SUMMARY BRIEF

MULTI-BENEFITS OF A NATIONAL BIOFUEL INDUSTRY

Multi-benefits analysis shows that a biofuels industry in Australia, based on biomass feedstocks, would have substantial environmental, economic, employment and wider social benefits on a national scale - especially for rural and regional Australia. The inability of Commonwealth and State Governments to recognise the potential of biomass resources is holding back the opportunity of a sustainable economic revival in rural and regional Australia.

- Based on studies undertaken in the United States and Australia, it is estimated that a commitment to a national biofuels industry would create between 200,000 to 400,000 direct new jobs and an economic revival in rural and regional Australia.

- The skills required to sustainably produce and exploit Australia's biomass resources already exist in the agriculture and forestry sectors, and the corporate knowledge base within organisations such as the AGO, CSIRO, and Department of Agriculture, Fisheries and Forestry.

Energy from biomass, solar, wind and tidal resources are uniquely placed to produce sustainable large scale reductions in greenhouse gas (GHG) emissions on a national and global scale. Net GHG reductions associated with biofuels can be generally equivalent to the amount of fossil fuel replaced.

Australia is a biomass rich country. Existing biomass residues from agriculture and forestry, agri-forest industries, biomass from urban waste, and development of new energy crops suggest Australia would have the capacity to supply 100% of its future transport fuels needs from biomass by 2050.

- Hundreds of millions of litres of bioethanol can be produced from waste streams from the downstream industrial processing of food crops (eg wheat, sugar).

- The 11 million tonnes of bagasse produced annually by the sugar cane industry is an ideal biomass resource for biofuel production.

- Thinnings and residues from Australian forests are a huge biomass resource. Forest industry residues alone in Tasmania, for example, are sufficient to replace 65% of all petrol and diesel fuels imported into that state per year.

- Tens of millions of tonnes of crop stubbles and residues are produced in Australia each year.

- 40% of Australia's annual stockpile of 6 million tonnes of urban waste is available as a biomass resource.

- In North-Western NSW alone there are sufficient woody weeds to produce over 7 billion litres of bioethanol.

Although Australia can be considered a mineral and energy resource rich country, oil and petroleum transport fuels represent a major weakness in the nation's energy and resource portfolio. All of Australia's future liquid transport fuel requirements could be supplied from biomass in the form of biofuels such as ethanol.

- Government statements predict the exhaustion of Australia's domestic oil reserves within 10 to 15 years. Australia's domestic oil industry, and their overseas parent companies have entered a period of transition with company mergers, restructuring and job shedding the norm.

- Sharp declines in global oil supply are also anticipated by 2050.

- Failure to plan ahead for the inevitable demise of oil will in the future impact heavily on the Australian and global economy.

The benefits of a national biofuels from biomass industry reach far beyond the replacement of liquid fossil fuels and reductions in greenhouse gas emission.

Land Sustainability - A biofuels industry would provide the added economic stimulus needed to sustain the projected large scale use of trees and vegetation required to restore the quality of our soils and water resources.

Urban Air Pollution - Trials conducted overseas, and by the Commonwealth in Australia, have identified major benefits associated with biofuels such as ethanol in reducing petrol and diesel vehicle exhaust emissions that contribute to urban air pollution, and pose a risk to human health.

Environmental Risk Mitigation - Biofuels such as ethanol are miscible with water and thus do not pose the environmental risk associated with oil and petroleum products - particularly to shorelines, mangroves, coral reefs etc.

Agriculture & Forestry - A biofuels from biomass industry offers new value added products for farm and rural industries from traditional agricultural wastes and residues, and from new biomass feedstocks suitable for biofuels.

The planting of trees and expansion of forest plantations are seen as important instruments in restoring water quality and land sustainability, in sequestering carbon, and in any future carbon trading system. The lack of economic value for thinning and other activities during the growth phase is a major impediment to new investment in forest plantations. The use of thinnings, residues, and mature trees at the end of their growth or carbon sequestration phase as feedstocks for biofuels would supply the economic stimulus needed to promote large scale forest plantation development.

- The use of forest thinnings and residues alone in Tasmania would be sufficient to support 10 bioethanol plants; produce 500 m/l of ethanol per year (65% of current transport fuel use); create 3,200 new direct jobs, and from 12,000 to 15,000 indirect jobs.

Waste Feedstocks & Woody Weeds - 2.4 million tonnes, or 40 % of Australia's 6 million tonnes of urban waste, is biomass suitable for biofuel production. Woody weed resources in NSW and Queensland alone are sufficient to produce billions of litres of bioethanol, and in doing so restore economic viability to woody weed infested regions.

National Infrastructure - Ports & Rail - As biomass feedstocks for biofuels are land resources, a domestic national biofuels industry would progressively reduce Australia's dependence on the transport of oil imports and exports by sea. The transport of biofuels from rural and regional Australia would be predominantly by rail and road. Carriage of Australia's transport fuel requirements by rail (currently over 30 billion litres per year) would revitalise the economics of rail transport services, particularly in rural and regional Australia.

National Infrastructure - Fuel Storage & Distribution - Biofuels such as ethanol are compatible with existing petroleum storage, distribution and retail structures, offering major cost savings compared to the projected infrastructure costs associated with fossil alternative fuels such as CNG/LPG.

National Infrastructure - Industry - The economic value associated with the design, fabrication and construction of between 1,200 to 1,600 bioethanol plants ranging from 10 to 100 million litres of ethanol per year would range from $60 to $90 billion, and provide a major boost to the engineering and construction industries.

Computer and vehicle technology advances such as the introduction of Flexible Fuel Vehicles (FFV's) in the United States capable of alternating between neat petrol and up to a 85% ethanol blend, is a clear indication that the transition from fossil to biofuels would be an essentially seamless and non-disruptive process for the automobile industry.

National Economic Benefits - In addition to providing the same benefits as the oil industry, but without the negative impacts of oil, a biofuels industry would;

- create national energy security in transport fuels and strengthen the national Balance of Payments ledger;
- create a major economic/employment revival in rural and regional areas;
- achieve low cost and economically efficient reductions in GHG emission;
- provide economic stimulus for industry, and strengthen agriculture and forestry structures by creating value for low or no value biomass.

Regional and Rural Australia - A biofuels from biomass industry is uniquely placed to produce an economic, employment and social revival in rural and regional areas across Australia. The level of benefit would be limited only by the type, size and availability of biomass feedstocks suitable for conversion to biofuels. U.S. studies indicate that $0.80 of every dollar spent on local production of *biofuels* is retained locally, whereas $0.80 of every dollar associated with *oil* leaves the local area of origin.

It is proposed that Australia take the lead position in the development of biomass resources for energy purposes such as biofuels by adopting the following Milestones.

Year 2005 - The production of 2% of Australia's transport fuels (over 450 million litres) from biomass in the form of biofuels such as ethanol, together with a net reduction of 1 million tonnes of CO_2 per year from Australia's net GHG emissions from the transport sector.

Year 2010 - The production of 5% of Australia's transport fuels (over 1.4 billion litres) from biomass, together with the net reduction of 3.5 million tonnes of carbon from Australia's net annual GHG emissions.

Year 2025 - The production of 40% of Australia's transport fuels (over 11 billion litres) from biomass in the form of biofuels such as ethanol, together with net reductions of over 29 million tonnes of CO_2 from Australia's net annual GHG emissions.

Year 2050 - Production of close to 100% of Australia's transport fuels from biomass in the form of biofuels and the effective removal of the transport sector from Australia's annual inventory of GHG emissions.

(BIETHSUM)

BIOMASS
MULTI-BENEFITS

Introduction

Globally, greenhouse gas abatement represents a massive and costly goal for many countries. *For others it represents potential opportunity*.

Australia, with its arable land mass, skilled and educated population, general energy security, stable economy, and high technology base, is in an excellent position to successfully take up this challenge. In this regard, Australia also has the opportunity to show leadership to both the developed and developing world.

Australia is equally well placed to make substantial progress towards major reductions in greenhouse gas emissions, as well as accruing major economic and social benefits, in a relatively short period of time.

Success will not involve a single "silver bullet" solution, but rather a combination of strategies embracing a wide range of renewable energy options including solar, wind, tidal, and *biomass energy*.

BIOMASS

Throughout the course of its history, Australia has taken a narrow and selective view of biomass, its most abundant and renewable resource

Over the past 150 years, Australia, driven by a perceived economic imperative, undertook large scale clearing of its ancient forests and vegetation in the name of agricultural and economic efficiency. As a consequence, Australian soils and water resources are now under severe stress.

Biomass regeneration, in the form of large scale planting of trees and plants, is seen as an essential strategy for restoring the quality of our soils and rivers, and for absorbing much of the carbon dioxide emitted by the burning of fossil fuels.

- Domestic, and global oil and gas reserves are derived from ancient biomass.

Due to the nationwide distribution of Australia's arable land and existing substantial biomass resources, biomass is positioned to play a major role in Australia's efforts to reduce greenhouse emissions. This is achievable through the sustainable commercial energy use of biomass, and using biomass as a mechanism for the collection and storage of greenhouse gases and carbon sinks. Australia's already *efficient agricultural and forestry industry/infrastructure* is available to support and underpin this effort on a national scale.

The missing element, *until now*, has been the inability to recognise and acknowledge the environmental, economic, and wider social benefits associated with supporting the development and sustainable economic exploitation of biomass.

There are sufficient existing biomass resources, and potential *new* biomass resources associated with agriculture, forestry, and biomass in urban waste in Australia, to support the establishment of a target to produce 2% of Australian transport fuel in the form of renewable bioethanol/petrol blend by **2005;** 5% of Australia's transport fuel in the form of ethanol/petrol blend by **2010;** 40% in the form of ethanol by **2025;** and close to 100% by **2050**.

Establishing a national goal of replacing Australia's dependence on fossil transport fuels with renewable fuels, such as ethanol from biomass, over the next 50 years, would provide the necessary economic stimulus for a revival of biomass resource development generally on a national scale. It would also establish an economic rationale, and identify for the private sector, the benefits associated with tackling the degradation of the environment and over-exploitation of our soils and water resources on a national and global basis.

FOSSIL FUELS

Prior to the advent of fossil fuels, most of man's non-food consumer products and industrial raw materials (other than inorganic minerals) were derived from biomass in the form of plant and animal matter. From World War I, through to 1970 petroleum progressively displaced biomass in virtually every product category. Today, oil accounts for the majority of global transport fuels, and more than 95 percent of industrial organic chemicals. Petrol and diesel fuel are also major sources of tax revenues.

Perceived economic and national security imperatives pressed successive Australian governments into making heavy investments of public funds, in the form of subsidies, to the oil industry over the past 60 years. This was done to encourage transport fuel, and energy security, through oil and gas exploration, and the development of supporting infrastructure.

Yet, despite this investment, fossil liquid transport fuels remains the only energy source in which Australia is not self-sufficient. It is anticipated that Australia's domestic oil reserves will be exhausted in 10 to 15 years.

The evidence of the multi-benefits of fossil fuels is nevertheless pervasive, and has generally justified the large investment in public funds in the Australian petroleum industry.

Despite the obvious benefits associated with fossil transport fuels yesterday, **today** the cost of global and national dependence on fossil fuels is equally pervasive in terms of deteriorating environmental quality caused by greenhouse and other emissions from the combustion of fossil fuels, such as air toxics, carbon monoxide, and ozone-forming volatile organic compounds.

The acknowledged demise of Australia's domestic oil reserves, whether 10 or 20 years into the future, combined with the recognised negative impacts of petrol and diesel fuels, provides ample reason for a fundamental review of Australia's traditional approach to transport fuels, and biomass on a multi-benefits basis.

Such a review is opportune, as Australia's domestic oil industry, and their overseas parent companies, have also entered a period of transition with company mergers, restructuring, and job shedding a day to day occurrence.

Renewable liquid transport fuels such as ethanol from biomass offer essentially the same benefits as petrol and diesel fuel - but without the detrimental environmental and health impacts. Unlike fossil alternative fuels, renewable liquid fuels are compatible, with minor adaptation, with the existing petroleum infrastructure and vehicle fleet. This offers significant benefits as a low cost infrastructure path for the phased replacement of fossil transport fuels with biofuels.

Biomass, the source of yesterday's industrial raw materials, fuel and power could once again, along with wind, solar and tidal energy, be put in the position to supply tomorrow's energy. Agricultural and forest residues, energy crops, fibre plants, crop stubbles, plantation forest thinnings and woody wastes will feature prominently in this process.

A national commitment to biomass industries would offer an equally wide range of multi economic, infrastructure, and social benefits on both a national and global scale. This would include the potential creation of between 200,000 to 400,000 direct new jobs in regional and rural Australia, where the bulk of biomass industry development would be located. The combined impact would be economic and social revival in regional and rural Australia.

In addition to making a major contribution to the restoration of the quality of Australia's environment, soils and water, an aggressive sustainable biomass based biofuels industry would virtually eliminate Australia's greenhouse gas emissions from the transport sector (approximately 120 million tonnes of CO_2 equivalent per year, or 25% of Australia's net emissions).

Genuine energy security is achievable under an aggressive national biomass strategy, along with a national security dividend that Australia would accrue by reducing its future dependence on imported oil.

These multi-benefits, outlined below, warrant serious consideration in the context of the development of national policies and projects under the Greenhouse Gas Abatement Program.

BIOMASS - BIOFUELS MULTI-BENEFITS ANALYSIS

Following is a summary multi-benefits analysis of bioethanol. Other biomass and renewable energy resources also offer a range of multi-benefits. Bioethanol is unique in offering economic stimulus and impacts on a broad national scale, and thus has the capacity to also act as a catalyst for a wider range of biomass initiatives.

1. The Environment

1.1 BIOMASS - ETHANOL AND GREENHOUSE GAS EMISSIONS

The net reduction in greenhouse gas emission associated with the sustainable growth, harvesting, industrial processing, and use of biomass products such as ethanol fuel is significant. It is roughly equivalent to the level of fossil fuel displacement achieved (the Life Cycle illustration of ethanol below refers).

- A 25% displacement of petrol or diesel fuel by ethanol would deliver a net CO_2 emission reduction benefit equivalent to approximately 25% of the CO_2 emission from the production of the fossil transport fuel, and its use.

- GHG emissions in CO_2 equivalent from total petroleum fuel production and fuel use in Australia is approximately 120 million tonnes each year.

Fossil alternative fuels such as CNG/LPG deliver no significant benefit in terms of net reduction in GHG emission. Their benefit is limited to reducing the existing level of other exhaust emissions from petrol and diesel fuels.

Currently renewable fuel ethanol is used in the form of a 10% blend with petrol, or a 15% blend with diesel fuel. Net replacement by ethanol of 2% of petrol and diesel used as transport fuel (a target achievable by 2005) would result in a net reduction of some 1.2 million tonnes of CO_2.

The current use of waste streams from industrial processing of wheat and sugar cane does not attract emission debits from the growth, production and transport cycle, as the crops are grown for food purposes.

1.2 BIOMASS - LAND SUSTAINABILITY

Land and water are the essential base for Australia's oldest biomass industries - agriculture and forestry.

A legacy of the past 150 years of Australia's economic development is dry land salinity, soil depletion through erosion, and salt and chemical contamination of inland rivers and national water resources. While it is beyond the capability of any single policy resource to address these national challenges, the comprehensive restoration of vegetation on a national scale is seen as an essential instrument for restoring the quality of Australia's soils, water, and ecological balance.

In addition to the capacity to restore ecological balance, soils and vegetation have an additional significant benefit through their capacity to absorb and store carbon dioxide.

The size and scope of the task of biomass regeneration in Australia is so significant that success is beyond the resources of Government alone. The active and full support of Australian farmers, forest growers and managers, and the private sector will be essential if the economic incentives required to sustain this task are to be developed.

A range of niche markets for regenerated forest products such as eucalyptus and tea tree oils, and the combustion of fast growing tress for electricity and steam generation are currently being pursued. None of these activities are sufficient to sustain biomass regeneration on a national scale.

The fact that biomass is mainly distributed throughout rural and regional Australia, with only a few exceptions, is an added bonus. In addition to the general economic, employment, social and environmental benefits that would accompany this activity, the resources and skill sets associated with existing agricultural and forestry structures are readily adaptable to this task.

1.3 URBAN AIR POLLUTION

The production of renewable transport fuels from biomass has, over the past 20 years, proved to be an effective means of reducing fossil fuel vehicle emissions that add to greenhouse gas emission, contribute to urban air pollution, and adversely impact on human health.

Bioethanol - Petrol

An intensive Commonwealth field trail in 1998 (ERDC Project No. 2511) of a 10% v/v ethanol blend with petrol in a range of vehicles representative of the Australian Road Transport Fleet, found that;

- a 10% ethanol/petrol blend offers significant benefits in terms of reductions in vehicle exhaust and greenhouse gas emissions.

The Commonwealth trial found that a 10% ethanol/petrol blend also had the following benefits in terms of exhaust emissions that impact on air pollution:

- a decrease in carbon monoxide (CO) by approximately 32%,
- a decrease in total hydrocarbon (THC) approximately by 12%,
- reductions in carbon dioxide (CO_2) of approximately 7% on a full carbon cycle analysis.

Reductions in toxic exhaust emissions harmful to human health and the environment included:

- a decrease in 1-3 butadiene emission by approximately 19%;
- a decrease in benzene emission by approximately 27%;
- a decrease in toluene by approximately 30%, and;
- a decrease in xylenes by approximately 27%.

The results of the Commonwealth trials closely parallel those obtained in countries such as the United States that have been using ethanol/petrol blend fuel for over 20 years.

Substantially greater regulated and non-regulated emissions reductions benefits are achieved with higher levels of ethanol blended with petrol.

Technology advances achieved in the United States by Ford, General Motors, and Chrysler have made the attainment of this goal achievable in the short term. The gradual introduction into the United States commercial passenger vehicle fleet of Flexible Fuel Vehicles (FFV's), which have the capacity to use up to a 85% v/v ethanol blend with petrol without engine modification, now brings this goal within reach.

Bioethanol - Diesel

Diesel vehicle exhaust emissions contribute to urban air pollution, in the form of particulate (PM) and other emissions that represent a threat to human health.

Diesohol is a practical clean burning fuel developed in Australia which achieves substantial reductions in particulate and other emissions from diesel engines. A typical Diesohol fuel contains 84.4% diesel v/v, 15% hydrated ethanol, and 0.6% emulsifier.

Emissions tests and vehicle component compatibility trials of Diesohol conducted by the Commonwealth (ERDC Project No.2538) found that as a stable emulsion of hydrated ethanol and diesel fuel, Diesohol offered substantial benefits:

- Reductions of 20% to 50% in Particulate emission from modern (eg EURO II) diesel engines(reductions of 60% - 70% were achieved in older diesel engines).
- Reductions of up to 20% in Carbon Monoxide.
- Reduction of up to 25% in Hydrocarbons.
- Reductions of up to 10% in NOx.
- Diesohol can be used in older or advanced diesel engines (eg EURO II) with no , or only minor engine adaptation required.
- It can be used interchangeably with diesel fuel (eg if no Diesohol is available the vehicle can revert back to neat diesel use).

1.4 ENVIRONMENTAL RISK MITIGATION

Fossil fuels such as oil represent a major and ongoing disaster risk to the environment, land, water, wildlife, fisheries, and national heritage assets. The global record of past oil related disasters associated with spills on land and water; leakages of petroleum products from storage sites, and waste oils, catalogues the day to day risks associated with oil exploration, transport, production and use.

Oil and petroleum products are highly toxic and flammable, and require chemical retardants to control them which also impact on the environment when accidents or spillages occur.

Bioethanol is a renewable fuel of low toxicity and is miscible with water. The risk posed by ethanol to the environment, land, water and living species is thus significantly lower than that posed by oil and petroleum products.

Domestic production of Australia's transport fuel requirements in the form of renewable ethanol removes the need for the transport of oil by sea, and thus the risk to sea shore, estuaries and coral reefs.

2. Agriculture & Forestry

2.1 BIOMASS: AGRICULTURAL STRUCTURES

The agricultural and forest industries are the oldest and most well established traditional users of biomass.

Traditional Agricultural Structures

Agriculture in Australia has earned a well deserved reputation for management, and technical efficiency. This has come however, at a price in terms of stress on the quality of our soils and inland water resources.

A combination of greater efficiency, associated structural rationalisation, predatory and unfair trading practices in key overseas markets, and the vagaries of nature have all contributed to a sense of crisis and transition in rural and regional Australia. The development of new industries that complement the traditional rural based industries such as food and fibre production and processing has been identified as one of a range of measures required to deal with this complex process of change.

The development of new uses and markets for biomass resources not fully exploited in current agricultural practices, and the development of new high value biomass products from non traditional sources offer the potential of an economic and social revival in rural and regional Australia.

Value Adding

Adding value is being strongly pursued by companies involved in the industrial processing of food crops. The Manildra Group and CSR Distilleries are two examples of Australian companies that are producing bioethanol from waste streams associated with their industrial wheat and sugar operations, respectively.

The hard pressed sugar industry is an example of an agricultural industry that is highly efficient, but under constant price pressures from overseas sugar production. Currently the bagasse from the sugar cane is inefficiently combusted for electricity and steam generation, while the remaining stalk residues are disposed of by burning in-situ. Introduction of new technology for the conversion of lignocellulosic materials to ethanol and lignin would

allow the production of ethanol from sugar cane bagasse and other stalk residues, while the by-product, lignin (which has a high calorific value), could be used for electricity and steam generation.

> The addition of these two new value added by-products could make the difference in competitiveness in the sugar industry in the future.

Crop stubbles and other crop residues from both food and non-food crops can also become value added by-products as feedstocks for the production of bioethanol. They also offer two new value added by-products to traditional crop production - bioethanol and lignin. In addition to providing energy for ethanol production, the lignin would produce excess electricity that would be available for use via local grid networks.

Non-food energy crops such as Lawson wheat are expected to become available for the production of ethanol and starch based products such a protein rich feed for aquaculture. Canola is grown for cooking oils, and can be used as biodiesel and bio-oil substitutes. Kenaf is also an example of the multi-product crops that could also be used as feedstocks for renewable energy.

In the United States special varieties of grasses and plants such as switchgrass are being developed as feedstocks for the production of renewable ethanol fuel. In Australia there are a range of woody weeds and native brush which have a proven capacity for regrowth and revegetation that could be harvested as lignocellulosic feedstocks for renewable transport fuels such as ethanol.

All of these activities are compatible with and complement the existing skills base that currently supports traditional agricultural practices.

Market Potential

Australia has extensive resources of biomass available for the development of a wide range of renewable energy products, as does many of the biomass rich countries in our region that are deficient in fossil fuel resource deficient.

The potential market for these products cannot be fully estimated at this time, but is huge on any scale of measure. The production over the next 40 to 50 years of Australia's liquid transport fuels from biomass from traditional agriculture and forest industries could alone cause an economic and social transformation in rural and regional Australia. It would also assist in restoring national self sufficiency in energy and transport fuels, and reduce greenhouse gas emissions.

It is estimated that between 1,200 and 1,600 bioethanol plants, ranging from 10 million litres to 100 million litres capacity per year, would be required to meet Australia's transport fuel requirements. The overwhelming majority of these bioethanol plants would be located in rural and regional Australia.

A 1996 study undertaken by The Centre for Agricultural Research and Regional Economics (CARE) of a partial list of biomass feedstock resources in the Gwydir Valley, indicated that the area could possibly support two to three ethanol plants with a capacity of 50 million litres per year, with each biorefinery having a total direct new jobs impact of some 159 jobs, and between 600 to 800 indirect jobs in the area.

New energy crops such as the non-food Lawson wheat variety are being planned for introduction into non-food crop growing regions as a feedstock for bioethanol, and a high protein feed for the domestic and international aquaculture industry. The consortium behind this feedstock estimates that the Lawson wheat variety could, by 2010 - 2015, be producing some 1.8 billion litres of ethanol for the transport fuel market.

> This would be the equivalent of replacing 10% of Australia's current consumption of petrol for transport use with ethanol, or converting all 100% of the petrol currently used in Australia into a 10% ethanol, and 90% petrol blend (E10).

Studies by the U.S. Departments of Energy and Agriculture found that $0.80 of every dollar associated with the production of oil is exported outside the region, whereas $0.80 of every dollar associated with the production of renewable energy in the form of biofuels remained in the region of origin.

A recent American report by the President's Committee of Advisers on Science and Technology estimated that the potential worldwide market for clean energy over the next 20 years was valued at US$10 trillion.

At this time it is not possible to fully estimate the economic and employment impacts of a bioethanol industry based on agricultural crops and residues. It is undoubtedly significant, and has the added advantage of those benefits being widely distributed throughout rural and regional Australia.

2.2 BIOMASS: FORESTRY

Forestry, like agriculture, is a traditional biomass industry. Forest industries drawing on both public and private forests, and forest growing regions in rural and regional Australia are also under the stress of transition and restructuring as a result of environmental pressures, and government regulation.

Forestry, like agriculture, is a repository for a large part of the national biomass resources, and thus represents a substantial stockpile of potential biomass feedstocks for renewable energy products.

Forests are efficient carbon sinks due to their capacity to absorb carbon dioxide emitted from the burning of fossil fuels, or ancient biomass. Globally, and domestically forests are seen as playing a vital role in reducing greenhouse gas emission and addressing climate change. Forests are also considered an essential mechanism underpinning any future international carbon credit or trading scheme.

Commercial farm forestry is seen as offering significant benefits to land repair, and sustainable land management.

The Challenge of Forest Biomass

The benefits associated with the expansion of forest resources, however, are inexorably linked with the identification and development of economic value for the 60% to 70% of unavoidable output in state and private forests that is not of sawlog quality. The same principle applies equally to the use of tree species grown to treat salinity of soils and to restore the quality of Australia's inland rivers, and water resources.

> Namely, the development of by-products such as tree oils or energy use to provide the economic incentives needed to undertake and sustain these activities on a large scale.

Timber industry wastes and residues (eg sawdust, off-cuts etc) also represent potentially valuable sources of biomass suitable for ethanol fuel production.

In Western Australia, and in countries such as the United States, substantial resources are being invested in the identification and development of fast-growing tree species such as willow, bamboo and some species of eucalypts as energy crops. This has been accompanied by increasing interest in the combustion, at high temperatures, of biomass in the form of wood wastes and bagasse for electricity production.

- From a long term perspective this is a crude and least value approach.

- New Lignocellulosic conversion technologies would convert the same products into high value ethanol, and lignin which has a high calorific content suitable for efficient combustion into electricity.

It is difficult at this time to accurately estimate the size of the potential biomass resource that could be secured each year within Australia from State and private forest industry residues of non sawlog or pulpwood quality. By any estimate the resource is very significant, and would represent a major feedstock source for a bioethanol industry in Australia.

A limited survey of the potential impacts of a forest based biomass industry in Tasmania, provides an insight of the multiple benefits that could be derived from this industry alone. Forests Tasmania has estimated that 1.6

million tonnes (wet) of forest residues could be available, in the form of biomass feedstocks, from commercial hardwood operations in the State each year. Private Forests of Tasmania estimate that 1 million tonnes (wet) of forest residues could also be available from private forests. The multi-benefits of a bioethanol industry based on these feedstocks alone in Tasmania would be in the order of:

- 10 ethanol plants each with a capacity of 50 million litres per year;
- the total direct employment impact (plant, production, flow-on) would be around 3,200 new jobs (some 322 per plant), together with between 12,000 to 15,000 indirect jobs;
- an associated gross output of $39 million per biorefinery to the region;
- production of 500 million litres of renewable bioethanol transport fuel, or over 65% of Tasmania's annual use of petrol and diesel transport fuels;
- a reduction of 65% in Tasmania's dependence on imported transport fuels;
- creation of significant economic value for no value waste products;
- enhancement of the quality of timber products in state and private forests, and economic stimulus for the expansion of private forest plantations; and
- contribution to a modest economic, employment and social revival in rural and regional Tasmania.

(Estimates based on 1996 study by CARE)

The multi-benefits estimate provided above does not take into account wastes and residues from sawmilling, or the potentially substantial agricultural (particularly vegetable) biomass residues available as bioethanol feedstocks in Tasmania.

Impacts of the same general magnitude would be experienced in every State and Territory in Australia that has exploitable biomass feedstocks. The extent of those impacts however, would vary from State to State depending on the type, range and volume of available biomass feedstocks.

3. New Feedstocks

3.1 BIOMASS: WASTE FEEDSTOCKS

In addition to agricultural and forestry wastes and residues, bioethanol can be produced from a wide range of other waste materials including:

- brewery waste
- municipal biomass waste
- retail/commercial biomass waste
- waste paper and cardboard
- lawn and garden trimmings
- whey from cheese making
- woody weeds

Biomass from municipal waste represents a substantial source of potential feedstock for bioethanol production. Total wastes delivered to municipal sites around Australia each year is approximately 6 million tonnes. On average, 40% (2.4 million tonnes) of municipal waste is in the form of recoverable biomass, and would be suitable for conversion to renewable liquid or gaseous fuels.

Municipal waste has become an increasing problem for urban areas due to the lack of available land sites suitable for urban waste disposal. This is a pressing problem for cities such as Sydney, which produces 1.6 million tonnes of municipal wastes each year. Many city, urban and regional councils are now being forced to confront the costly option of transporting municipal waste to country areas for disposal.

Trials undertaken by the Western Sydney Waste Board, for example, have successfully demonstrated techniques for separating biomass from other waste materials at a competitive price.

The 644,000 tonnes of biomass waste produced by Sydney each year would have the potential for supplying sufficient biomass feedstock to supply 2 plants, each with an annual capacity of 50 million litres, and 1 plant with an annual capacity of 25 million litres of bioethanol for transport use.

3.2 WOODY WEEDS

Woody weeds are native or imported plants infesting large areas of fertile, semi-arid and arid regions of Australia. Their distribution and mass is increasing due to favourable environmental conditions and lower incidence of fire.

Woody weeds restrict pasture growth which increases the susceptibility of land to erosion, reduces livestock stocking rates, reduces livestock health, and manageability of the land. The cost of reducing the spread of woody weeds is generally prohibitive.

While national estimates of this biomass resource are not currently available, it is estimated that 15-20 million hectares of North-Western NSW and South-Western Queensland are affected by woody weeds. Any productive use of the plants would increase the economic viability of regions such as these.

The availability of woody weeds alone in New South Wales alone is estimated to be sufficient to produce a total of 7 billion litres of bioethanol. If harvesting of woody weeds were part of a regeneration process the potential of this resources increases significantly.

4. National Infrastructure

The development of a national renewable liquid transport fuel industry in Australia that had the goal of replacing Australia's dependence on fossil fuels over the next 50 years, would have a substantial impact on national infrastructure such as ports, rail, fuel storage and distribution sites, and industry structures such as engineering and the automobile industry.

4.1 PORTS and RAIL

Oil, petrol and diesel fuel are currently transported to, from and within Australia by ships, road and rail transport.

While Australia is currently producing approximately 70% of its oil requirements in the form of light crude, a large volume of Australia's light crude oil is sold and shipped overseas to support the purchase of heavy crude oil from Asia and the Middle East. The use of overseas and domestic shipping for the transport of fossil fuels is very high, contributing to strains on Australian ports and the attendant risks associated with oil spillages.

The requirement for the high usage of shipping by the oil industry also explains the siting of oil refineries on coastal sites. Oil products, and refined petrol and diesel fuels are shipped inland from coastal sites by road and rail.

A biomass based transport fuel and energy industry in Australia would see the transfer, over the next 50 years, of the transport of liquid transport fuels from water to land transport infrastructure such as rail and road.

Today, this would be the equivalent of transporting each year 30 billion litres of transport biofuels from rural and regional Australia to urban centres by road, and principally by rail. A development of this scale would completely transform the economic viability and performance of rail transport in Australia, and lead to a revitalisation of rail services and infrastructure in rural and regional Australia.

4.2 FUEL STORAGE and DISTRIBUTION

It has been conclusively demonstrated in the United States and Brazil over the past twenty five years, that the existing oil, petrol and diesel storage and distribution structures are completely compatible, with minor adaptation, with bioethanol fuel.

Bioethanol and bio-oils are completely compatible with, and would also utilise, the existing transport fuel retail infrastructure. This has the added advantage of requiring no changes in the behavioural patterns of existing light and heavy duty vehicle users.

- The cost of converting an existing petrol retail site to an ethanol/petrol blend fuel is between $800 and $1,000.

The cost advantages to Australia of a bio-fuels industry would be enormous, particularly when compared to the infrastructure costs associated with the large scale uptake of fossil alternative fuels such as CNG and LPG. It is estimated that the cost a establishing a national transport fuel infrastructure for CNG and LPG would be in the range of $2 billion to $2.5 billion. This does not take into account the very high vehicle conversion costs associated with CNG/LPG.

4.3 INDUSTRY: ENGINEERING and AUTOMOBILE

The establishment of a biofuels industry in Australia on a national scale would have significant impacts across a range of industries, including chemical industries. The impacts on the engineering and automobile industries are of special note.

Engineering

To meet the target of replacing Australia's current dependence on imported and domestically produced fossil transport fuels, would require the design, fabrication and construction of between 1,200 and 1,600 bioethanol plants ranging in capacity from 10 million to 100 million litres per year.

- The majority of these biorefineries would be sited, constructed and operated in rural and regional Australia.

The cost of fabrication and construction of these biorefineries could range (depending on the type, size, and feedstock), between $60 billion and $90 billion.

The impacts of this scale of development on the size and distribution of engineering infrastructure on a national basis would be significant.

Automobile Industry

The automobile and heavy duty vehicle industries make a significant contribution to the national economy, and in terms of employment.

- It is not widely known that the automobile and heavy duty vehicle manufacturing industries have also been responsible for over 96% of the improvements made in vehicle exhaust emissions performance.

The automobile and heavy duty vehicle industries are at risk of being heavily impacted by any major technology shifts in the modes of transport used to carry people and goods.

Biofuels, and technology advances in computer and vehicle design offer a strong and growing future for the vehicle manufacturing sector.

In the United States the design, manufacture and commercial sale by Ford, Chrysler and General Motors of Flexible Fuel Vehicles (FFV's) capable of interchangeably using neat petrol, or up to a 85% ethanol blend with petrol, without engine conversion, makes the large scale take up of bioethanol increasingly practical in the short and medium term.

These and ongoing computer and vehicle technology advances means that the transition from fossil fuels to biofuels derived from biomass would be a basically seamless and non-disruptive process for the automobile industry.

In the short term, until higher bioethanol production capacity is achieved, the transition to renewable fuels will be achieved by initially pursuing the conversion of the light duty fleet to a 10% ethanol blend with petrol (E10), and the heavy duty fleet to a 15% ethanol blend with diesel fuel (E15).

- No vehicle conversion is required with an E10 blend.

- Conversion costs associated with E15 diesel blend would range from no cost for small vehicles, to between $200 to $1,500 for heavy duty vehicles. (These conversion costs are significantly lower than the $13,000 to $60,000 required to convert heavy duty vehicles to CNG/LPG.)

5. Economic and National Benefits

5.1 NATIONAL ECONOMIC BENEFITS

A constant challenge for Government is the anticipation of major shifts in industry, resources and national assets that could have a significant impact on the national economy. Maintaining a balance between the outflow of capital from imports relative to exports is important to maintaining a stable Balance of Payments. Another is maintaining energy security. For Australia, oil supply is a weakness in our otherwise strong national energy portfolio.

Oil has particular implications for the Australian economy due to both the pervasiveness of its use in the transport, energy and industry sectors, and because it is a major source of tax revenue for both Federal and State governments. The projected exhaustion of Australia's domestic oil reserves within 10 to 15 years, the projected peak in global oil supply around 2025, and the progressive decline thereafter in global oil supply, thus poses a major challenge, and opportunity for policy makers.

The long term challenge for government is to explore and encourage the development of cost competitive replacement energy resources which, hopefully, will intersect in sufficient volume at a point in time when the domestic supply of oil declines, and cost of oil globally rises. This would be the most desirable and least disruptive outcome for the Australian and global economy.

Desirably, as well as providing an increasing source of tax revenues, the replacement transport fuels would also offer a range of other national benefits including greenhouse gas abatement.

The production of biofuels such as ethanol from biomass meets all of these criteria.

- Australia has access to sufficient quantities of traditional and new sources of biomass to attain self sufficiency in transport fuels over a period of 50 years.

- Technology advances have halved the cost of ethanol production over the past 20 years, with the process expected to accelerate over the next 10 years through advances in conversion rates in existing processing technologies, and the introduction of new

technologies that open up a wide renewable pool of new biomass feedstocks for high volume conversion to ethanol.

- A robust Australian biofuels industry would, in restoring national security in transport fuels, shield Australia from the impacts of future international oil crises.

- A robust biomass based biofuels industry would create an economic, employment and social revival in rural and regional Australia, freeing up and contributing additional financial resources for other nation building programs.

- The development and deployment of large scale renewable and biomass based industries on a national basis, offers the most significant and widest possible impact in reducing greenhouse gas emission on a national and global basis in the short, medium and longer term.

- Creating value for biomass wastes and residues also addresses chronic economic problems in traditional agriculture and forest industries in Australia, along with land sustainability.

The potential benefits of biomass based industries are sufficient to warrant a closer and more detailed study by the government

5.2 RURAL and REGIONAL AUSTRALIA

The actual scale and scope of the multi-benefits that an aggressive approach to the development of biomass industries would bring to rural and regional Australia are beyond the capacity of this submission.

The type, range and volume of available feedstocks in a given region will be an important indicator of potential benefit, together with the type of technologies most suited to the conversion of the feedstocks. Available infrastructure such as rail, and the availability of water are other factors that could determine the size of biorefineries constructed.

Three general types of biofuels production approaches are anticipated in rural and regional Australia.

1. The production of ethanol from waste streams from the downstream industrial processing of food crops (eg wheat and sugar cane).

2. Production by stand alone biorefineries of biofuels and starch by-products from specific non food energy crops, and by biofuel plants co-located with livestock feedlot operations.

3. The production of ethanol and lignin from lignocellulosic materials such as agriculture and forest residues, woody weeds, fast growing trees and grasses, biomass from urban waste, and other biomass resources.

The first two production models represent the foundation platform, and infrastructure from which a wider biomass based biofuels industry will develop and grow. These production models will also continue to co-exist with and operate alongside future high volume ethanol production from wider biomass feedstock sources.

Brazil

Brazil does not provide a representative model of the economic and employment impacts of a biomass based biofuels industry in Australia, as its national scale ethanol industry is based on a dedicated food crop - sugar. Brazil does however, provide some idea of other national impacts.

- Brazil reduced its oil imports by nearly 70% between 1979 - 1992.
- Brazil's trade balance (in US dollars) improved from - $3.5 billion in 1975 to + $14.9 billion in 1992.
- Brazil's dependence on imported oil reduced from 44.3% in 1985 to 21.7% in 1992.
- Ethanol fuel in Brazil is transported by road, rail, ship, and by pipeline on a daily basis.

Australia

Studies undertaken by CARE and CSIRO in Australia, and by the Departments of Energy, and Agriculture in the United States are likely to be more representative of the economic and employment impacts of a biomass based biofuels industry in Australia. Studies by CARE of the Gwydir Valley, and Richmond-Tweed regions in NSW indicated the following:

	Gwydir Valley	Richmond-Tweed
Local/Regional Economic Impact (gross output & flow-on)	$30 m/pa	$39 m/pa
Direct Employment Impact (plant & region)	159	322
Indirect Employment Impact	600 to 800	1,200 to 1,600

Assessment of the economic and employment impacts of a biomass based biofuels industry on rural and regional Australia is complicated by the probability that a range of biorefineries ranging from a production capacity of 10 million to 100 million litres per year would be likely, and that between 1,200 to 1,600 biorefineries would be required around Australia to produce all of Australia's liquid transport fuels from biomass. The majority of the biorefineries would be located in rural and regional Australia.

Another measure of the potential industry is the import and export of crude oil and other refinery feedstock to and from Australia. In 1997-98, imports into Australia were valued at $25 billion. Exports of crude oil and other refinery feedstock from Australia in 1997-98 amounted to $14.8 billion.

6. SUMMARY

It is without question that the multi-benefits flowing to Australia from a biofuels industry would be substantial, and that the economic and employment impacts would be highly significant.

The environmental benefits in terms of greenhouse gas abatement are also significant, and unique to biofuels . Urban air quality would also be improved.

Taken together, the multi-benefits associated with a biofuels industry warrant close and detailed examination, and serious consideration for inclusion under the Greenhouse Gas Abatement Program.

7. RECOMMENDATIONS

The scale of the endeavour set out in this submission extends beyond the four years of anticipated Government support proposed under the current Greenhouse Gas Abatement Program. For this reason it is recommended that the Government also set out an achievable set of Milestones for the establishment of a biofuels industry on a national scale.

The following **Milestones** are recommended for consideration.

Year 2005

The production of 2% of Australia's transport fuels (more than 540 million litres) from biomass in the form of biofuels such as ethanol.

The net reduction of over 1 million tonnes of carbon (CO_2) per year from Australia's net annual GHG emissions from the transport sector.

Year 2010

The production of 5% of Australia's transport fuels (more than 1.4 billion litres) from biomass in the form of biofuels such as ethanol.

The net reduction of over 3.5 million tonnes of carbon (CO_2) per year from Australia's net annual GHG emissions.

Year 2025

The production of 40% of Australia's transport fuels (more than 11 billion litres) from biomass in the form of biofuels such as ethanol

The net reduction of over 29 million tonnes of carbon (CO_2) per year from Australia's net annual GHG emissions.

Year 2040

The production of 85% of Australia's transport fuels from biomass in the form of biofuels such as ethanol.

Greenhouse Gas Abatement Program

The following recommendations are proposed to cover the first two critical foundation building phases essential to establishing a platform for the accelerated development, and high volume production of biofuels from biomass on a national scale under the Greenhouse Gas Abatement Program. Stage One and Stage Two would be undertaken simultaneously.

Stage One is based on expansion of the use of biomass feedstocks for the production of biofuels to meet the national milestone set for 2005. This would involve the consolidation and expansion of existing industry foundation structures, and the advancement of innovative technologies and strategies for accelerating reductions in biofuel production costs.

Stage Two is based on the identification, demonstration and commercial development of new technologies for the high volume, and cost competitive production of biofuels such as ethanol from a wide range of lignocellulosic biomass feedstocks on a sustainable basis.

Recommendations:

Years 2000 to 2004

- A National Centre for Biomass to identify the range and type of potential biomass resources on a national basis, and strategies for their sustainable use for the production of biofuels.

- Extension of the Alternative Fuels Grant Scheme to petrol as well as diesel fuel.

- Extension of the Alternative Fuels Conversion Program to renewable biofuels such as ethanol

- A Biofuels Infrastructure Program providing a rebate of 50% of the cost of modification of petrol/diesel fuel retail, and petrol and diesel blending sites.

- A Biofuels Development Fund for the commercial development of advanced technologies, and innovative strategies for achieving reductions in current cost structures associated with the production of biofuels for transport use.

  2000 $ 5 million
  2001 $10 million
  2002 $15 million
  2003 $20 million

  * Roll over provisions would apply to roll unexpended funds from one year of the program into the next year.

- A Biomass Technology Development Program providing grants of $5 million to $10 million for the accelerated demonstration and commercial development of new technologies such as the conversion of lignocellulosic materials to ethanol and lignin.

  2000 $ 5 million
  2001 $10 million
  2002 $20 million
  2003 $25 million

  * Roll over provisions would apply to roll unexpended funds from one year of the progran into the next year.