Regional Benefits of an Integrated Oil Mallee Processing Plant

A background paper prepared for the State Sustainability Strategy

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Contents

Summary

The Oil Mallee Project has been under way for over a decade. The proposal to construct a 5 Megawatt (MW) Integrated Wood Processing (IWP) plant at Narrogin is a significant milestone in the development of the oil mallee industry. In addition to the benefits realised by the project owners the IWP will provide a wide range of benefits to the Great Southern Region, Western Australia and Australia. This report highlights the wider potential benefits of the Oil Mallee Project, specifically the proposed 5MW IWP at Narrogin, to regional communities, the state and nation.

The plant would create an additional 88 permanent jobs and 447 temporary job years within the Australian Economy. 25 people would be directly employed in permanently operating and supplying the plant in the Great Southern Region.

A 5MW IWP at Narrogin could deliver direct financial benefits to the project owners and to landholders. The Net Present Value (NPV) of the project to the owners of the IWP would be $7.78 million. For landholders the NPV of planting mallees to supply the IWP compared to the existing land use would be $6.16 million. Additional economic activity, including employment would be generated within the regional and national economies from the operating and capital expenditure and profits from the IWP.

Other potential benefits include reduced land degradation, biodiversity preservation, reduced reliance on chemicals in agriculture, economic diversification for landholders and regional communities, provision of renewable energy, sequestration of atmospheric carbon dioxide and improved landscape amenity. The project is an outstanding example of sustainable development and the transition to a sustainable society and economy in Western Australia.

1 Introduction

The Oil Mallee Project involves farmers in Western Australia planting local indigenous eucalypts as a means of reducing land degradation while receiving a commercial return by harvesting the above ground biomass and processing it into products including eucalyptus oil, activated carbon and electricity. The project could provide numerous benefits to regional communities in Western Australia and could make a significant contribution to the sustainability of the Western Australian economy.

The Oil Mallee Project developed throughout the 1990s with support from the Western Australian Department of Conservation and Land Management (CALM). In 2002 a 1MW pilot Integrated Wood Processing plant (IWP) will be built at Narrogin in the Great Southern Region. If the pilot plant is successful a 5MW commercial IWP will be built. The potential benefits of a 5MW IWP built at Narrogin are the focus of this report.

This report is the first of two reviewing the benefits of the Oil Mallee Project to regional communities and landholders. The second report by David Bennett, "Can planting trees have an economic benefit by saving downstream assets", reviews current literature and data relating to the impacts of planting trees, including oil mallees, on protecting water supplies, infrastructure and remnant biodiversity from dryland salinity.

1.1 Aims of this report

This report aims to

- identify and, where appropriate, quantify regional benefits of oil mallee processing, specifically at Narrogin; and
- describe the potential for an oil mallee industry, as an example of a native woody perennial crop, to contribute to sustainable regional development in Western Australia.

1.2 Context of this report

This report has been written in the context of a number of recent publications, state government policy initiatives and developments in the Oil Mallee Project. In 2001 the State Salinity Taskforce reported to the government recommending support for the development of industries based on woody perennial species such as the Oil Mallee Project[1]. The State Sustainability Strategy is currently being developed, providing a useful framework for considering regional developments such as the oil mallee industry. The Oil Mallee Project is beginning to provide returns to growers in the form of income from eucalyptus oil at Kalannie and integrated processing of mallee biomass at the Narrogin pilot plant. Publications including Enecon (2001) and MacGill et al (2002) have analysed the Narrogin proposal from differing perspectives.

1.3 Structure of this Report

The analysis of the benefits of the Narrogin IWP is presented in the broader context of sustainable regional development in Western Australia, which is the basis of Chapter 2. Chapter 3 outlines the methodology for the analysis of benefits, which are presented in Chapter 4. The analysis of benefits of the Narrogin project in Chapter 4 includes quantification of income and jobs created by a commercial scale integrated processing plant, and describes a number of non-quantified benefits. The report concludes by assessing the Narrogin development against the broader claims of the Oil Mallee Project as a contributor to regional sustainability in Western Australia.

[1] Frost et al 2001

2 Background

Analysis of the benefits of a 5MW IWP at Narrogin must be considered in the context of the history of the Oil Mallee Project, the challenges facing communities in the Western Australian wheatbelt and the transition to a sustainable economy and society in Western Australia.

2.1 Brief History of the Oil Mallee Project

The Oil Mallee Project has been driven by the need to develop a commercial tree crop for low rainfall areas of the southwest agricultural region. The scale of land degradation requires large-scale revegetation with deep-rooted perennial species as part of an integrated approach to prevention and remediation[2]. Large-scale revegetation on private land that is currently economically productive is unlikely unless the revegetated species can provide a commercial return. Oil mallees are the first native woody perennial species to be promoted as a commercial crop in the lower rainfall areas of the South West Agricultural Region. The project has been promoted as part of the solution to the problem of dryland salinity that brings wider commercial and social benefits[3].

The Oil Mallee Project has its origins in research conducted at Murdoch University during the 1980s into the chemistry and potential uses of eucalyptus oil and efforts to establish a eucalyptus oil industry in Western Australia[4]. The project developed throughout the 1990s with strong support from the CALM. A growers association was formed in 1995 and by 2001 the Association had approximately 1000 members. The Oil Mallee Company was formed by the Association in 1997 in order to enhance the commercial development of the industry.

Oil mallees are a group of eucalypt species native to the southwest corner of Australia. The project has selected 6 species that have high oil content in their leaves as the basis for developing a eucalyptus oil industry[5]. Mallees are hardy plants that have evolved in the soils and climate of Australia. Mallees are particularly well suited as a perennial crop through their ability to re-sprout after the above ground biomass has been lost from fire or harvesting. This ability comes from the large mallee root which stores carbon under the ground to allow the mallee to re-sprout quickly and effectively if the above ground biomass is lost.

In the first decade of the project plans for commercial returns involved processing the mallee leaf material to produce eucalyptus oil. In 2000 a group of oil mallee growers from the Kalannie district formed a company called Kalannie Distillers and have begun producing eucalyptus oil for the Australian market. Integrated processing of mallee biomass to produce electricity, activated carbon and eucalyptus oil in a centralised processing facility has been the main focus of industry development since the late 1990s. Western Power, together with a private firm Enecon and the Oil Mallee Company, propose to construct an Integrated Wood Processing plant (IWP) using oil mallee feedstock at Narrogin in the Great Southern region of Western Australia. This proposal has the potential to increase the commercial returns on mallees and improve the viability of the emerging industry. Since the Kyoto Protocol on Greenhouse Gas emissions was signed in 1997 carbon credits have also been investigated as a potential income from mallees[6].

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[2] Frost et al 2001
[3] Bartle 1993
[4] Barton 2000
[5] 5 of the 6 species used in the Oil Mallee Project are native to Western Australia. One species, *eucalyptus polybractea* or blue mallee, is native to Victoria.
[6] Shea 1999

The Oil Mallee Project has been promoted as a commercially viable solution to dryland salinity and has been identified as holding enormous potential as an example of sustainable regional development[7]. While integrated processing is piloted at Narrogin it is timely to identify and, where possible quantify, the broader regional benefits that the industry might bring on a commercial scale.

2.2 Current Challenges in the Western Australian Wheatbelt

Farmers and communities in the Western Australian wheatbelt, like people in rural regions around the world, currently face many challenges. These challenges include decline terms of trade for agricultural products, declining rural populations, loss of government services and businesses, environmental degradation, increasingly sophisticated markets and technology and climatic variability and climate change[8]. On some of these issues, particularly farm business management and the implementation of technology, Western Australian farmers are better placed than many farmers in other regions of the world. Other issues, such as declining employment opportunities and environmental degradation, are proving more difficult for Western Australian communities to address on the scale required. The challenges for wheatbelt communities in Western Australia are interconnected but may be broadly summarised as issues of land degradation, biodiversity loss, climate change and fossil fuel consumption, population and employment decline and maintaining financial viability.

1) Land Degradation

Environmental degradation is both a cause and a consequence of declining agricultural profitability and the declining fortunes of rural communities. While farmers, community members and governments throughout Australia have devoted significant resources to improving land and nature conservation, notably through the Landcare movement, the scale of environmental degradation over shadows improvements made through voluntary schemes. Soil degradation, including salinity, arises fundamentally from farming methods and systems that are incompatible with local ecological processes. Solutions to the problems of land degradation must ultimately address these systemic causes.

Dryland salinity is widely discussed in the media, in government and in the community as a serious threat to agricultural productivity, biodiversity, infrastructure, communities and health in the wheatbelt of Western Australia[9]. It has been widely reported that currently 10% of the Western Australian wheatbelt is affected by human induced dryland salinity and that within 50 years up to 30% of the wheatbelt could be affected[10]. Dryland salinity is caused by rising water tables that result from clearing deep-rooted native perennial vegetation and replacing it with shallow rooted annual crops and pastures. The immediate focus on dryland salinity as a threat to the viability of agriculture in Western Australia provides an opportunity for new industries, land management and landscape systems that could also address many other underlying threats to the sustainability of the wheatbelt[11].

2) Biodiversity

The South West of Western Australia has been identified as one of 25 global hotspots for biodiversity[12]. This designation reflects both the immense diversity of flora and fauna in this region and the extreme pressure remnant biodiversity is under due to environmental degradation. Remnant vegetation is threatened by continued grazing by domestic livestock, dryland salinity and other

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[7] Bartle 1993, Bell et. al. 2001
[8] ABARE 1999, Gray & Lawrence 2001
[9] State Salinity Council 2000, Beresford et al 2001
[10] State Salinity Council 2000
[11] Frost et. al. 2001
[12] Myers et al 2000

forms of land degradation and the viability of remaining fragments of native bush is weakened where the remnants are too small, or are not linked together by corridors of vegetation.

3) Greenhouse and Fossil Fuels

Western Australia relies heavily on fossil fuels for electricity and transport energy. Western Australia has large resources of natural gas, which it uses within the state and exports. While the wealth created through the development and use of fossil fuel resources drive economic growth and improve the standard of living in Western Australia, industries, government and communities must plan and act for a transition to renewable energy resources. Global climate change and the international agreements that have been developed to combat it require all developed nations to work towards reducing greenhouse gas emissions by reducing fossil fuel consumption.

Agricultural and transport industry reliance on oil as a fuel source is threatened by the prospect of long-term shortages as production begins to decline. Global oil production is expected to peak in the next decade leading to worldwide shortages and increasing prices[13]. Western Australia's resources of natural gas may provide an alternative fuel source in the short term, but renewable energy sources for transport and agriculture are required for long term viability and sustainability.

4) Population and Employment

The issues facing farmers and rural communities throughout the world interact systemically. Declining terms of trade lead to a heavier reliance on agricultural technologies, larger farm sizes and increased pressure on the biophysical environment. Technological innovation and the need to reduce farm business costs lead to a reduction in on-farm employment opportunities. This, combined with farm amalgamation, is reducing rural populations. As populations reduce, government and business services are withdrawn from towns, further reducing employment and population in rural regions[14].

5) Financial Viability

Western Australian farmers participate in global markets as consumers of agricultural machinery and chemicals and as suppliers of commodity food and fibre products. As commodity prices decline agricultural industries look to improve the marketing of their products to achieve greater control over the entire supply chain. Quality assurance systems are increasingly a component of the management of farm enterprises. Market concerns over food safety, animal welfare and environmental sustainability are leading to increased pressure on farmers around the world to manage their operations in a safe, ethical and environmentally sustainable manner. The "clean and green" image of Western Australian producers currently assists the marketing of agricultural products. As global food and fibre consumers place increasing scrutiny on agricultural producers it will be more important for Western Australian agriculture to demonstrate sustainable, ethical and safe systems and methods of farming.

The Western Australian economy depends heavily on commodity exports from primary industries[15]. Resource development and the need for secondary industries are recognised as important for the future of the state's economy. The long term sustainability of agriculture and the secondary processing of agricultural products are significant elements in the long-term economic stability for Western Australia.

[13] Fleay 1994
[14] Garnaut et al 2001
[15] Department of Treasury and Finance 2002

2.3 Sustainable Development

The challenges facing Western Australia, particularly communities in the wheatbelt, require planning and action for change on two time horizons. The need for immediate adaptation to maintain short-term viability of existing industries drives much policy and business planning in agriculture. In addition, policies need to be developed and action taken now to enable the longer-term transformation to a more sustainable agricultural system in Western Australia.

Sustainable development requires the integration of ecological, economic, social and cultural factors in planning and decision making. An integrated approach to development avoids tradeoffs between conflicting priorities and maximises opportunities for mutual benefit. Sustainable development is enhanced by partnerships between government, communities and industries.

The Western Australian State Government defines sustainability as

> "the simultaneous achievement of environmental, economic and social goals."[16]

and outlines four principles for sustainability –

- "Conservation of biological diversity and ecological integrity (as the basis on which life depends);
- The precautionary principle (lack of scientific certainty should not delay measures to prevent environmental degradation and other damage);
- Inter and intra-generational equity (our decisions today should not compromise the choices of those generations still to come and should provide for equity within generations); and
- Improved resource valuation, pricing and incentive mechanisms to protect and repair the environment."[17]

The dual requirements for immediate adaptation to maintain viability and the transformation to sustainability are at times in conflict for resources and focus, both at the level of farm businesses and rural communities and at the level of government policy making and political lobbying.

Maintaining Viability

Action and policies to maintain the viability of existing industries are driven by a need to adapt to changing economic, social and environmental conditions. As a response to declining profit margins agricultural industries have adapted by increasing productivity and expanding farm size. Responding to increasingly sophisticated markets, industries have adapted by moving towards integrated supply chains and implementing quality assurance programs. Some rural development programs have focussed on opportunities for secondary processing of primary products as a means of increasing employment opportunities and rural population, others have focussed on alternative enterprises and addressing social problems. Responses to dryland salinity which demonstrate a focus on helping existing industries adapt to environmental degradation include providing farmers with information to help predict saline areas, earthworks on farms, tree planting on non-productive land, increasing water use of crops and pastures, and increasing the productivity of salt-land pastures.

While actions and policies to maintain the viability of existing industries may pre-empt some challenges, they often do not address the underlying causes of systemic problems facing agriculture. It is vital that existing rural enterprises and communities remain viable in the short-term if underlying systemic problems are to be addressed. It is equally important that governments, communities, industry groups and farmers take action and make plans for the longer term goal of improving the overall sustainability of the wheatbelt.

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[16] Government of Western Australia (2001)
[17] Government of Western Australia (2001)

Transition to Sustainability
The transition to sustainability in the Western Australian wheatbelt requires the transformation of the agricultural system through new industries and new land management systems and techniques[18]. In order to prevent further salinisation and to conserve soils an agricultural system incorporating large areas of deep-rooted perennial species is required. The use of native perennial species in agricultural systems will enhance the biodiversity value of the system and may improve the vigour of crops that form the basis of new industries.

The transition to a sustainable economy in Western Australia requires change across all sectors. Renewable energy industries utilising biomass produced on wheatbelt farms from native woody perennials could improve the sustainability of the agricultural system, the viability of rural communities and reduce the state's reliance on non-renewable fossil fuels as well as reducing greenhouse gas emissions.

Sustainable development requires systemic change and will produce widespread benefits. A cultural change is accompanying the transition to sustainability as Western Australians learn to live within their local landscape while participating in the global economy.

2.4 The Oil Mallee Project and the transition to Sustainability

The Oil Mallee Project is a leading example of sustainable development in regional Western Australia. The strong commitment to economically viable, commercially attractive tree crops as a means of addressing dryland salinity provides a strong foundation for fulfilling the objectives of sustainable development.

In addition to the environmental and commercial benefits the project potentially has many social and cultural benefits. The involvement of growers in the development of the industry so far highlights the strengths and talents that exist in many regional communities and individuals. The requirement for local processing of oil mallee biomass has the potential to provide new employment opportunities in regional towns, helping to resist and reverse declines in regional populations.

The Oil Mallee Project has the potential to contribute significantly to the sustainability of the state of Western Australia. Renewable energy from mallee biomass could reduce the state's reliance on fossil fuels and reduce net greenhouse gas emissions. Returning deep-rooted perennial vegetation to the agricultural landscape will reduce the risks of extreme flood events. Local economic activity and export of industrial products from oil mallees could improve the state's trade balance.

1) Land Degradation

The hydrological benefits of mallees are still being investigated for a range of catchment conditions. Initial evidence suggests that in order for trees to have a significant long-term impact on reducing water tables they must be planted in large numbers over large areas of a catchment and that plantings must be situated strategically to maximise hydrological impact[19]. While planting mallees in small areas on farms may not have a large impact on ground water levels, commercial scale planting in conjunction with other land management improvements and engineering works could play and important role in the long-term prevention and amelioration of dryland salinity.

In addition to reducing water tables oil mallees planted on farms help reduce soil erosion. Oil mallees planted in an alley configuration act as wind-breaks and reduce surface water runoff.

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[18] Lefroy et. al. 1992, Frost et al 2001
[19] See Bennett 2002, the second part of this series, for a review of the hydrological impact of tree planting

2) Biodiversity
Preservation of the remaining biodiversity is a key element in the sustainability of Western Australia. Environmental restoration and conservation is inherent in new agricultural systems incorporating native perennial species such as oil mallees. Utilising species that have adapted to the soil, climate and hydrological conditions of the wheatbelt reduces soil degradation, chemical dependence and vulnerability to pests and weather fluctuations. The wildlife and biodiversity values of remnant vegetation are more easily incorporated with agricultural values. The aesthetic value of the landscape is improved by woody perennial species, which provide green belts across paddocks that are otherwise dry for much of the year.

3) Greenhouse and Fuels
The transition to renewable energy has begun in Western Australia, partly encouraged by the federal government policy requiring that 2% of all new electricity generation comes from renewable sources[20]. Wind farms have been constructed at Esperance and Shark Bay and the proposed IWP at Narrogin will further help Western Power achieve its required 2% renewable energy target[21]. The federal policy assists in the development of renewable energy technology and resources but is only the beginning of the transition to wider use of renewable energy in the Australian economy.

Alternatives to fossil fuels for transport and agricultural machinery are emerging. Ethanol produced from woody biomass, such as oil mallees, can be used as a liquid fuel. The performance of ethanol is improved by the addition of eucalyptus oil[22].

4) Population and Employment
Farmers and communities in the Western Australian wheatbelt are resilient and dynamic. In spite of the pressures of low commodity prices, environmental degradation, increased complexity of farm management and declining populations, many individuals and communities have shown strong capacity for change and to engage in the processes that affect their businesses, communities and environment. While they require continued support from government agencies, non-governmental organisations and industry groups, the communities and farmers of the Western Australian wheatbelt have demonstrated the capacity to survive under adverse conditions and to adapt to changes in the global economy, government policy and local communities.

Although many people and communities display high resilience, people living in wheatbelt towns are suffering from loss of employment and services. Diversification of industry in the wheatbelt and additional employment opportunities arising from processing, including an oil mallee industry, in rural communities could help address many social and health problems currently seen in these communities.

5) Financial Viability
The developing oil mallee industry does not disrupt existing industries and can be incorporated into existing farming systems and rural communities relatively easily. The key to the integration of native perennial species into agricultural systems is commercial viability. Products must be developed and marketed locally and globally. While native species hold strong potential for new products they must be developed into viable commercial industries. This presents an enormous hurdle to the establishment of new industries that could form the basis of a sustainable agricultural system in the wheatbelt. Investment in new industries and product development is high risk and requires a long-term commitment from investors and stakeholders. The commitment of growers,

[20] Newman 1998
[21] Western Power 2002
[22] Barton & Tjandra 1989

CALM and other stakeholders to the Oil Mallee Project could be rewarded by the commercial success of the IWP at Narrogin and provide an example for other emerging industries.

New industries which process biomass from sustainably managed crops of native species could provide export income from the sale of products into niche markets. Such industries would be well placed to take advantage of the global demand for sustainably produced natural products as replacements for existing chemicals and materials which have negative impacts on the environment throughout their lifecycle.

Agriculture remains a significant contributor of export earnings for the Western Australian economy[23]. An agricultural system that is less reliant on chemical inputs and supplies sustainable, safe products for sale outside commodity markets has the potential to improve the state's balance of trade.

New agricultural industries, which are not based on food and fibre commodities, provide Western Australian farmers with the opportunity to engage in local and global markets for new products. Local, national and global investors will also interact in establishing and maintaining new industries in Western Australia. In developing new industries based on native species farmers potentially reduce their consumption of fertilisers and other agricultural chemicals while selling biomass products to local processors who could supply energy to the local economy and manufactured products to the global economy. Industries based on native species, such as oil mallees, have the potential to reduce both the input costs to farmers and their vulnerability to global commodity markets, thus improving the resilience of their businesses and the Western Australian economy.

[23] Department of Treasury and Finance 2001

3 Methodology

This report presents a case study of the proposed oil mallee processing plant at Narrogin. It draws on previous studies of this project to provide an assessment of the regional benefits of a commercial scale IWP at Narrogin. This allows for an assessment of the general claims of the Oil Mallee Project against the specific projections of the Narrogin development.

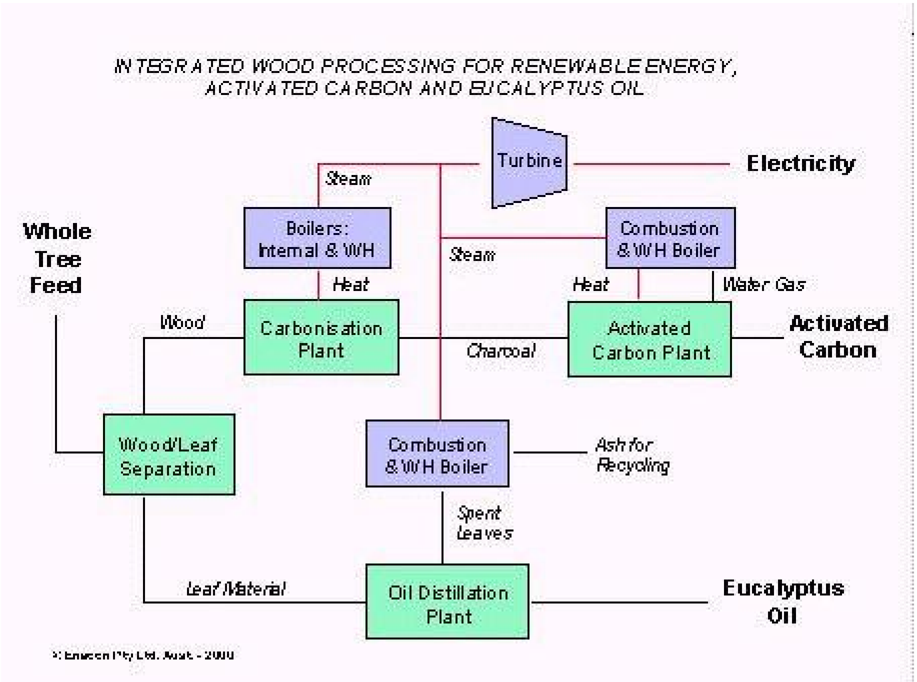
Where appropriate, the benefits have been quantified. Many of the values presented have been calculated in previous studies, which investigate the IWP from a number of different perspectives. Previous studies focused on landholder costs and benefits, economic projections for the processing plant, employment and investment in the renewable energy technology and other specific components of the overall development. This report draws together these different analyses to highlight the regional, state and national impacts of a commercial processing plant (5MW) at Narrogin. Indirect and direct employment creation is presented for the Great Southern Region and Western Australia. Employment numbers are based on Enecon (2001), Magill et al (2002), Clements and Ye (1995) and data reported by representatives of the Oil Mallee Association and nursery owners. Present Values of investment and income related to the processing facility are taken from Enecon (2001) which uses a discount rate of 12.5% and a project life of 15 years. The Net Present Value of income to landholders from planting oil mallees is calculated using Herbert's model (2000) with a discount rate of 7% over a project life of 20years. In addition to jobs and economic benefits a number of benefits that have not been quantified are also described.

In aggregating regional economic benefits it is recognised that some benefits to the regional economy and community may correspond with a cost to project owners or landholders. For example, labour requirement for operating and maintaining a processing plant are a cost to the plant owners but are a benefit to regional communities. Conversely, benefits to owners may not correspond to direct regional benefits. Chapter 5 presents a summary of the potential benefits of a 5MW IWP to the project owners, landholders supplying mallee biomass, the Great Southern region and Australia.

4 Benefits of an Oil Mallee Processing Industry

In 2001 Western Power, together with the Oil Mallee Company and Enecon announced plans to construct a pilot IWP at Narrogin in the Great Southern Region of Western Australia. The pilot plant will produce 7.5 GWh of electricity, 210 tonnes of eucalyptus oil and 690 tonnes of activated carbon each year.[24] The process flow diagram for the proposed IWP is presented in Figure 1.

Figure 1: Process Flow Diagram for Integrated Wood Processing Plant



(Source: Enecon 2000)

If the pilot plant proves that the integrated processing technology is viable it will be expanded to commercial scale production. This chapter estimates the benefits of a commercial IWP built at Narrogin. The analysis assumes a full scale commercial IWP that will produce 5MW of electricity, 3100 tonnes per year of activated carbon and 1050 tonnes per year of eucalyptus oil[25]. The relative contributions of income from the three products will be 60% from activated carbon, 20% from electricity sales and 20% from eucalyptus oil.

The benefits from oil mallee processing at Narrogin are summarised as:

- benefits and costs to landholders;
- benefits and costs to owners of the IWP;
- job creation; and
- non-quantified benefits and costs.

[24] Chegwidden et al 2001
[25] Enecon 2001

4.1 Benefits and Costs to Landholders

Alan Herbert (2000) has reported the economics of oil mallee production on the farm. The basic analysis assumed:

- 15% of oil mallees in 2 row hedges in a paddock,
- planted at a cost of $0.50 per tree to the farmer or $0.60 by contract,
- harvested after 4 years and re-harvested every two years;
- with a yield of 15 kg/tree (38 t/ha) at $15 per tonne at stumpage ($15 per tonne was allowed for harvesting and haulage costs to the processing plant, where the cost was assumed to be $30 per tonne)
- project life of 20 years
- discount rate 7%

This scenario achieves a Net Present Value (NPV) of $510 per hectare compared to $511 without oil mallees. Herbert explores a number of sensitivities and concludes that the stumpage value is probably the most important, but harvest intervals are also critical.

Using Herbert's Excel Spreadsheet model, but using 6.5% discount and $19.30 per tonne for oil mallee cuttings at the farm gate (Enecon, 200), plus taking some recent information provided for Toolibin Lake catchment[26], where, in twenty years, salinity is expected to continue to increase from 8% to 16% without mallees and to increase to 10.3% with mallees, the NPVs are $496 per hectare with oil mallees and $629 per hectare without. The NPV benefit of oil mallee hedges compared with the existing land use in the Toolibin Lake catchment would therefore be $133 per hectare.

A 5MW IPP at Narrogin will require 20 million mallees to supply biomass. Using Herbert's assumptions of 2400 mallees/ha, 20 million mallees will require 8 333 ha of land which at 18% plantings equates to 46, 294 ha of paddock. The NPV of the net benefit to landholders of planting mallees in the Toolibin catchment to supply a 5MW IWP at Narrogin would therefore be $6.16 million over 20 years.

[26] Richard George Personal Communication July 31st 2002

4.2 IWP Owner Benefits and Costs

Financial analysis of a 5MW IWP presented by Enecon (2001) calculates a base case NPV of the project for the owners of $7.78 million. The calculation of net benefits to the owner is important in determining the viability of the project. Income from the IWP benefits the project owners and will generate national economic activity, but may be of little direct benefit to the Great Southern Region. Conversely some costs to the project owner represent economic benefits to the region and nation, most notably employment.

This section reviews the Enecon (2001) analysis and draws on additional data to present the main benefits and costs to the owner of the IWP in the context of the overall regional and national benefits of the project. The main sources of revenue and expenditure are summarised as –

- Income from eucalyptus oil
- Income from activated carbon
- Income from electricity
- Income from Renewable Energy Credits
- Capital expenditure
- Operating expenditure

4.2.1 Eucalyptus oil

Eucalyptus oil would contribute around 20% of the income of the Narrogin IWP. Enecon (2001) estimate that a 5MW IWP will produce 1050 tonne of eucalyptus oil each year. At an estimated price of $3, 000 /t eucalyptus oil will provide an annual income of $3.15 million with a present value of $15.85 million for the life of the project[27].

The majority of the world's eucalyptus oil is currently sold for use in pharmaceutical and household products such as liniments and cleaning products. Most of the world's eucalyptus oil is produced in China as a bi-product of the eucalyptus timber plantation industry. The world market for pharmaceutical and domestic use of eucalyptus oil is about 4000 tonne each year and the price of eucalyptus oil fluctuates between US$2, 000 and US$10, 000 per tonne. In recent years the price has been relatively stable at between US$3, 000 and US$4, 000 per tonne.[28]

The production of 1050 tonnes of eucalyptus oil each year from the Narrogin IWP would be likely to have a significant impact on the existing world market, hence the conservative estimate of price received relative to current prices. In the future the viability of additional production of eucalyptus oil depends on developing new markets. Research and development has shown potential new markets in industrial solvents, fuel additives and as raw materials for a range of industrial processes[29].

4.2.2 Activated carbon

Activated carbon is a product used in gold processing and water treatment. It adsorbs chemicals including gold complexes and chemicals that contribute to taste and odour allowing them to be removed from water. The current Australian market consumes 2500 tonnes of activated carbon each year in water treatment and 5000 tonnes each year in gold processing. The global market consumes 700 000 tonnes of activated carbon in various applications each year.

[27]All PV calculations for IWP revenues use Enecon (2001) assumptions: 15 year project life, 10% production year 2, 100% production years 3-15, 12.5% discount rate

[28] Enecon 2001

[29] Barton 2000

The Narrogin plant is expected to produce three grades of activated carbon. Enecon (2001) estimate that a 5MW IWP will produce 2720 tonnes of granular activated carbon (GAC), 1090 tonnes of CSIRO activated wood pellets (CAWP) and 294 tonnes of powdered activated carbon (PAC). It is expected that the gate prices for GAC and CAWP will be $3000 /t and that the price received for PAC will be $1000 / t. Over the life of the project the present value of carbon production is expected to be $23.3 million.

As is the case with eucalyptus oil, it is also expected that production of activated carbon from Narrogin will have a significant impact on domestic and world markets. Determining the quality and saleability of the activated carbon produced from an IWP will be a significant objective of the pilot plant as this product is the main source of income for the plant.

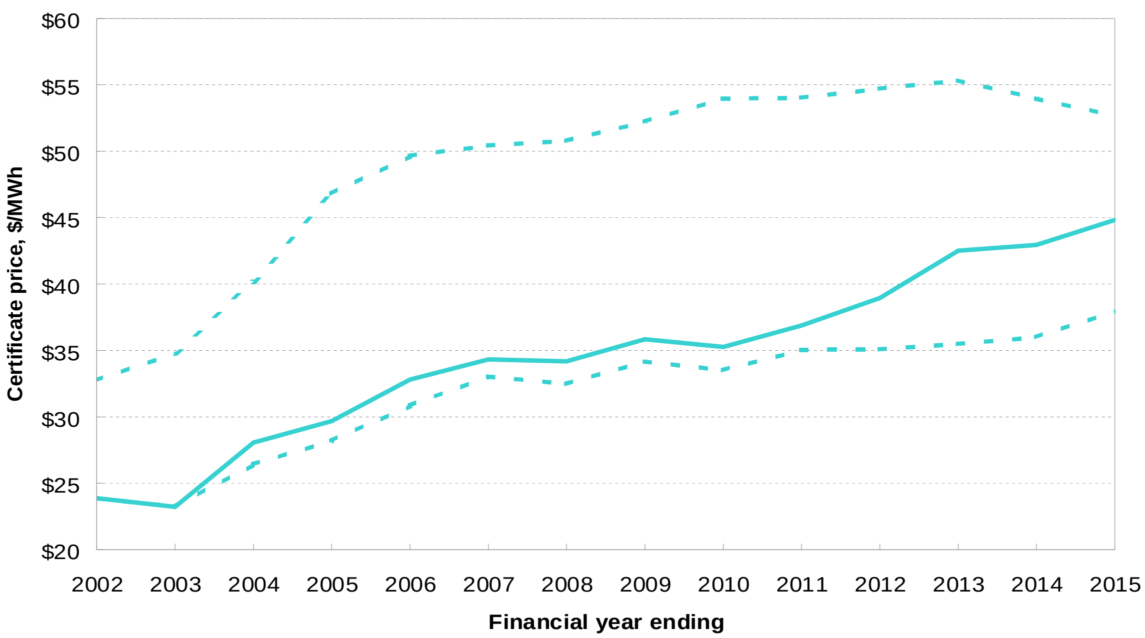
4.2.3 Electricity Generation

Financial analysis performed by Enecon for RIRDC in 2001 estimates the price received for electricity produced by the Narrogin IWP as $60/MWh[30]. A 5MW IWP will produce 40 000 MWh/year resulting in an estimated annual income of $2.4 million from electricity production. Electricity production will have a present value of $12.08 million over the project life.

4.2.4 Renewable Energy Credits

The Federal Renewable Energy Act (2001) requires all electricity retailers and large electricity customers to source an additional 2% of their electricity from renewable sources by 2012. A market in renewable energy certificates is currently being established as a mechanism for achieving this target and interim targets at the least cost. The mechanism functions by allocating Renewable Energy Certificates to producers of electricity from renewable sources. Electricity retailers and large customers may purchase these certificates to fulfil their requirements under the Act. Projections show the price of RECs could range from $24-$45/MWh[31] (Figure 2).

Figure 2: Potential uncertainty in prices for renewable energy certificates, $/MWh, real mid 2001 dollar terms



(Source: Gerardi et al 2001, p19)

[30] Enecon 2001
[31] Gerardi 2001

Income from RECs was not included in initial financial analysis of the project's viability[32]. While it is difficult to estimate the value of the RECs allocated to the Narrogin IWP it is likely that they will contribute to the overall profitability of the IWP as a renewable energy project developed by Western Power. At 40 000 MWh/year, assuming a minimum price for RECs of $24/MWh, a 5MW IWP could conservatively receive $960 000 each year for its allocated RECs. Using the discount rate of 12.5% over a project life of 15 years Renewable Energy Credits return a Present Value of $4.83 million to the project. This benefit for the project owner could be in the form of income if the credits were sold or in avoided costs if they helped Western Power achieve its mandated renewable energy targets without purchasing RECs on the market.

4.2.5 Capital Expenditure

The construction of a 5MW IWP at Narrogin would require an estimated capital investment of $28.39 million. Labour, finance, material and equipment for construction of the plant would be sourced within the Great Southern Region and Australia as well as from overseas. MacGill et. al. (2002) estimate that at least 20% of the capital cost of the IWP will be spent in the region and 90% of the capital will be spent in Australia.

4.2.6 Operating Expenditure

The annual operating cost for a 5MW IWP would be $7.89 million under the base case scenario developed by Enecon (2001). The majority of this will be spent within the region with the highest costs being labour and feedstock. Further expenditure on maintenance, utilities and other services and charges is likely to be distributed between the Great Southern Region and other parts of Australia. The distribution of annual operating expenditure is summarised in Table 1.

Table 1 Distribution of IWP Operating Expenditure

Expense	Cost	Beneficiary
Feedstock	$1.5 M	Growers
Harvest and transport	$1.5 M	Contractors
Employment	$1.06 M	Regional labour market
Maintenance, utilities, services and charges	$3.83 M	Regional suppliers and agents, local government, other suppliers, governments and contractors mostly within Australia
TOTAL	$7.89M	

[32] Chegwidden et. al. 2001

4.3 Job creation

Job creation is a cost to landholders and project owners but a benefit to the region and the national economy. The Oil Mallee Project has created jobs in the Narrogin region and further employment would be created in the region during construction and operation of the IWP. Jobs would be created directly as a result of planting oil mallees on farms and processing mallee biomass. A distinction is drawn between ongoing permanent jobs and construction and resource development jobs that will be of limited duration. A number of indirect jobs would also arise from the economic activity generated by the oil mallee industry.

Employment related to establishment and support for oil mallee seedlings is estimated from current levels of employment at the Tincurrin nursery and other estimates provided by a representative of the Oil Mallee Association. Short-term and permanent employment numbers at a 5MW IWP are taken from *Job and investment potential of renewable energy: Australian Case Studies* by MacGill, Passey and Watts (2002), the financial analysis of Enecon (2001) and communications with representatives of the Oil Mallee Association. Indirect employment levels are calculated from the direct employment data using multiplier factors taken from *A New Input-Output Table for Western Australia* by Clements and Ye (1995).

4.3.1 Direct Jobs

Direct jobs relate specifically to the construction and operation of a 5MW IWP and the development of the biomass resource to supply that plant. Direct jobs would be created in the short-term project development and in the ongoing supply, operation and maintenance of the processing plant.

Temporary Jobs

Jobs created for construction of the processing plant and establishment of the mallee biomass resource are not permanent. These jobs are counted in Job Years, a measure that reflects both the number of jobs created and the duration of those jobs[33].

Mallee Biomass Resource Development Jobs

One of the benefits of mallees as a biomass resource is their ability to re-grow after harvesting. Planting mallees to supply the IWP will only be done once. For this reason the majority of seedling supply and establishment jobs directly dependent on the IWP are not considered permanent. Some jobs in these activities will continue to depend on the IWP due to the requirement to replace dead mallees, however this is likely to be an insignificant source of employment in the long term and is not considered in this analysis.

Additional mallees may be planted in the Narrogin region after the supply for the 5MW IWP has been met. However these plantings are beyond the scope of this analysis. This analysis only counts jobs directly related to the IWP and the establishment of mallees to supply this plant is considered a short-term activity. Once enough mallees have been planted to supply the 5 MW IWP the only permanent seedling supply and establishment jobs dependent on the IWP are those relating to replacement of dead mallees.

The estimate of the number of jobs created to supply and establish mallees for the 5MW IWP is based on current employment levels and seedling supply levels and the total number of mallees required to supply the IWP. Current employment levels are based on the supply, distribution and

[33] For example 1 Job Year is equivalent to employment for one person over one year or 4 people for 3 months each.

planting of 1.3 million mallee seedlings each year[34]. Jobs directly related to oil mallee seedlings in the Upper Great Southern Region at present are:

Table 2 Employment from growing and planting oil mallees

Role	Equivalent Full Time Jobs Each Year	Jobs Years/ million seedlings	Comments
Nursery Staff and Seedling Delivery	5.14	3.95	The Tincurrin nursery supplies and delivers 1.3 million seedlings each year and employs 5.14 people full time equivalent.
Site Preparation	0.04	0.03	1 week work for spray contractor and earth works contractor
Seedling Planting	0.4	0.3	5 people planting for one month
TOTAL		**4.28 job years / million seedlings**	

Supply, delivery and planting of one million mallees requires 4.28 job years. The 5MW IWP will require 20 million mallees[35], requiring 86 job years of work. Some of the required 20 million mallees are already established. This means that some of the 86 job years required for the supply and establishment of the mallees have already been completed.

Construction Jobs

Jobs created for the duration of construction of the IWP at Narrogin are quoted from MacGill et al (2002). Some of the components of the IWP will be constructed outside the Great Southern Region of Western Australia however most of the construction employment will be located in Narrogin.

100 temporary jobs would be created from construction of a 5MW IWP and the development of the biomass resource to supply it, as summarised in Table 3.

Table 3 Employment from planting oil mallees and constructing the 5MW IWP

Activity	Role	Job Years	Comments
Seedling Supply, Delivery and Planting	Nursery Person Seedling Delivery Site Preparation Seedling Planting	85.6	4.28 job years/ million seedlings, 20 million seedlings planted
Biomass Processing[36]	Plant construction – on site	14	All located in Narrogin
TOTAL		**99.6 job years**	

[35] Enecon 2001
[36] Mac Gill et. al 2002

Permanent Jobs

The stable supply, operation and maintenance of a 5MW IWP at Narrogin is expected to provide employment for 24 people full time in the Upper Great Southern Region (see Table 4). These jobs will be in managing and supporting growers, harvesting and transporting mallee biomass from farms to the IWP and in the management, operation and maintenance of the IWP in Narrogin.

Table 4 On-going employment from the oil mallee industry

Activity	Role	Number of Full Time Jobs	Comments
Grower Management	Oil Mallee Association Region Manager – grower support and advice	1	This role is currently underway. Presently involves promotion and support for seedling supply and establishment but considered permanent, as role will fill other administrative demands when processing plant is operating.
Biomass Supply[37]	Harvesting	2	Chippers
	Biomass transport	6	Truck drivers
Biomass Processing[38]	Operation and Maintenance of IWP	16	On site at IWP
TOTAL		**25 jobs**	

[37] MacGill et. al. 2002
[38] Enecon 2001

4.3.2 Indirect Jobs

Resource development and processing industries have a wider impact on regional employment than the people directly employed. Service and support for these industries and the people they employ creates further employment. The number of indirect jobs created varies for different industries and types of economic activity. The multiplier factors used in this analysis are taken from Clements and Ye (1995), *A New Input-Output Table for Western Australia*. A number of multiplier factors are used, reflecting the different activities within the oil mallee processing industry, which does not correspond to standard industry definitions.

Indirect Jobs Temporarily Dependent on IWP

Temporary jobs reported as job years in the previous section are multiplied by the Clements and Ye (1995) factor that most closely represented the activity. Jobs created in developing the oil mallee biomass resources are multiplied by the "Forestry and Logging" industry factor. IWP construction jobs are multiplied by the "Construction Industry" multiplier. Manufacturing jobs are quoted from MacGill et. al. (2002). 347 indirect jobs arise from temporary jobs created by the construction of a 5MW IWP at Narrogin and the development of a mallee biomass resource to supply it, as summarised in Table 5.

Table 5 Indirect Jobs Temporarily Dependent on IWP

Activity	Direct Job Years	Multiplier	Indirect Job Years
Biomass resource development	85.6	1.96[39]	167.8
Plant construction	13.5	2.93[40]	39.5
Manufacturing			140[41]
TOTAL			**347.3 job years**

Indirect Jobs Permanently Dependent on IWP

Permanent jobs arising indirectly from jobs dependent on a 5MW IWP at Narrogin are also calculated using a variety of employment multipliers from Clements and Ye (1995). Indirect jobs arising from the Oil Mallee Association Region Manager's role was multiplied by the "Business Services" factor. The "Services to Agriculture" multiplier was used to calculate indirect jobs arising from harvesting and transporting mallee biomass to the IWP. Permanent jobs at the IWP were multiplied by the "Electricity gas" factor. The permanent, indirect employment created by a 5MW IWP at Narrogin are summarised in Table 6.

Table 6 Indirect Jobs Permanently Dependent on IWP

Activity	Direct Jobs	Multiplier	Indirect Jobs
Region manager	1	2.15[42]	2.1
Harvesting and transport	8	1.61[43]	12.9
Plant operation	16	3.01[44]	48.2
TOTAL			**63.2 jobs**

[39] Clements and Ye 1995. Forestry and logging industry
[40] Clements and Ye 1995. Construction
[41] MacGill et al (2002) calculate Australian construction and manufacturing jobs arising from the capital investment in the IWP based on an estimate of $200K/job year.
[42] Clements and Ye 1995. Business services
[43] Clements and Ye 1995. Services to agriculture
[44] Clements and Ye 1995. Electricity gas

4.3.3 Total Jobs

Construction and operation of a 5MW IWP at Narrogin and the development and harvesting of the mallee biomass resource to supply it will create permanent and temporary jobs within the Great Southern Region of Western Australia as well as in other parts of the country. In addition to jobs created directly in the oil mallee industry, a number of jobs will be created indirectly as a result of the economic activity that industry generates throughout the economy. 88 Permanent jobs and 447 temporary job years could be created in Australia by a 5 MW IWP at Narrogin are summarised in Table 7.

Table 7 Total Jobs from 5MW IWP

	Temporary Job Years	Permanent Jobs
Direct Jobs in Great Southern Region	347	25
Indirect Jobs in Australia	100	63
Total Australian Jobs	**447 Temporary Job Years**	**88 Permanent Jobs**

4.4 Non-quantified Benefits and Costs

While jobs and income are the most easily quantified benefits arising from a 5MW IWP at Narrogin there are a number of other benefits. Many of these relate to the potential of the oil mallee industry as an example of sustainable development and are connected to issues highlighted in chapter 2 of this report.

Carbon Credits

Carbon credits are a potential income stream from the planting of oil mallees to feed a 5MW IWP that cannot be reliably quantified within the scope of this report. Under the Kyoto Protocol to the United Nations Framework Convention on Climate Change trading carbon emission and sequestration credits is a central mechanism to help developed countries reach their emission reduction targets. Negotiations are continuing regarding carbon accounting systems and the eligibility of various carbon sinks. It is not certain whether oil mallees planted in rows would be considered to be Kyoto compliant forests. The Kyoto Protocol remains to be ratified by the required number of countries for it to come into force as a legally binding international treaty. Australia remains party to the Kyoto protocol although it is unlikely that Australia will ratify the treaty.

In the event that the Kyoto Protocol comes into effect, whether or not Australia ratifies it, uncertainty remains about how a market in carbon credits would operate internationally and within Australia. It is therefore difficult to predict possible prices for carbon credits although estimates vary from $5 to $191 per tonne of carbon dioxide[45]. Estimates of accounting for carbon sequestered by oil mallees planted to feed a 5MW IWP require projections of the age of the mallees during the first commitment period of the protocol (2008 – 2012). The age of these mallees will depend on the starting date for the IWP and the level of existing plantings that will feed the plant. The calculation of carbon credits associated with plantings for the 5MW IWP would require many assumptions, which are beyond the scope of this report to make with any validity or reliability. The level of uncertainty associated estimating income from carbon credits for the 5MW IWP precludes the quantification of this potential benefit at this stage.

Land Conservation and Biodiversity

Oil mallees planted to supply the IWP at Narrogin will have direct benefits in land conservation in the areas where they are planted as well as costs in terms of lost production. While there remains uncertainty in estimating the extent to which oil mallees reduce ground water tables, hence salinity, growers who have planted large numbers mallees based on a alley farming configuration have reported a number of benefits to their farming system. Oil mallees reduce water tables where they are planted and consume rainfall and ground water throughout the year. Mallees planted in rows reduce wind erosion by acting as wind breaks and consuming or modifying surface water runoff. Other benefits reported by farmers who have planted large numbers of oil mallees include improved aesthetics and stock shelter provision

However tree breaks also reduce crop yields and thereby reduce gross margins in all but a few cases[46]. These effects have not been taken into account in Section 4.1 above, as the results have only recently come to hand. Sudmeyer reports that yield reductions are highest in barley and wheat, whereas lupins derive most benefits from windbreaks, with canola and faba beans yielding intermediate results.

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[45] Australian Greenhouse Office 1999

[46] Sudmeyer 2002, personal communication

Oil mallees can also be planted to provide benefits to local biodiversity. In addition to improving the biological diversity of the agricultural system mallees have been planted to link remnant vegetation and provide corridors for native wildlife. If mallees are planted in large enough numbers over a catchment they may also have a significant enough impact on local hydrology to reduce the threat of salinity to remnant vegetation in valley floors. However, depending on the soil type, the area required to be planted to arrest salinity impacts on valley floors and downstream assets may be as high as ninety percent of the catchment[47].

Community Capacity Building

The oil mallee industry has developed with strong grower and community involvement and support. The strong local input into the industry improves local community capacity and helps maximise local benefit and control of the emerging industry. Community members, growers, investors, government and owners working together to construct, supply and operate a 5MW IWP at Narrogin are able to build on their relationships and knowledge to the further improvement of their region.

Industry Pioneer

The IWP at Narrogin is a pioneering development in integrated processing of mallees. The lessons learned and the experience gained at Narrogin will help in future proposals for oil mallee processing at a centralised facility for multiple products. If the IWP is successful at Narrogin other plants may be constructed in other parts of the Western Australian wheatbelt[48]. In addition to the expansion of the IWP technology proposals using other processing technology may also benefit from the administrative, legislative and commercial frameworks set up for the IWP at Narrogin. The commercial success of the Oil Mallee Project, to be demonstrated by the IWP at Narrogin, will also provide a pathway to be followed in the commercialisation of other native, perennial crops. Lessons learned and frameworks developed for the IWP at Narrogin will be of benefit to other regions proposing to construct an IWP, other proposals for integrated processing of oil mallees and other new industries based on native perennial species.

[47] Mauger et al (2001)
[48] Chegwidden et al 2000

5 Distribution of Benefits

The owner, landholder, regional and national benefits that could flow from the development of a 5 MW IWP at Narrogin are set out in Table 8.

Table 8 Quantification of benefits

	Details	Benefit	Notes
Owner	Net Present Value	$7.78 M	Does not include $4.83M possible revenue from Renewable Energy Credits
Landholders	Net Present Value	$6.16 M	Net benefit compared with existing land use
Region	Capital Expenditure	$5.68 M	20% of Owner CAPEX[49]
	Annual Expenditure	$3.00 M	Feed Costs[50]
	Temporary Job Years	100	Direct Jobs
	Permanent Jobs	25	Direct Jobs[51]
Nation	Capital Expenditure	$25.55 M	90% of Owner CAPEX[52]
	Net Annual Income	$17.27 M	Export income and import replacement
	Annual Expenditure	$7.89	100% of Owner CAPEX
	Temporary Job Years	447	Total Jobs
	Permanent Jobs	88	Total Jobs

[49] MacGill et. al. 2002

[50] This is a conservative estimate which includes only the operating expenditure spent on feedstock, including both the price of the biomass paid to the growers and the cost of transport and harvesting paid to local contractors. $1.5million of this expenditure is also reflected in the grower NPV as the amount paid for the biomass feedstock. Other expenditure on goods, services and charges will be spent in the region however the total proportion of operating expenditure in the region cannot be accurately estimated from the available data. Operating expenditure on employment is counted as jobs rather than expenditure in the region.

[51] Jobs created in the region contribute $1.06M to annual operating expenditure for the IWP.

[52] MacGill et. al. 2002

6 Conclusions

The Oil Mallee Project has been promoted for over a decade as a potentially commercial tree crop to help address land degradation in the lower rainfall areas of the Western Australian wheatbelt. The proposal to build an IWP at Narrogin using oil mallee biomass feedstock represents a significant milestone in the development of an oil mallee industry. This industry could bring many benefits to regional Western Australia and provides an outstanding case study of sustainable regional development.

This report shows that a 5MW IWP at Narrogin would provide significant economic benefits, both income and employment, to the Great Southern Region and to the Western Australian economy. The Western Australian economy and society benefit from the provision of renewable energy from the IWP. In an era of enhanced Greenhouse effect and reducing reserves of fossil fuels the transition to renewable sources of energy is a major challenge facing all developed economies. Federal government legislation provides incentives for electricity retailers to supply additional renewable energy and the IWP owners could benefit from the sale of renewable energy credits established under this legislation.

Landholders, regional communities and Western Australian society benefit from reduced land degradation and other benefits of returning native perennial species into the agricultural landscape. These species require minimal chemical input and thrive under local conditions. Landholders also benefit from reduced erosion, reduced salinity threat and stock shelter. Incorporating mallees into existing enterprises improves the biological diversity of the farming system and can help protect remnant local biodiversity by providing corridors for wildlife and conserving land surrounding remnant vegetation.

A strong commercial incentive has underpinned the development of the Oil Mallee Project and may be realised in the success of the IWP at Narrogin. The focus on commercial viability was driven by the recognition that the scale of change required to prevent further environmental harm can only be achieved by integrating deep rooted perennial species as commercial crops in farming enterprises. The recognition of the need for systemic change to prevent environmental harm and enhance communities, while maintaining economic viability is a core issue in the transition to sustainability. The development of the 5MW IWP at Narrogin could provide a pioneering example of achieving this transition. The frameworks developed and the experience gained from developing the IWP would be of relevance to further proposals for processing oil mallees, other new industries based on native perennial species and more broadly in the wider transition to a sustainable economy and society.

The commercial success of the 5MW IWP could bring a wide range of benefits to the region, most notably additional employment. The development of a new agricultural industry based on native species and the provision of renewable energy and natural products for industrial use leads to a wide array of economic, ecological, social and cultural benefits to Western Australia. As the state moves to address the threat of dryland salinity, the requirement for greenhouse gas abatement and the need for regional economic development within a framework of sustainable development the Oil Mallee Project stands out as pioneer in the transition to a sustainable economy and society.

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