a 50:50 mix of palm oil and tallow. This is taken to be the best estimate of future production levels. The price volatility on XYZ Renewable Diesel's feedstock is a significant exposure and the European Biodiesel Sector over the last 10 years has experienced periods of low or negative operating margins leading to run cuts. In view of this exposure, XYZ Renewable Diesel's high confidence production level has been assessed at 85% of its operating plan levels. The low confidence production level has been assessed as at 110% of operating plan based on test run results at optimal performance.

The non-renewable hydrogen element has been factored out of the reported estimated cumulative quantities of the energy products

Project Lifetime: Based on a technical assessment there is a high confidence level that under the current maintenance schedule (sustaining capex spend) the plant has a technical lifetime of 20 years, a moderate confidence level of 25 years and a low confidence level estimate of 30 years. There is at this stage no proposal to re-invest in the plant to significantly extend its operating life beyond 30 years.

Feedstock Supply Access and Entitlement:

Palm Oil: XYZ Renewable Diesel sources 50% of its Palm Oil requirements from a major Palm Oil Trader via a 5 year supply deal that has a further 2 years to run. At this stage it is there is a high confidence level that this contract will be renewed for a further 5 years, and a moderate confidence level that further renewals thereafter will be possible.

The remaining 50% of the Palm Oil supplies are sourced by a mix of annual supply deals and spot arrangements. This approach (in combination with the LT supply deal) has ensured that the plant has been supplied with sufficient product for the last 3 years. Therefore, there is a high confidence level that this can be assured for a further 3 years. Thereafter, ongoing supply from this tranche of volume is to a moderate confidence level.

Animal Tallow: 100% of XYZ Renewable Diesel's tallow requirement is sourced via 4 year supply deal from a single supplier that has a further 1 year to run. Negotiations are on-going to renew this supply deal, but the recent imposition of the 7% food base biofuel cap has significantly increased the competition for this feedstock, and currently there is only a low confidence level that this will be renewed at a price that is acceptable. XYZ Renewable Diesel is currently exploring alternative options. However, the current alternatives are either to take a category 2 tallow from the same supplier (however this category of tallow is not acceptable in the German market, XYZ Ren Diesel's key market), or to source additional palm oil supplies. However in this case XYZ Ren Diesel would exceed the 7% food based cap and not be able to place the product in the European market. Exports to the US may be possible, but the viability is highly dependent on the soya oil / palm oil spread. In summary, the current conclusion is that there is only a low confidence level that this tranche of supply will be successfully / economically extended beyond the remaining 1 year.

Conversion Plant Access and Entitlement: XYZ Renewable Diesel has 100% equity of the plant and is the owner operator.

Monetisation of Energy Products:

Renewable Diesel: XYZ Renewable Diesel has a mix of annual supply contracts with fuel suppliers in the German and Dutch markets. These supply contracts price at the monthly average Platts FAME (biodiesel) quotation for the delivery month + a premium that varies by supplier.

Bio Naphtha: Plant has contracted its entire volumes to a French gasoline blender in an annual supply contract. The French gasoline blender blends the bio naphtha into its gasoline pool to taking advantage of surplus octane and the high incentives for biofuel / biogasoline blending in France. The pricing formula is the monthly Platts gasoline quotation + a premium.

Bio propane: Plant has contracted its entire volumes via an annual supply deal to a neighbouring refinery in the Rotterdam area and supplies the product via a short pipeline. The refinery pays the Platts C3 monthly quotation. As the propane goes into the refiners C3 pool XYZ Renewable Diesel receives no premium for the propane bio credentials (despite attempts).

4. UNFC-2009-Classification and Quantification

Class	Sub Class	Classification	Energy Products	Quantity	Units
Commercial Project	On Production	E1.2 F1.1 G1	Renewable Diesel	200	Kte
			Bio Naphtha	12	
			Bio propane	12	
			Total	**225**	
		E1.2 F 1.1 G1 + G2	Renewable Diesel	784	
			Bio Naphtha	49	
			Bio propane	49	
			Total	**882**	
		E1.2 F 1.1 G1 + G2 + G3	Renewable Diesel	2587	
			Bio Naphtha	162	
			Bio propane	162	
			Total	**2911**	

Additional Quantities in Place Associated with Resource	E3.3 F4 G1	Total Energy Products	25	
	E3.3 F4 G1 + G2		98	
	E3.3 F4 G1 + G2 + G3		323	

5. E Category Classification and Sub-classification

Category	UNFC-2009 Definition	Reasoning for classification
E1	Extraction and sale has been confirmed to be economically viable	The plant is an operating viable concern, with all necessary approvals, authorisations and commercial contracts in place.
Sub-category	**UNFC-2009 Definition**	
E1.2	Extraction and sale is not economic on the basis of current market conditions and realistic assumptions of future market conditions, but is made viable through government subsidies and/or other considerations.	Economic viability is dependent on regulatory support, specifically German, Dutch and French biofuel targets/mandates. The uncertainty on future evolution (post 2020) of this legislation is considered in the G Axis categorisation.
Category	UNFC-2009 Definition	Reasoning for classification
E3	Extraction and sale is not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability.	Considers the difference of the total energy supplied to the plant as defined by the cumulative lower heating value of the palm oil and animal tallow supplied and the cumulative energy (lower heating value) of the energy products extracted / produced. At this stage there is no realistic prospect of increasing the conversion of the palm oil/animal tallow supplied into final energy products.
Sub-category	**UNFC-2009 Definition**	
E3.3	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic extraction and sale in the foreseeable future.	

6. F Category Classification and Sub-classification

Category	UNFC-2009 Definition	Reasoning for classification
F1	Feasibility of extraction by a defined development project or mining operation has been confirmed	A current operational unit.
Sub-category	**UNFC-2009 Definition**	
F1.1	Extraction is currently taking place	
F4	No development project or mining operation has been identified	No feasible technical option to increase unit conversion beyond 90%, due to fundamental stoichiometric constraints.

7. G Category Classification and Sub-classification

	Reasoning for classification		
UNFC-2009 Definition	**G1**	**G1 + G2**	**G1 + G2 + G3**
	Quantities associated with a known deposit that can be estimated to a high level of confidence.	Quantities associated with a known deposit that can be estimated to a moderate level of confidence.	Quantities associated with a known deposit that can be estimated to a low level of confidence.
Project			
On Production	Annual production at 85% of operating plan projections (high confidence level estimate of performance) for a period of 3 years. The period of 3 years is the aggregate high confidence level estimate of the confidence in securing supply based on the assessment of the supply contracts. The high confidence level estimates for the period of regulatory support (5 yrs to 2020), and the technical life of the asset (20 yrs) are not constraining factors.	Annual production at 100% of operating plan (moderate confidence level estimate) for a period of 10 years (to 2025). The period of 10 years is the moderate confidence level estimate of the future longevity of sufficient biofuel regulatory in XYZ Renewable Biodiesel key markets required for economic viability. The moderate confidence level estimates for the aggregate longevity of supply contracts, 13 years, and the technical life of the plant 25 years are not constraining factors.	Annual production at 110% of operating plan (low confidence level estimate) for 30 years. The period of 30 years is the low confidence level estimate of the technical lifetime of the plant. The low confidence level estimates of the longevity of the supply contracts (35 years) and regulatory support (35 years) are not constraining factors.
Additional Quantities in Place Associated with Resource	The un-extracted energy in the vegetable oil feedstock represented the difference of its lower heating value (36.5 GJ/te) and the sum of the energy extracted in the form of Renewable Diesel, Bio naphtha and Bio propane (as assessed by their lower heating values) consistent with the respective G1, G1 +G2, G1+G2+G3 assumptions as below: -		
	Annual production at 85% of operating plan rates for a period of 3 years.	Annual production at operating plan rates for a period of 10 years.	Annual production at 110% operating plan rates for a period of 30 years.

8. Glossary (Units)

Volume	
KM^3	Thousand cubic meters
Mass	
Kte	Thousand metric tonnes
Ktpa	Thousand metric tonnes per annum