LIFECYCLE ASSESSMENT OF GREENHOUSE GAS EMISSIONS

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1 PURPOSE OF THIS DOCUMENT

Agri Energy Limited (AAE) is proposing to construct three grain to ethanol plants in New South Wales, Australia. These are to be located at Condobolin, Coleambally and Oaklands. All of these plant are identical and each will produce 200 million litres of ethanol per year. These plants are to be based on an identical Plant in Beatrice, Nebraska and will only differ in the nature of the raw material inputs (grains and energy) and co-product mix. These variables are fully configurable in the model that has been prepared for the NSW operations. The design and operation of these Plants will also be similar to, but at double the capacity, of an ethanol Plant that is currently being built by AAE near Swan Hill in Victoria.

The primary aim of this report is to accurately estimate greenhouse gas emissions (GHG) and net energy requirements on a life cycle assessment (LCA) basis for the biofuels (Fuel Ethanol) produced at the proposed Australian Biofuels Pty Ltd (Division of AAE), NSW sites.

An equally important purpose of this report is to compare the greenhouse emissions from the use of the AAE outputs (ethanol) with those from produced from alternative fuels such as gasoline (PULP) and LPG.

2 REPORT STRUCTURE AND INTENT

This report will explain and justify the estimated greenhouse gas emissions in a Life Cycle Assessment by:

- reviewing the relevant policies and calculation methodologies relevant to Greenhouse Gas (GHG) emissions;
- calculating the GHG emissions from the Project including the emissions from the environmental impact assessment calculations;
- placing the GHG emissions from the Project into context in a national and international arena;
- assessing the potential impact on climate change and the requirement for ethanol based biofuels in a national and international context; and
- assessing the above in light of the principles of relevant legislation and ecologically sustainable development
- outlining a greenhouse gas emissions abatement plan

3 *GREENHOUSE GAS EMISSIONS, GLOBAL WARMING AND CLIMATE CHANGE*

The greenhouse effect is the term used for the warming of the Earth's atmosphere by heat energy from the sun being trapped by naturally occurring atmospheric gases. Without the natural greenhouse effect created by our atmosphere the world's average temperature would be minus 18^{o}C rather than the 16 ^{o}C which supports our ecosystem. In simple terms, sunlight passes through the atmosphere, warming the Earth. In turn, the Earth radiates this energy back towards space. As it passes back out through the atmosphere, greenhouse gases (primarily water vapour, carbon dioxide, methane and nitrous oxide) absorb part of the outgoing heat energy. This means the greater greenhouse gas concentration in the atmosphere, the greater the amount of the sun's heat energy that becomes trapped rather than being released to space, resulting in a warming of the lower part of the atmosphere, land masses and oceans.

Since the Industrial Revolution the concentration of greenhouse gases in the atmosphere, mainly carbon dioxide and methane has been increasing as a result of human activities. The main contributors to the increase are industrial processes, fossil fuel combustion and changes in land use such as de-forestation. The majority of scientific opinion is that the increasing concentration of these gases has led, and will continue to lead, to an increase in the world's average temperature. This is called the enhanced greenhouse effect because it is additional to the naturally occurring greenhouse effect.

Scientists predict that the major consequence of the enhanced greenhouse effect is that the Earth's climate systems will change. The exact impact of the enhanced greenhouse effect on climate systems (climate change) is difficult to predict but scientists warn that the increased incidence of extreme weather events such as damaging storms and prolonged drought periods are a likely consequence. As the global average temperature rises (predicted to rise by as much as 4^{o}C by 2100) sea levels will also rise from melting ice caps and expansion of the seas.

In February 2007, the Intergovernmental Panel on Climate Change (IPCC) released a summary of the Fourth Assessment Report that concluded that scientists have a higher confidence in projected patterns of warming and other regional-scale features, including changes in wind patterns, precipitation and some aspects of extremes and of ice melting.

4 METHODOLOGY

4.1 Emissions Associated With NSW Ethanol Production

An interactive Excel Spreadsheet Model (the Model) was developed to calculate the CO_2 emissions associated with AAE's proposed NSW ethanol operations and on burning of the fuel in motor vehicles. In addition the model also provides an Energy Balance from the energy inputs required to produce fuel ethanol and the energy inherent within ethanol as a fuel. The model outputs have then been used to compare and contrast ethanol based fuels against petroleum based alternatives in terms of GHG emissions and Energy Balance. The model is configurable to allow for a mix of different feedstock grains (wheat, corn, barley and sorghum) and for other inputs such as energy requirements under AAE's control.

Some of the data for the model has been provided by AAE, predominantly on the technical, logistical and design parameters of its plants. Where other specific data has been required it has been gathered from an extensive literature review.

The allocation of total life cycle emissions to co-products in a multi-input/output production process is one of the most critical issues in life cycle assessment of greenhouse gas emissions. In determining the allocation of agriculture emissions to ethanol production it is considered that ethanol and dried distiller's grain are equally important co-products. This has been confirmed since ethanol plants are generally not economical without sales of dried distiller's grain. In dry mills, about 59% of the total energy purchased is expended on the production of ethanol.[1] As a result, AAE has taken the industry recognised approach that all the greenhouse gas emission performance and energy consumption associated with the production of AAE products must be allocated on this same basis between ethanol and co-products such as dried distiller's grain.[2] Therefore, in the model all the CO_2 emissions associated with AAE's plants have been allocated to ethanol (59%) and dried distiller's grain (41%) on that basis.

AAE has used credible and supportable co-product allocation methodologies. Greenhouse emission estimates have been calculated using principles and methodologies developed by The Australian Greenhouse Office (AGO) over a number of years. The Department of Environment & Heritage (DEH) released the AGO Workbook in December 2005 that was subsequently updated in 2006. The AGO Workbook provides current GHG emission factors for use by Australian organisations to estimate their greenhouse gas emissions and abatement values.

The emission factors presented in the 2006 edition of the AGO Workbook have been harmonised with the international reporting framework of the GHG Protocol.

4.2 AGO Workbook

A primary purpose of the AGO Workbook is to define the scope of emissions to be assessed and calculated. Participants in AGO programmes are required to report both direct and indirect GHG emissions.

"Direct Emissions" are defined in the AGO Workbook as being produced from sources within the boundary of an organisation and as a result of that organisation's activities. These emissions mainly arise from the following activities:

- ❖ generation of energy, heat, steam and electricity, including carbon dioxide and products of incomplete combustion (methane and nitrous oxide);

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[1] Shapouri et al (2004)
[2] Shapouri et al (2004)

- manufacturing processes, which produce emissions (for example; cement, aluminium and ammonia production);

- transportation of materials, products, waste and people (for example; use of vehicles owned and operated by the reporting organisation);

- fugitive emissions: intentional or unintentional greenhouse gas releases (such as methane emissions from coal mines, natural gas leaks from joints and seals); and

- on-site waste management, such as emissions from company-owned and operated landfill sites.

For example, a company with a car fleet would report greenhouse gas emissions from the combustion of petrol in those motor vehicles as direct emissions. Similarly, a mining company would report methane escaping from a coal seam during mining (fugitive emissions) as direct emissions and a cement manufacturer would report carbon dioxide released during cement production as direct emissions.

Emission factors for calculating direct emissions are generally expressed in the form of a quantity of a given greenhouse gas emitted per unit of energy, fuel or a similar measure. Emission factors are used to calculate greenhouse gas emissions by multiplying the factor with the activity data.

"Indirect Emissions" are defined in the AGO Workbook as:

> *"Indirect Emissions are emissions generated in the wider economy as a consequence of an organisation's activities (particularly from its demand for goods and services), but which are physically produced by the activities of another organisation. The most important category of indirect emissions is from the consumption of electricity. Other examples of indirect emissions from an organisation's activities include upstream emissions generated in the extraction and production of fossil fuels, downstream emissions from transport of an organisation's product to customers, and emissions from contracted/outsourced activities. The appropriate emissions factor for these activities depends on the parts of upstream production and downstream use considered in calculating emissions associated with the activity."*

As discussed above, to achieve harmonisation with the international reporting framework, the AGO Workbook adopts the emissions categories of the "GHG Protocol" and provides that the scope of emissions that are reported by an entity under the AGO Workbook is determined by whether the activity is within the entity's boundary (Direct - Scope 1) or outside it (Indirect - Scope 2 and Scope 3).

- **Scope 1** covers direct emissions from sources within the boundary of process production such as fuel combustion and manufacturing processes. In an ethanol plant Scope 1 emissions arise from the fermentation of simple sugars by yeast to alcohol with the concomitant release of CO_2. Steam is also used generated on-site for the Plant primarily for the conversion of starch to these simple sugars. The Heat Energy required to generate this steam is derived from LNG, LPG or natural gas and the on-site burning of these fuels will also generate Scope 1 CO_2 emissions.

- **Scope 2** covers indirect emissions from the consumption of purchased electricity, steam or heat produced by another organization. Scope 2 emissions result from the combustion of fuel to generate the electricity, steam or heat and do not include emissions associated with the production of fuel. The provision of water and electricity, that are required for the production of Ethanol and Distiller's Grain, will be obtained from an external source so that the CO_2 emissions to provide or generate these fall into the Scope 2 category.

  Scopes 1 and 2 are carefully defined to ensure that two or more organizations do not report the same emissions in the same scope.

- **Scope 3** includes all other indirect emissions that are a consequence of an organization's activities but are not from sources owned or controlled by the organization. For an ethanol Plant Scope 3 emissions are generated as the result of crop production and haulage, transport of denaturant (petrol) to the site and transport of fuel ethanol from the site to bulk distribution points,

An assessment of the Scope 1, Scope 2 and Scope 3 energy and GHG emissions from the proposed Project was undertaken over the life of the Project from "farm to fuel".

4.3 Accounting for Biomass Carbon Dioxide Emissions

Since the Kyoto Protocol and Intergovernmental Framework Convention on Climate Control methodologies for determining greenhouse gas emissions only include carbon dioxide derived from fossil fuels, carbon dioxide generated from the combustion of a renewable fuel, such as biodiesel or ethanol, is not included in the calculation. Carbon dioxide emitted from the burning of renewable fuel, such as ethanol derived from cereal crops, is **offset** by that which is absorbed by the plant from the atmosphere during its growth (AGO Workbook, 2006). It is AAE's opinion that the same applies to carbon dioxide emitted from the fermentation of biomass to produce ethanol. This view is in line with the majority of studies conducted in the USA and Australia over the last 20 years (AGO Workbook, 2006). Based on these studies the fermentation carbon dioxide emissions have effectively been excluded by "crediting" the same amount as absorption by plants during their growth.

4.4 Net Energy Balance

Net Energy Balance estimates have been calculated using US Department of Agriculture methodologies (Shapouri, 2004).

5 GREENHOUSE EMISSIONS - LIFE CYCLE ANALYSIS

5.1 NSW Input Data

A defined set of Inputs for the NSW operations including the amount of ethanol produced, type and amount of feedstock used, water use, energy requirements such as electricity and gas, as well as the need for road and rail transport have been used for the modelling.

The NSW plants will use a mix of corn, wheat, barley. The model is configurable to use a mixture of these grains in any proportion. This incorporates factors such as grain moisture, starch content and feedstock haulage distances for each of the grain feedstocks: corn, wheat, barley. Due to the location of the proposed Plants in NSW sorghum is unlikely to be considered as a potential feedstock. By taking into account the location of each Plant, the availability of grains in that region as well as the historical levels of grain prices in the region, the most likely combination of grains that will be used for the production of ethanol will be 45% corn, 35% wheat and 20% barley and this proportion has been used to generate a weighted average model for NSW.

The NSW operations may use a mixture (not necessarily concurrently) of natural gas, LNG and LPG. Once again the model is configurable to accommodate any mix of these fuels. The model calculates emissions and Energy Balances for each of these inputs separately and then uses a weighted average, based on the availability of fuel at each site, to determine the final outputs.

The model calculates $CO_{2\text{-}e}$ Emissions and Energy Balances for each of the above inputs and constructs a weighted average to determine the final outputs from “farm to fuel”.

5.2 NSW Output Data and GHG Emissions

By using the AGO Workbook calculations as a guide and incorporating the above Inputs, along with the amount of ethanol and co-products that are produced, transported and the energy required, the amount of $CO_{2\text{-}e}$ emitted could be calculated so that it includes all emissions associated with the production of ethanol as well as the emissions released during the combustion of the fuel in motor vehicles. Emissions were classified into Scope 1, Scope 2 and Scope 3 GHG emissions.

Table 1 shows the estimated emissions associated with a NSW plant that will produce 200 million litres of ethanol per year like the ones to be built at Condobolin, Coleambally and Oaklands. The estimated energy and GHG emissions for the Project based on production schedule and operational scenarios are as defined by the Scope Classification in the AGO Workbook. They have been calculated using AAE data and additional data collected during literature review. The results are expressed in terms of tonnes of CO_2 produced (t $CO_{2\text{-}e}$) and grams of $CO_{2\text{-}e}$ produced per Mega Joule of Ethanol energy (g/MJ Ethanol).

Table 1: Scope 1, 2 and 3 Category Greenhouse Gas Emissions per Annum

Emission Classes	Amount	Unit
Scope 1 Direct Process Emissions		
*Fermentation	130,000	t $CO_{2\text{-}e}$
Heat Energy	106,318	t $CO_{2\text{-}e}$
Total Class 1 Direct Emissions	106,318	t $CO_{2\text{-}e}$
	= 22.4	g/MJ Ethanol
Percentage	**36%**	
Scope 2 Indirect Process Emissions		
Water Provision		
Electricity	14,750	t $CO_{2\text{-}e}$
	37,933	t $CO_{2\text{-}e}$
Total Class 2 Indirect Emissions		
	52,683	t $CO_{2\text{-}e}$
	=11.1	g/MJ Ethanol
Percentage		
	18%	
Scope 3 Other Indirect Emissions		
Crop Production	125,515	t $CO_{2\text{-}e}$
Crop Haulage	2,041	t $CO_{2\text{-}e}$
Denaturant Transport	175	t $CO_{2\text{-}e}$
Emissions from denaturant production	38	t $CO_{2\text{-}e}$
Road Transport	7,446	t $CO_{2\text{-}e}$
*Absorption by Plants during growth	-130,000	t $CO_{2\text{-}e}$
Total Class 3 Other Indirect Emissions	135,215	t $CO_{2\text{-}e}$
	=28.6	g/MJ Ethanol
Percentage		
	46%	
Total Emissions	294,216	t $CO_{2\text{-}e}$
	=62.1	g/MJ Ethanol

***** Carbon dioxide emitted from the fermentation of biomass to produce ethanol is **offset** by CO_2 absorption by the plant from the atmosphere during its growth (AGO Workbook, 2006, refer to Section 4.3,).

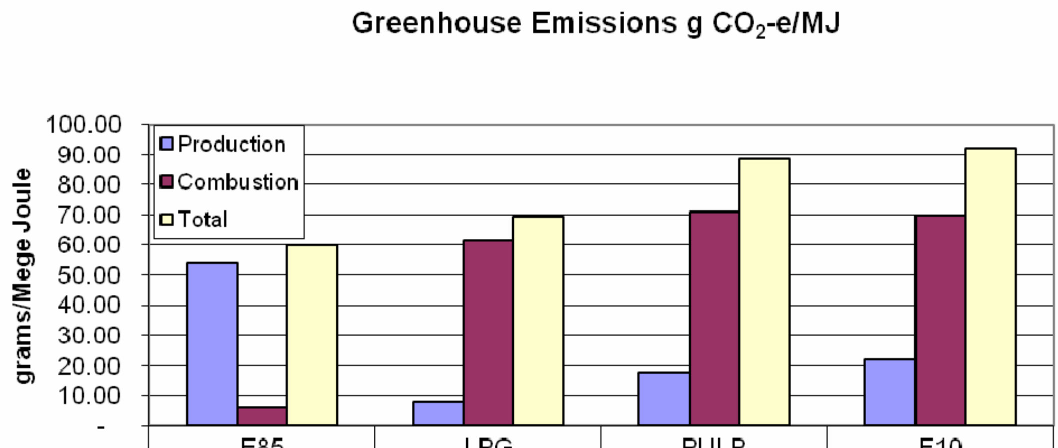
These figures are based on maximum production with continuous 24 hour operation of the Plant, 330-340 days per year with all of the distiller's grain being dried and, in terms of CO_2 emissions, represent the worst case scenario. It is anticipated that some of the distiller's grain will be sold direct to local cattle feedlots, negating the need to dry all of this material, leading to reduced Heat Energy and Electricity consumption and therefore, less CO_2 emissions.

In 2002 the total CO_2 emissions in Australia were 337,379,700 tonnes (earthtrends.wri.org/searchable_db/index.php?step=countries&cID%5B%5D=9&theme=3&variable_ID=460&action=select_years) so the 294,216 tonnes from one NSW Plant represents 0.087%.

The CO_2 emissions data generated for the production of fuel ethanol for motor vehicles by an ethanol Plant has been compared with the amount of CO_2 emissions that are currently being generated by the Petroleum Industry for other fuels such as PULP and LPG for motor vehicles.

Figure 1 compares the relative greenhouse emissions associated with the production and combustion of E85, LPG, PULP and E10 on a g/MJ basis and demonstrates that E85 generates 32% ***less*** greenhouse gas emissions than premium unleaded petrol (on an energy equivalent basis).

Figure 1: NSW Ethanol Greenhouse Emissions for Various Fuels – g CO_2-e/MJ



	E85	LPG	PULP	E10
Production	54.08	7.80	17.70	22.14
Combustion	6.00	61.50	71.00	70.00
Total	60.08	69.30	88.70	92.14

The total GHG emissions for E10 and PULP are similar, however, it must be remembered that each NSW Plant producing 200 million litres of ethanol is **displacing** the use of the non-renewable, 200 million litres of petrol.

Although the current legislation in Australia limits the amount of ethanol that can be added to fuel to a maximum of 10% (E10 blends), vehicles that can utilize E85 (Flex Fuel Vehicles) are gaining wide popularity in Brazil with over 84% of the cars sold in Brazil during February, 2007 being Flex Fuel vehicles (www.brazzilmag.com/content/view/7996/54/). The USA President and all of the major motor vehicle manufacturers in the USA have also given a commitment that 50% of the vehicles produced in the USA will be Flex Fuels by 2012 (www.whitehouse.gov/news/releases/2007/03/20070326.wm.v.html). Just as Australia has followed the lead set by the USA and Brazil on the use of E10 blends for motor vehicles it is likely that they will also follow their lead on the uptake of E85 blends to take advantage of the greenhouse and other benefits of switching to this type of fuel. The Queensland government has already been trialling vehicles on E85 ethanol blends (www.cabinet.qld.gov.au/MMS/StatementDisplaySingle.aspx?id=49915).

It is envisaged that introduction of the measures described in Section 7 (Greenhouse Gas Emissions Abatement Plan) will eventually decrease CO_2 emissions by at least 10% and therefore enable the E10 blends to release less greenhouse than PULP.

Some of these greenhouse savings measures will be gathered from the experience gained in operating AAE's ethanol Plant in Swan Hill, that will commence production in late 2008, and these will be incorporated into the design and construction of the NSW Plants that are planned to come on line, one at a time, commencing in late 2009 until the last one is complete in approximately 2013. As each NSW Plant is built and operated the experience gained in reducing CO_2 emissions and energy requirements by maximizing throughput, fermentation and Plant efficiency, further reductions in energy, and therefore CO_2 emissions, are likely.

The greatest potential for the most significant saving of 130,000 tons per annum will arise from the ability for AAE to enter into Joint Agreements with Companies, such as Air Liquidé and BOC Gases, to capture, purify and compress the CO_2 gas that is released during the fermentation process so that it is not emitted into the atmosphere at AAE's NSW sites. This purified CO_2 will then be used for food and other applications. Although use of this purified CO_2 for some applications will cause the release of CO_2 (eg in soft drinks) a proportion will be retained in the liquid as dissolved gas in the form of carbonate and bicarbonate. If all of the purified CO_2 could be utilised in non-emitting applications it has the potential to effectively reduce AAE's GHG emissions by 44%.

The measures described above will ensure that industry best practice procedures for minimising and reducing GHG emissions from an ethanol plant are in place. With these measures, and the others that are described in Section 7 as part of the Abatement Plan, it is estimated that an effective reduction of at least 10% CO_2 (equivalent to 29,000 tonnes of CO_2) can be achieved from the time the first NSW Ethanol Plant is built in 2009 until the last is completed in approx 2013. This is also likely to result in E10 blends releasing fewer greenhouses than PULP and increase even further the already significant difference between E85 and PULP GHG emissions.

In Australia fuel ethanol is currently being produced by CSR from molasses derived from the growing and processing of sugar cane, and by the Manildra Group in NSW that produces ethanol from various cereal grains. Information on the GHG Lifecycle emissions for each of these Plants and processes are not available to AAE.

It is thought that due to the nature of the CSR process (growth and transport of sugar cane, extraction, separation, purification and evaporation of sugar, isolation of molasses followed by fermentation of the molasses to ethanol) it is more energy intensive than the AAE NSW Ethanol Plants and therefore would release more GHG.

In contrast to the AAE ethanol process that utilizes a “Dry Mill” technology to produce ethanol, the Manildra process uses a “Wet Starch” extraction process that requires Milling to produce a flour from wheat, extensive separation and extraction procedures to isolate the gluten and high grade starch from the flour before a low grade starch by-product is used for ethanol production. In addition to this by-product starch a “Dry Mill” stage is then used with additional grains (eg sorghum, wheat) to increase the amount of ethanol that is produced by Manildra. Therefore, the nature of the Manildra process will require more energy and therefore increase the GHG released.

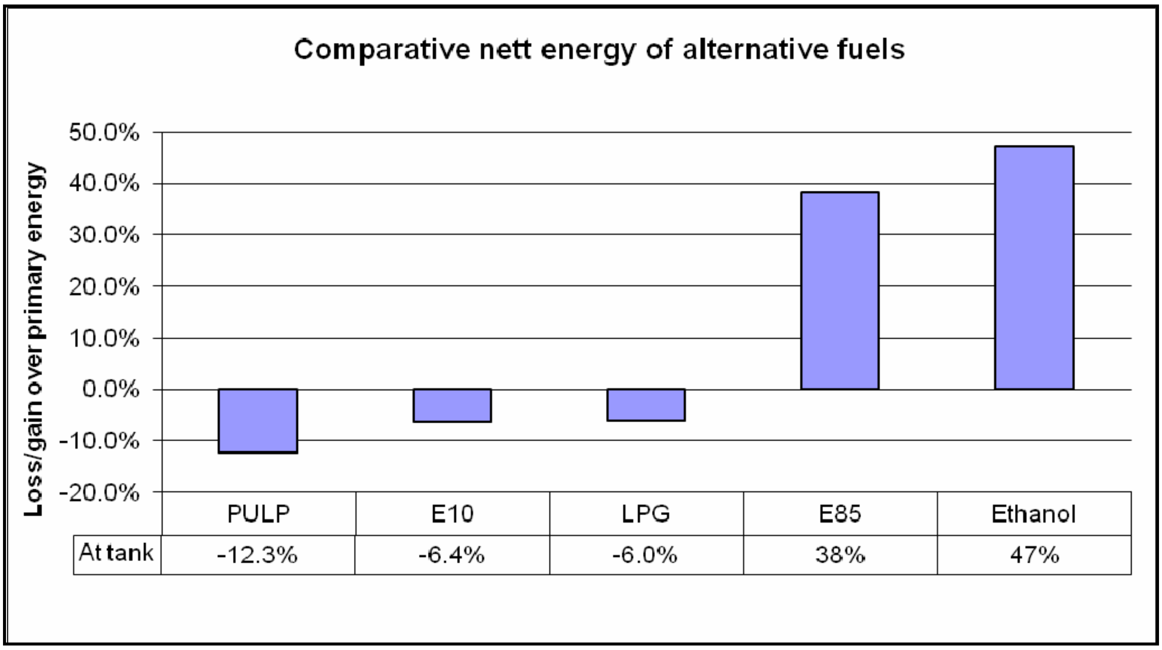
There are no “Dry Mill” ethanol plants in Australia so no direct, comparative data on GHG emissions is available.

5.3 NSW Energy Balance for Ethanol Based Fuels

The Energy Balance for NSW ethanol has been determined by comparing the energy contained in the ethanol output to the total fossil fuel energy required to produce the grain, process the grain to produce ethanol and transport required to move grain, ethanol and denaturant (gasoline). The energy consumed to produce the denaturant has also been included. All energy inputs are primary energy i.e. energy consumption has been adjusted to account for losses in the production and delivery of useful energy to the point of consumption.

A number of compare and contrast scenarios have been prepared for the NSW ethanol operation. The Comparative Nett Energy (Figure 2) compares the energy available on a percentage basis, from one unit of raw material. The zero line on the chart represents the raw material energy and the energy inputs required to make the various products. For instance 1 unit of PULP will deliver 12.3% less energy than the sum of the crude oil and process energy required to produce it. One unit of ethanol on the other hand will deliver 47%, or almost 1 ½ times the energy required to produce and deliver it. E85 and E10 are proportionally less due to the volume of petroleum product used in their manufacture.

Figure 2: NSW Ethanol Comparative Nett Energy



From the results above it can be seen that both E10 and E85 have a higher comparative energy value than PULP, with E10 contain *5.7%* ***more*** energy than is required to produce it and is almost on par with LPG.

6 SUMMARY OF KEY FINDINGS FOR NSW ETHANOL

- From the data it is clear that by displacing unleaded petrol with the total ethanol output of one NSW plant as an E85 blended fuel will ***reduce*** greenhouse emissions by approximately 170,000 t per annum on an energy equivalent basis. This is equivalent to taking about 37,700 cars off the road.[3] [4]

- E85 generates 32% ***less*** greenhouse gas emissions than premium unleaded petrol and 13% ***less*** greenhouse gas emissions than LPG (on an energy equivalent basis). [5]

- While premium unleaded petrol in Australia contains 12% ***less*** energy than is required to produce it E10 blends contain *5.7%* ***more*** energy and E85 contains 38% ***more*** energy than is required to produce it. [6]

[3] On average each car produces 4.5 tonnes of greenhouse gas emissions each year (CO_2-e) Source - Department of Energy Utilities and Sustainability

[4] Total E85 production per plant = 235 ML x emissions rate of 1,520 t CO_2-e/ML. 235 ML E85 = 173 ML PULP on an energy equivalent basis. 173 ML PULP x emissions rate of 3,030 t CO_2-e/ML. Energy equivalent basis means volumes of the fuels have been adjusted to reflect their relative energy contents.

[5] A blend of 85% ethanol and 15% petrol (gasoline) used as a fuel for vehicles.

[6] Energy required to produce fossil fuel products includes the initial crude oil energy value less energy expended in production and other losses

7 GREENHOUSE GAS EMISSIONS ABATEMENT PLAN

Objective: To achieve a continual improvement in energy conservation and greenhouse gas emissions.

Target: To reduce absolute energy consumption and greenhouse gas emission levels to at least 10% below the estimated base level year (2009) by 2013 based on business as usual projections.

Environmental Performance Indicators: Develop and monitor appropriate energy and greenhouse performance indicators that illustrate true progress against a background of ongoing Industrial Operations. Proposed performance indicators include:

- GJ energy per litre of ethanol produced
- CO_2-e TPY
- Electrical consumption usage reportable and measurable over time. i.e; KWH or MWH

No.	Strategy	Year of Commencement
1	Identify key areas of greenhouse emissions and water conservation during initial design and build phase and either take suitable abatement actions during the initial project execution or list areas of abatement opportunities and suggested actions to the Agri-Energy executive board. • Standard abatement project initiatives to be implemented during pre-operations in Annexure 1.	Ongoing during site project Execution
2	Appoint an Energy and Water Conservation Manager (EWCM) as a collateral duty from the relevant site management staff within 3 months after formal site commissioning and operational activities commence. This role will be to coordinate a Greenhouse emissions base-load validation study and report. Also will act as a reportable point of contact with AAE head office on this subject heading.	Year 1
3	Develop and monitor energy and greenhouse performance indicators across the plant facility to provide a benchmark for measuring improvement.	Year 1 and ongoing
4	Include energy, water and greenhouse indicators on monthly utility reports forwarded to the Plant and/or Operations manager for reporting to the AE executive board via the CEO AAE.	Year 1 and ongoing
5	Evaluate the market to identify new energy conservation technologies and consider recommendations for action and communicate relevant information to stakeholders on a regular basis. (Stakeholders assumed to be defined as Facility management staff, AE executive board and AAE executive management)	Year 1 and ongoing

6	Establish energy supply arrangements, which provide for a 2% increase in green power use per year based on commercial feasibility and availability. • A suggestion is made to commence year 1 operations with at least 5% of energy fuel requirement (ie: boiler fuel source) being satisfied by non-fossil fuel source. • An ongoing process improvement program to continuously improve upon measures implemented upon listed in addendum table 1	Year 3
7	Develop and assist areas to adopt a purchasing policy that promotes the purchase of products with good energy efficiency ratings, life cycle costs and, where practical and data is available, considers embodied energy.	Ongoing
8	Develop and implement water, energy conservation & greenhouse awareness programs for Staff integrated with other environmental initiatives	Year 2 and ongoing
9	Use architects, Engineering firms, planners, builders and designers who provide energy efficient design.	Pre-Operational design and build phase
10	Establish clauses for inclusion in all contracts for services that include specific provisions which encourage contractors to develop energy efficient work practices	Pre-Operational design and build phase
11	Establish specific showcase Environmentally Sustainable Design projects.	Pre-Operational design and build phase
12	Ensure the production cycle transport GHG “costs” are managed even with raw feedstock supply • Ethanol plants are geographically close to feedstock supply therefore minimizing transport fuel consumption • As the majority of heavy transport equipment and farming machinery is diesel power based. Every effort is made to encourage feedstock producers and transporters to use Bio-Diesel	Post Operational

Greenhouse Gas Abatement standard measures to be implemented during design and construction stage of Ethanol production plants

Action or measurable task	Expected benefit and/or outcome	Conformance measure
Separation of plant single and 3-phase power supply- Implement Grid-interactive technology with renewable energy source	Minimum of 100 KW equivalent 240 VAC single phase power used for perimeter lighting, office and lab power is generated by renewable energy sources (wind/solar) via grid interactive inverter.	Grid-interactive metering will clearly show consumption vs excess production capacity to/from the grid. Displaced grid-produced power from the coal fired power stations is quantifiable via REC trading value.
Hi amp loading plant process motors are controlled by VFD and soft starter technology wherever possible in key process points. • 110kw –raw water line • 700kw- hammer milling • 300kw- grain transfer • 750kw- cooling tower fans • 1000kw-Various process pumps-ie; centrifugal and vacuum pumps	Variable speed/frequency inverter technology will dramatically limit peak start-up loads. This will have significant long term cost savings on HV load from grid due to high start-up current. Approx. 5-7% reduction in annual total electricity consumption. This will also lesson end-rush load on grid infrastructure on an operation of this electrical magnitude- est. load to be in worse case scenario in the range of 9-10 MW	Equipment specification data plates and monthly energy usage
"Right sizing" of electrical process equipment	Ensuring that the motor/pump/blower/etc. size loading in each relevant process requirement is optimally selected in regards to energy efficiency vs. the consumable energy load.	Equipment specification data plates and monthly energy usage
Selection of new generation cast resin dry-type Hi efficiency transformers for both MV and LV	• Environmentally "green" friendly in regards to end of life cycle disposal requirements • Hi efficiency design minimizes efficiency loss in comparison to standard wet type transformers. This results in less Green house gas produced as a result of excess power produced to make up for line losses • Dry resin cast design negates the need for hazardous material spillage measures.	Equipment specification data plates and monthly energy usage
All lighting requirements internal and external to be selected on energy efficiency criteria. Large scale area lighting will be	Higher energy efficiency will result in power consumption requirement reductions of over 125% over conventional technology	Equipment specification data plates and monthly energy usage. In addition the end of life

energy efficient rated and of next generation technology. • No use of incandescent lamps will be used • Outdoor lighting will be Low Pressure Sodium or similar High efficiency equivalent lamp based		disposal requirements are more environmentally friendly. No hazardous material associated with disposal. Minimizes landfill.
Main process steam boiler will be cleaner burning LPG or CNG based with back-up “dual-fuel’ capability of consuming liquid based glycerin (a bio-diesel production by-product), bio-diesel, Bio-based oil (Pyrolysis) and ethanol	Fuel used to produce steam will be either a fossil fuel that is significantly less CO_2 emitting than brown coal as used in conventional power stations. Alternatively, a bio-based fuel source will be used. This is therefore displacing a certain predictable amount of CO_2emissions that would have otherwise been generated by burning brown coal to achieve the same end.	Fuel tonnage calculated by material type and known calorific value standards.
Parallel solid bio-mass capable boiler- I.e.; wood chips, Almond hulls, municipal green waste	Fuel used to produce steam will be a biomass-based fuel that is significantly less CO_2 emitting than brown coal as used in conventional power stations. This is therefore displacing a certain predictable amount of CO_2 emissions that would have otherwise been generated by burning brown coal to achieve the same end.	Fuel tonnage calculated by material type and known calorific value standards.
CO_2 capture from fermentation process	Joint arrangement with AIR LIQUIDE AUSTRALIA to capture the CO_2 emitted from the fermentation process. This will mitigate the amount of CO_2 would have otherwise been released into the atmosphere as a direct result of our operations. A 200mlpa facility will recover 130,000 tons per annum of CO_2	Process metering will accurately depict the amount of CO_2 captured from the fermentation process.
Utilize high energy efficient design philosophy and engineering solutions in relation to offices, manned control rooms, laboratories and climate controlled areas of plant	Overall higher energy efficiency in regards to heating and cooling will result in less energy consumption associated with environmental control	Equipment specification data plates construction material data sheets and monthly energy usage

8. REFERENCES

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