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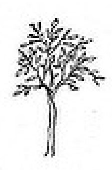
Seeing the Forest for the Trees – Australian Forest Biomass for Energy

An Investigation of Understanding, Acceptance, Trust & Legitimacy

Kai Ulrik



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"Minds are like parachutes, they work best when open" - *Thomas R. Dewar*

Abstract

Forest biomass used in bioenergy systems, is a proven, large scale, cost-effective and growing renewable energy source in numerous countries. In Australia, the technical potential and environmental benefits of forest biomass for energy purposes are evident to many social and market actors, yet implementation is minimal. This work investigates a number of the underlying factors for the low implementation of forest derived bioenergy.

This paper works from a point of departure that bioenergy from forests has potential for economic, social and environmental merit, and that a major constraint is a lack of understanding and acceptance among important stakeholders. The analysis focuses on the views and attitudes towards utilising forest biomass for energy purposes in Australia - aiming to seek clarity into why forest biomass energy is not utilised in Australia; as it is internationally. This research seeks insights into why it is constrained, and how it can develop the legitimacy it needs if it is to contribute to Australia's renewable energy mix. It considers an analysis of stakeholder salience and works within the institutional theory to explore the importance of stakeholder legitimacy in forest biomass for energy.

Findings indicate that implementing forest biomass for energy purposes in Australia has been overshadowed by disputes regarding Australian 'native forests' - which has damaged social acceptance of forest biomass and discredited bioenergy in Australia. This thesis concludes with tentative recommendations directed at developing greater understanding of forest biomass through product differentiation of bioenergy forms, and integrating regional forest biomass for energy applications to enhance social acceptance and a community licence for forest biomass use in Australia.

Keywords: Forest biomass, Wood waste, Harvest residue, Legitimacy, Social Acceptance

Executive Summary

The thirst of the human population for energy is ever increasing. The continual trend of extracting, processing and burning fossil fuels to quench the globe's energy demand has resulted in an increase in the generation of Greenhouse gas emissions (GHG), which in turn contribute to climate change. Renewable energy technology has been identified to be part of the solution for lowering GHG emissions from the energy system while still satisfying the global demand - six renewable energy technologies have been identified by the IPCC as viable energy services which include wind power, solar energy, geothermal, hydropower, marine energy and bioenergy.

From an Australian perspective, Australia contributes approximately 1.5 per cent of the global GHG emissions and yet is one of the highest per capita emitters in the world. Australia has an abundance of coal and natural gas resources, with approximately three quarters of Australia's electricity produced from coal-fired thermal generation. In a bid to contribute to a global strategy in reducing climate change, Australia extended its national renewable energy target in 2009 which aims to achieve 20 per cent renewable energy by 2020 and transition away from the current reliance on coal. In accordance with the IPCC, Australia currently implements six renewable energy sources; of which solar PV and wind are receiving the greatest attention, support and investment. Bioenergy in Australia involves utilising woody wastes such as forest residues, agricultural industry wastes such as bagasse, along with biogas production from sewage and landfill. In 2011 bioenergy contributed around one tenth of Australian renewable electricity generation, however contributed three quarters to Australia's total renewable energy supply when taking into account heat and transport fuels.

This investigation focuses specifically upon one aspect of bioenergy - forest biomass. Forest biomass involves utilisation of woody wastes, also known as residues, from forest harvest operations and mill wastes from logging and timber processes; a form of bioenergy which is ingrained in numerous European Union (EU) countries' renewable energy mix. Australia contains 4 per cent of the world's forests, which covers almost a fifth of the country's landmass. Australia has a unique natural environment, with diverse native forests and unique biodiversity found nowhere else on the globe. Australian commercial forestry dates back to the 1800's and today forest harvest for timber products and woodchip takes place in both plantations and selected areas of so called 'sustainably managed' native forests. Forest biomass is derived from Australian forestry operations, which encompass the collection, transport and processing of forest harvest residues and mill wastes such as saw dust and shavings. Forest biomass is a form of bioenergy where the technical and market potential, along with the environmental and social benefits, has been documented by bioenergy proponents and forestry associations alike – woody biomass' potential to provide a transition fuel which fits to Australia's existing energy infrastructure with the ability for co-firing is a key driving force. However, forest biomass for energy contributing to Australia's future renewable energy mix to-date has received little support or attention from the federal government, or the Clean Energy Councils 'Clean Energy Australia 2011 outlook'.

This is a story of two sides, two environmental issues at stake, and two valid perspectives. On one side of the net there are the Australian Greens Party, numerous Non-Government Organisations (NGOs) and campaigners for native forests – this stakeholder group perceives Australian native forests to be threatened, or at risk, from the Australian forestry industry and have fought for decades to increase the area of conservation reserves and to halt harvest operations in the countries 'natural forests', known as native forests. On the surface, it appears that this group perceives that the importance of protecting Australia's native forests far outweighs utilising forest biomass for energy as it has the potential to encourage and prolong the forestry operations in native Australian forests. These stakeholders centre their focus on

alternative renewable energy sources which can contribute to Australian renewable energy mix, namely solar and wind technologies. On the other side of the net is a group of stakeholders that support the emergence of forest biomass for energy - this group is a mix of bioenergy proponents and Australia forestry industry actors. They support optimising resource efficiencies from current Australian forestry operations. The technical and market potential of utilising the by-products, or residues, from Australian forestry operations for energy purposes have been well documented by bioenergy proponents (Bioenergy Australia and World Bioenergy Association members), government departments (Rural Industries Research and Development Corporation), industry associations (Clean Energy Council) and forestry bodies (Australian Forest Product Association) indicating significant potential of forest biomass to provide electricity, heat and transport fuels. Such potential of Australian forest biomass energy, along with the examples of international implementation of forest biomass for energy purposes, provides the point of departure for this research.

Aim & Research question:

The expression 'can't see the forest for the trees' can be interpreted as getting caught up in the fine detail, and failing to understand the bigger picture. The objective of this investigation is to seek clarity (understand the bigger picture), into the views and attitudes towards forest biomass for energy purposes in Australia, identifying the key stakeholders involved in both driving, and constraining the renewable energy source. The focus question proposed in this paper is '*How can forest biomass energy develop sufficient legitimacy to allow it to contribute to Australia's future renewable energy mix?'* In an attempt to answer this question three tasks were designed to assist in navigating the research and data collection process.

Research Design & Methodology

In regards to research design, a problem statement, goal, focus questions and subtasks were established early in the research process to guide the data gathering procedure. A literature analysis was a vital aspect of research in order to understand the broad background context of forest biomass, this involved pursuing the native forest conflicts, historical and current forestry operations in Australia, renewable energy policy in Australia and commercial forest biomass cases. Once a foundation was established, then a process of work based within the institutional theory was carried out, such work was supported by Aldrich and Fiol (1994) and examined the emergence of new industries providing a theoretical lens to perceive aspects of legitimacy, understanding, acceptance and trust, which are themes that run throughout the paper. Following actions involved identifying key stakeholders and performing interviews in Melbourne, Australia which was key to building a transparent and accurate research paper. Whilst triangulation was fundamental to the research methodology, gaining input from all stakeholder angles was a challenge due to the sensitivity of the topic. The analytical framework provides a platform to identify stakeholder salience within the Australian forest biomass sector and Australian forestry sectors which was based on Agle, Mitchell, and Wood (1997).

Findings & Analysis

As identified in the literature analysis and findings, the fundamental constraining factor of forest biomass lies with the historical distrust which has arisen from the native forest conflicts between forest conservationists (including the Australian Greens Party and numerous environmental NGOs) and the Australian forestry industry. The source of this distrust sprouts from the Australian forestry industry's historical clear-felling operations in Australian native forests and the emergence of the native forest woodchip export market - the Australian Greens and supporting environmental NGOs perceive forest biomass as a threat to Australian native forests, and hence have taken a strong stance to oppose and discredit any operations related to supporting native forestry.

The Australian Greens Party and environmental NGOs have successfully captured the hearts and support of urban Australia surrounding the protection Australia's native forests – even though many native forests have hosted forestry for over a century. The Greens have gained increasing political and social support over the past decade which has provided increased publicity, exposure and reputation – such support has resulted in enhanced power to influence their supporters' awareness and understanding regarding key policy objectives; such as bringing a halt to native forestry in Australia. In a bid to disallow the Australian forestry industry from utilising native forest residues, the Greens and NGOs campaigned to discredit any use for all forms of forest biomass. This campaigning was highly emotive, yet was effective in influencing social understanding, awareness and reputation of forest biomass – discrediting bioenergy, and all forms of forest biomass use in the process. Whilst campaigning by the Australian Greens was emotive, and in some cases appeared to lack a technical argument against forest biomass energy, the element of socio-political legitimacy obtained by the Greens through reputation and trust from its supporters, contributed heavily to the social awareness and lack of acceptance of forest biomass for energy.

Despite the stance above, results indicate that the Greens and numerous NGOs do accept forest biomass if it is sourced from sustainably managed plantation or farm forestry residues, however the ability to differentiate support for plantation residues and native forest residues is 'politically impossible'. Therefore it appears that the Greens and NGOs see the protection of native forests as more of a priority than assisting the emergence of 'certain aspects' of forest biomass. It is clear that the NGOs and Greens will not support any operations involved with native forestry and will continue to discredit any future attempts to utilise native residues – therefore for an energy sector based on forest biomass to emerge, native forestry must remain out of the equation.

Bioenergy proponents and the Australian forestry industry that support the emergence of the forest biomass for energy sector have struggled to gain attention, acceptance and support. Findings and Analysis suggest there are two key reasons for why the potential of forest biomass has not been mobilized. The first reason is the Australian forestry sectors insistent backing for utilising native forest residues for forest biomass, along with past disputes with the Australian Greens and NGOs – this has resulted in the Greens and NGOs not supporting any operations which involved native forestry. The historical reputation of the forestry sector which has been forged by the Australian Greens and environmental NGOs during the native forest conflicts has ingrained a distrust and doubt in operations the forestry sector is involved in. The second reason involves the exposure, reputation and general awareness of 'Bioenergy Australia' – a government, industry and research information forum, which has the ability to spread knowledge, understanding and awareness about the numerous forms of bioenergy, along with communicating and pushing the bioenergy agenda to key industry associations such as the clean energy council. Whilst Bioenergy Australia provides strong technical and market cases, the forum appear to lack the power to influence the federal government agency in supporting the bioenergy agenda, and also appears to lack legitimate exposure compared to the Greens.

The Australian Greens have a hard-line stance on native forest with a key focus on native forests protection - forest biomass for energy is simply not a priority. The forestry industry won't admit to their past aggressive native forestry operations or the development a full scale woodchip market from native forest wastes, and will not accept that native forest residues is an ineligible renewable energy source. The ingrained distrust between the two sides has led to neither side budging on policy, overshadowing and slowing the case for forest biomass for energy purposes in Australia.

Conclusions & Recommendations:

The work in this thesis project has provided evidence that forest biomass for energy purposes in Australia has clear environmental and social benefits and can provide a meaningful contribution to the Australian renewable energy mix alongside solar and wind. However, this debate has been overshadowed by the disputes over utilising native forest waste. This issue appears to have discredited bioenergy and damaged social acceptance. For a forest biomass for energy sector to emerge in Australia, the analysis indicates that focus must shift significantly away from native forest residues; then it can begin to take some meaningful steps forwards. A shift in Australia's public perception needs to occur - to slowly build up the necessary trust that Australia can still protect the Australian "bush" by using forest biomass for energy purposes. This requires working with local and regional communities to build gradual understanding, acceptance and trust of forest biomass for energy.

Key recommendations are twofold: Bioenergy proponents such as Bioenergy Australia and the CEC need to work to develop cognitive legitimacy in terms of improving environmental literacy, knowledge and understanding of bioenergy. This can be achieve via product differentiation of bioenergy, enhancing knowledge of different bioenergy technologies and making a clear divide from native forestry involvement. Secondly, integrating small and medium scale, robust, regional forest biomass applications where wood waste feedstocks are readily available and economically viable. A regional approach for forest biomass can be supplemented by other forms of bioenergy, such as agricultural wastes and gradual integration of farm forestry. By utilising numerous international examples of regional forest biomass integration, there is an opportunity to develop a community licence and socio-political legitimacy through enhanced awareness, trust and reliability. Once the sector establishes its credentials and demonstrates its benefits, there may be avenues to expand – however the first step is to introduce robust regional operations, show forest biomass for energy is not destructive, and prove its benefits.

"It's not that you can't see the forest from the trees, you've never been out in the woods alone." - Ben Folds

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Abbreviations

ABARES: Australian Bureau of Agriculture, Resource Economics and Sciences

ABS: Australian Bureau of Statistics

ACF: Australian Conservation Foundation

AFPA: Australian Forest Products Association (merger of A3P & NAFI)

ANE: Australian New Energy

A3P: Australian Plantations Products and Paper Industry Council

BIGCC: Biomass Integrated Gasification Combined Cycle

BZE: Beyond Zero Emissions

BREAZE: Ballarat Renewable Energy & Zero Emissions

CCS: Carbon Capture and Storage

CEC: Clean Energy Council

CFBC: Circulating Fluidized Bed Combustion

CFMEU: Construction, Forestry, Mining & Energy Union

CHAF: Central Highlands Agribusiness Forum

CO_2: Carbon Dioxide

CSP: Centralized Solar Power

DBF: Denisfied Biomass Fuel

DPI: Department of Primary Industries

NSW: New South Wales

FFI CRC: Future Farm Industries Cooperative Research Centre

FSC: Forestry stewardship council

GHG: Greenhouse Gas

GWP: Global Warming Potential

HHV: High Heating Value

IEA: International Energy Agency

IFA: Institute of Foresters Australia

IPCC: Intergovernmental Panel for Climate Change

LRET: Large Scale Renewable Energy Target

LULUCF: Land Use, Land Use Change and Forestry

M^3e: Cubic Meters Equivalent

MC: Moisture content

MRET: Mandatory Renewable Energy Target

MPCCC: Multi party climate change committee

MSW: Municipal solid waste

NAFI: National Associations of Forestry Industries

NFI: National Forest Inventory (Australia)

PFT: Pellet Fires Tasmania

PPM: Parts Per Million

RE: Renewable Energy

RED: Renewable Energy Directive

RET: Renewable Energy Target

RFA: Regional Forestry Agreement

RIRDC: Rural Industries research and development Corporation

SEFE: South Eastern Fibre Exports

SRES: Small Scale Renewable Energy Target

TWS: The Wilderness Society

UNEP: United Nations Environmental Program

UNESCO: United Nations Educational, Scientific and Cultural Organisation

UNFCCC: United Nations Framework Convention for Climate Change

WAN: Wimmera agroforestry network

WBA: World Bioenergy Association

WMO: World Meteorological Organisation

WWF: World Wildlife Fund

1 Introduction

1.1 Background

Since the Industrial revolution the human population has had an ever increasing thirst for energy. Rising population levels, the pursuit of enhanced living standards and expanding industrial activity have fuelled the demand for energy which has been provided predominately by fossil fuels (Dow & Downing, 2007; Edenhofer et al., 2011; Flannery, 2007). The continual trend of extracting, processing and burning fossil fuels to provide energy for growing economies, to produce food for the increasing population and the manufacturing of new products from synthetic materials has led to a dramatic increase in the generation of Greenhouse gases emissions (Hartmann, 2004). There is general consensus in the climate science community that mankind has been contributing to accelerated global warming and this is indicated by the IPCC fourth assessment report in 2007 claiming "*most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increased in anthropogenic greenhouse gas concentrations" (IPCC, 2007, p. 10)*. In a bid to transition towards a low emission future, Edenhofer et al. (2011) claims that renewable energy is one of numerous options for lowering GHG emissions from the energy system while still satisfying the global demand for energy services. According to Edenhofer et al. (2011) and supported by CEC (2011a), in 2011 the IPCC stated that there are six key viable renewable energy technologies which include biomass, solar, geothermal, hydraulic, marine and wind energy and will be decisive in combating climate change[1].

The debate on reducing carbon emissions in Australia has been a major item within domestic and international political debate for the best part of a decade. Australia has a heavy reliance on coal-fired thermal generation, which dominates the current national energy mix and contributes to Greenhouse Gas emissions (GHG). Australia's energy system is built around its extremely large resources of coal of all qualities – it is estimated that Australia obtains 10.3 per cent of the world's black coal and almost 9 per cent of the world's lignite (BREE, 2012a). According to BREE (2012b), in 2009/10 75 per cent of Australia's electricity was produced using coal. Whilst renewable energy technologies have increased in significance in Australia and abroad, the understanding and acceptance of different alternative energy sources vary amongst the Australian public depending on the complexity of the technology (CEC, 2008). Renewable energy targets in the EU, and more gradually in Asia and Australia, have been the catalyst to increasing investment and integration of such renewable alternatives.

Bioenergy is one of the six viable renewable technologies identified by the IPCC and CEC. Bioenergy is used as an umbrella term for numerous feedstock's and technologies to produce 'energy carriers' that originate from organic material (CEC, 2010). According to the IPCC bioenergy is currently the most prolific renewable energy source in the world (Edenhofer et al., 2011); however bioenergy encompasses numerous forms – each form with differing environmental, social and economic footprints – and their relative merit as a legitimate renewable energy source are perceived differently by different stakeholders (Bucholz, Ramesteiner, Volk, & Luzadis, 2009). One form of bioenergy is biomass sourced from forest wastes or residues – referred to throughout this paper as 'forest biomass'. Solid biomass sourced from forest harvest residue and forestry mill wastes has been used as a fuel for

[1] Appendix 8.1 provides a further insight into the challenges of climate change, the role of renewable energy in transitioning to a low emission future and global climate change policy.

stationary electricity and heat purposes in numerous countries, particularly in the EU, for decades. Heavily forested countries such as Sweden and Finland rely on forest on forest bioenergy for significant portions of their national energy mix. As stated by the President of the World bioenergy association, in 2009 Sweden produced 28 per cent of their end-use energy from bioenergy (Knox, 2009) - according to Swedish Energy Agency figures this contribution rose to approximately 30 per cent bioenergy in 2011 (S.E.A., 2011a). Finland and Sweden produce the highest per capita electricity production from biofuels and waste in the world (S.E.A., 2011b). Whilst Finland and Sweden provide relevant best-case examples in forest biomass for energy, the scale and operation of forestry sectors in Australia and such Scandinavian countries differ significantly. However, Australia's corresponding forest resources provide substantial quantities of lumber, of which harvest residues are available.

Forest biomass can be defined by primary and secondary sources. The extractions of forest harvest residues rely on a robust, large scale forestry industry and include primary sources from forest thinning's, post-harvest treetops and branches and reject quality forest timbers. Secondary sources involve wastes and residues from sawmills such as saw dust, bark and shavings (Johansson & Salonen, 2008). Forest biomass is a proven renewable energy source in the EU, North America and is gaining momentum in both Japan and South Korea (Junginger et al., 2011). According to numerous sources; Johansson and Salonen (2008); Ximenes et al. (2012), forest biomass is recognised as a renewable energy source and is primarily employed to provide stationary electricity, thermal heat for industrial applications and domestic heating. As a country with significant forest resources located in distinct, relatively concentrated areas, analysts consider the utilisation of forest fuels as a valid strategy for assisting Australia to shift towards a wider, more diverse renewable energy mix (CEC, 2011b; Lang, personal communications, 20th June 2012; Peck, Berndes, & Hector, 2011)

Forest biomass for energy has emerged as a renewable energy source that can readily be derived from existing Australian forestry activities and be utilised in numerous forms, such as co-firing in existing thermal infrastructure, nevertheless the complication comes in the form of which forest types are utilised and what constitutes a residue[2]. Evidence is growing that the understanding and acceptance of forest biomass as a realistic future renewable energy source in Australia is limited (CEC, 2011b; Wickham, personal communication, 7th August 2012). Indeed, the lack of legitimacy of such forest biomass activities is already posing as a significant constraint to the industries advancement, along with social and political discourse in addressing the option (Lang, personal communication, June 20th 2012; Moroni, personal communication, 25th July 2012).

A fundamental and underlying challenge for the emergence of a forest biomass sector is held to stem from Australia's long term distrust between the proponents for the protection and conservation of Australia's unique native forests on one side, and the Australian logging industry on the other – referred to by Ajani (2011) as Australia's 'native forest conflicts' (Whitehead, personal communication, 24th July 2012). The Australian logging industry has been accused of showing scant respect for Australia's unique natural forest resources over a period of many decades, with logging conflict in areas such as Tasmania's old growth forests gaining both national and international attention (Flanagan, 2007). Moreover, there is broad scientific census both in geological and biodiversity circles that Australia is an incredibly sensitive continent susceptible to ecosystem degradation (ABS, 2010b). Added to these

[2] Waste Forest Biomass for value adding as an energy carrier can be derived from numerous forest types that undergo harvest operations (such as native forest, plantation, imported timber) (Johansson & Salonen, 2008). Native forest residues are not eligible as renewable energy in Australia.

concerns, ABARES (2011) indicates that since European settlement the continent has lost a substantial amount of vegetation to forestry and agriculture. ABS (2010b) claims that cleared native forest includes 34 per cent of rainforest, and 31 per cent of Eucalyptus open forest and woodlands. As such, there is a broad social position that Australia has had, and still has an unsustainable forest industry. The assertive stance taken by numerous environmental NGOs and the Australian Greens Party, and the apparent widespread acceptance of 'green' anti-forestry position in Australia are related to such historical native forest disputes.

Resource economist Judith Ajani explains that the definition of a 'forest' in Australia is interpreted differently by various stakeholders - "To environmentalists, "forest" means native forests – self-regenerating ecosystems. To the forestry industry, forests are both native forests and plantations (agricultural crops)" (Ajani, 2011 p1).

Australia sources its timber and wood products from numerous forest types[3] including native forests managed under regulated 'regional forest agreements' (RFA), an expanding plantation timber sector along with imported products. As stated by DAFF (2012) in 2010 some 26 per cent of harvested logs in Australia were sourced from native forests[4] with plantations providing 74 per cent of the 25.6 million cubic meters of harvested logs - *"the volume of logs harvested from plantations has increased by about 42 per cent in the past decade, while the volume harvested from native forests decreased by 44 per cent" (ABARES, 2011, p. 48).* The Australian logging industry supplies numerous industries with timber including construction, furniture, flooring, pulp and paper, wood chip export and wood product export (ABARES, 2011). As a by-product from these operations, primary and secondary forest residues have been recognised as a potential biomass feedstock for renewable energy generation, eligible for claiming subsidies in the form of renewable energy certificates (RECs)[5]. As stated by Hoy (2010), in the past RECs could be issued for all forest logging operations, including native forest timber harvest, as long as it was a by-product of a higher value use. The leader of the Australian Greens Party Christine Milne stated this was a massive loophole, with environmental campaigners and the Australian Greens Party immediately acting to disallow the native forest logging industry from gaining RECs subsidies (Hoy, 2010).

Campaigning and policy to protect native forests, particularly so called 'old growth forests' and forests of 'high ecological' significance, from the domestic logging industry has resulted in increased area of nature conservation reserves, decreased forestry activity in native forests and increased awareness about detrimental effects that can be caused by forestry operations in native forests. There is a clear trend from both state and federal governments of reducing the availability of native forests for forestry with the first significant fiscal incentives for plantation establishment beginning in the 1960s (ABARES, 2011; Peck et al., 2011). According to DAFF (2012) there are more than two million hectares of plantation in Australia, of which 50 per cent are native hardwood species and 50 per cent are exotic softwood species. Most recently, an almost doubling of plantations since the mid-1990s was stimulated by so called 'managed investment schemes' that were introduced in the mid-1990s

[3] A forest is defined as an area *"dominated by trees having usually a single stem and a mature or potentially mature stand height exceeding 2 metres and with existing or potential crown cover of over storey strata equal to or greater than 20 per cent - This definition includes Australia's diverse native forests and plantations"* (ABARES, 2011, p. 7)

[4] Australian native forest are classified by forest types (majority Eucalypts) and structure (majority medium hieght woodlands) – 6 tenure categories of land/forest ownership exist in Australia which include nature conservation reserves (15 per cent of native forest area) and multiple use forests (6 per cent of all forest area and avaiable for timber harvest). Private and leasehold forest make up 70 per cent of all native forest tenure (ABARES, 2011).

[5] RECs: Australian Renewable Energy Certificates are a subsidy available for all accepted renewable energy sources.

and early 2000s. These schemes had an explicit aim to reduce Australia's timber trade deficit which stands at almost $2bAud per annum (DAFF, 2012).

Early in 2012, an in-depth debate took place surrounding a tabled notice by Federal Independent MP Rob Oakeshott to disallow the Renewable Energy (Electricity) Amendment regulation 2011 (No.5) (Oakeshott, 2012). The proposed amendments aimed to exclude biomass from native forests as an eligible renewable energy resource, meaning that wood residues would no longer include products, by-products and wastes associated with the clearing or harvesting of native forests. The amendment was raised by the federal governments multi party climate change committee (MPCCC) and backed by the Australian Greens Party with support from numerous NGOs, the action by Rob Oakeshott was seen by the Australian Greens to undermine efforts to switch Australia to clean renewable energy such as solar, wind and geothermal (Hoy, 2010). Oakeshott claimed that all forest residues of existing sustainable harvests (primary residues which are currently left on the forest floor and burnt) along with secondary woody wastes could provide on-site electricity and heat for industry. Oakeshott failed in his bid to disallow the regulation and native forest residues are no longer eligible for claiming RECs, Oakeshott's point of view was supported by the CEC who claimed "*rather than a blanket exclusion of biomass from native forests under the RET, exclusion should only extend to native forest biomass that cannot be verified as sourced from sustainably managed forests" (Marsh, 2011).*

With increased forestry activity from Australia's expanding plantations and the ongoing implementation of Regional forestry agreements (RFA) monitoring forestry operations in native forests, the opportunity for using forest biomass for combustible renewable energy generation was well placed to continue growing. However, any promise of gaining value from forest biomass for energy has been overshadowed by the campaigning against the Australian logging industry, which has damaged the social acceptance of utilising any form of forestry for renewable energy generation. Whilst Lang (2011) claims there has been estimates that by 2040 plantation and native forests could provide 20 per cent of Australia's base load electricity, current political and environmental issues associated with removal and utilisation of native forest residues has ruled out short term mobilisation (Greaves & May, 2012). Nevertheless, opportunities to engage in alternative woody biomass resources, such as plantations and farm forestry remain. Greaves and May (2012) estimate that around 16 million cubic meters equivalent (M_3e) in forest biomass, excluding native forestry operations, are currently available in Australia - which is expected to increase to 28 million M_3e over the next 10-20 years. Such figures markedly exceed estimations performed by Peck et al. (2011) in 2009, calculating approximately 12 million m3e[6] in harvest residues from plantation alone, which were already projected as being of significant interest. Whilst the current short term outlook for Australia to use its forest waste resources as a part of the renewable energy strategy currently appears bleak, technical merits along with policy uncertainty[7] and market potential provide light for the emergence of a forest biomass for energy sector detached from native forest involvement.

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[6] A specific density of 500kg/m^3 has been used to convert m^3 roundwood equivalent to metric tonnes (Peck et al., 2011).

[7] Australian hung parliament since 2010 - political legitimacy of waste forest biomass for energy is key for mobilising market potential. Federal election of 2013 may lead to a shift in future policy direction towards bioenergy and specifically forest biomass for energy – Further elaborated upon in Appendix 8.2

1.2 Problem Statement

The focus of this paper centres on the views and attitudes towards the utilisation of forest-derived biomass for energy purposes. Australia has a unique natural environment, with diverse native forests ranging from Acacia, Callitris, Eucalyptus and Casuarina open forest and woodlands, Mallee shrub lands, tall Eucalyptus forests and rainforests (ABARES, 2011). Australia has a variety of bioregions with 16 natural world heritage listed sites including the wet tropics of Queensland, the blue mountains of NSW, the Stirling ranges of WA and the Tasmanian wilderness, however Australia also boasts the largest decline in biodiversity of any continent over the past 200 years (ABS, 2010b; UNESCO, 2012). Awareness of the irreplaceability, ecologically sensitivity and importance of forests to Australia's endemic biodiversity has grown over the past decades. Linked to such awareness are public perceptions of the intrinsic value regarding native forests, along with the fears that such a resource are threatened. ABARES (2011) indicates Australian forests cover 19 per cent of the landmass, nature conservation reserves represent 16 per cent of native forests, with 'multiple use native' covering 6 per cent of forest area utilised for lumber harvest and public access.

Whilst Australia has substantial forest resources both in the form of plantations and native forests, CEC (2011b); Greaves and May (2012); Wickham (2012, 7th August, personal communication) explains that utilising 'multiple use native forest biomass' has become embroiled in social and political debate. A long lasting dispute over native forest logging has largely removed social acceptance of logging activities in multiple use native forests and related operations, hence significantly slowing the advancement of the forest biomass for energy sector. Whilst the technical potential for forest biomass for energy has been well documented by Greaves and May (2012); Lang (2011); Peck et al. (2011), forest biomass also adds additional opportunities in adapting to climate change and reducing the severity of bush fires[8]. As stated by Peck (2012, 18th July, personal communications) primary harvest residues collection can play a part in controlling natural fires (build-up of forest fuel in sub-story) allied with adapting to climate change (more extreme droughts, higher temperatures and periods of very high fire risk). Although the estimated forest biomass potential has been brought to light by numerous stakeholders, mobilising this resource has been largely overlooked as a contributor to Australia's future renewable energy mix (Lang, personal communication, 20th June 2012; Wickham, personal communication, 7th August 2012).

On an international scale, the utilisation of forest biomass in the form of wood pellets for large scale, commercial purposes has been developed in numerous countries and provides an avenue for technology transfer to countries like Australia (Jonker et al., 2011). In particular, this has been championed in the EU as an easy, thermodynamically efficient, and socio-economically useful pathway; which has strong market potential and can be a very good part of the overall renewable energy mix (Peck, personal communications, 18th July 2012). Whilst the successful international implementation of forest biomass for energy can be observed in the EU, forest biomass for energy has also received criticism on the international stage such as when an European environmental NGO claimed "large biomass electricity schemes risk causing serious damage to wildlife and the climate" (Ends, 2011, p. 1). Johansson and Salonen (2008) states that in a bid to increase bioenergy usage a key challenge is how to restrict both the negative effects and socio-political concerns, that the increased demand for bioenergy may create. From an Australian perspective, forest biomass for energy emerged as a renewable energy option and was identified as an opportunity for economic diversification by the native and plantation logging industries. However, Hoy (2010) states that stakeholders

[8] South eastern Australia is one of the most fire prone ecosystems in the world (Pollard, 2012a, p. 8)

such as the Australia Greens Party and environmental NGOs, saw forest biomass for energy as a threat to native forests, a lifeline to the native forest industry and a diversion of RECs from other renewable sources such as wind and solar. Therefore, NGOs and the Greens campaigned against the use of native forest biomass for energy purposes – and were highly successful, which in turn appears to have tainted the overall social acceptance of forest biomass for energy and to an extent the reputation of Australian bioenergy in general.

Whilst the main issues have been delineated, there is much more complexity within this debate. The aim of this paper is to seek understanding and clarity into 'who' is driving the forest biomass sector forward and who are attempting to constrain it, 'how' such actors are pursuing their aims and most importantly 'why' they are doing so. The scope of this project looks specifically at the forest biomass sector in Australia, its potential to provide biomass for energy purposes, and its legitimacy as a future renewable energy source in Australia. This is a tale two separate environmental agendas; with forest conservationists and the Australian Greens Party passionate to protect Australian native forests, and bioenergy proponents along with the forestry industry providing positives aspects of forest biomass for energy. The current state of play indicates that the socio-political issues implicating native forestry with biomass have led to an apparent 'stalemate' between the Australian Greens and numerous environmental NGOs opposing the logging industry on one side, and bioenergy associations, the logging industry on the other. This has resulted in a lack of acceptance, trust and support; and hence there has been slow progress in meeting the market potential of forest biomass in Australia. However, the question remains, is this a fixed status, or does it remain dynamic?

Whilst the technical and market potential have been discussed by Greaves and May (2012); Lang (2011); Peck et al. (2011); Ximenes et al. (2012), the lack of understanding and general socio-political legitimacy of bioenergy in Australia, and specifically forest biomass for energy, has only recently begun to gather attention from influential government departments and industry groups (such as the RIRDC and CEC) in the form of workshops and surveys to engage stakeholders (Nichols, 2012). This paper identifies the drivers and barriers contributing to the lack of legitimacy and social acceptance of forest biomass sector, examines the relative merits of stakeholder arguments and provides alternate options for unlocking such technical potential. The key outcome centres in on the ability of the sector to emerge as a valid renewable energy source in light of current social and political challenges.

1.3 Focus Question

The point of departure for this thesis project is that forest biomass for energy purposes has been implemented effectively in numerous countries, and has potential to be integrated into part of the Australian renewable energy mix. The overarching question that has guided this work towards achieving the general aim listed above is '**How can forest biomass energy develop sufficient legitimacy to allow it to contribute to Australia's future renewable energy mix?** In order to answer this question, the following three tasks are identified:

Task 1: Why and how is Australian forest biomass utilisation constrained by issues of social and political acceptance?

Task 2: Who are the key stakeholders involved in determining the legitimacy and acceptance of forest biomass; as a part of the renewable energy mix in Australia?

Task 3: How and where can proponents of Australian Forest biomass for energy initially work to establish the social and political legitimacy required for the sector to emerge as a viable renewable energy source?

1.4 Method

From a personal viewpoint this application of biomass appeals to me as it embroils issues involving the renewable energy shift and natural resource efficiency with conservation values of Australia's natural environment. Whilst bioenergy, specifically forest biomass for energy, has been utilised for decades in regions such as Scandinavia and is accepted as a legitimate renewable energy source, it does not receive the same acceptance in Australia. As illustrated in the diagram on the right, the overall research project was broken down into the following activities. Preliminary research on the general topic of forest biomass for energy purposes in Australia involved consultation with IIIEE professors and identifying a research gap within the Australia biomass field. A discussion of topic focal points with IIIEE thesis supervisor provided initial direction to conduct a literature analysis on the background and trends of Australian forestry, the state of the Australian forest biomass sector and international cases of forest biomass. Literature analysis focused on triangulation and utilised a range of sources involving journals, government and industry reports, webpages and text books.

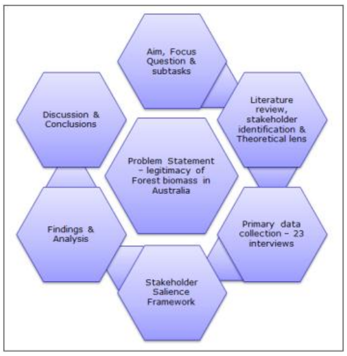

Figure 1-1 Research Design

The following phase involved topic definition with key informants, such as Australian bioenergy proponent Andrew Lang. This process involved identifying the fundamental issues more accurately, gathering a suite of names, roles and actor groups relevant to the issue, along with stakeholder and issue mapping for related items. Key themes to guide research direction and primary data collection were then established. The project is based within institutional theory that examines the emergence of new industries, institutional legitimacy is a central theme supported by Aldrich and Fiol (1994) and is an underlying theme throughout the research. The analytical framework based on stakeholder salience by Agle et al. (1997) also identifies legitimacy, along with urgency and power as key stakeholder attributes. Further aspects of legitimacy from an institutional context included Dimaggio and Powell (1983) that look into political power and institutional legitimacy, and Oliver (1991) that combines resource dependency and institutional theories to providing strategic behaviours that organisations can implement in response to pressures within the institutional environment.

Emphasis then turned to primacy data collection. Preparation for data collection included interview and question structure, the development of initial interview approach, accessing stakeholder's contact details, and appealing to stakeholders in a volatile and sensitive debate. Empirical data collection was conducted via semi-structured interviews with various stakeholders groups and was required to form the basis of the stakeholder analysis and findings – it was fundamental to capture views from both the bioenergy proponents and supporters of native forest conservation. Interviewees were provided the option to converse via meetings, phone calls or emails – a total of 23 candidates contributed to the primary data gathering process. Data Collection constraints were anticipated at the outset of the project and are detailed in section 1.5. Following interviews, documentation of interview transcripts were compiled and interviewees reviewed information to verify accuracy. The analysis incorporated the framework based on the stakeholder salience theory formulated by Agle et al. (1997). Findings were then applied through the theoretical lenses of institutional theory proposed by Aldrich and Fiol (1994); Dimaggio and Powell (1983); Oliver (1991) to identify the legitimacy issues involved in the Australian forest biomass for energy sector. Finally, sculpting the discussion involved utilising key findings to complete the stated research tasks, answering the overlying focus question and providing recommendations for the target audience.

1.5 Limitation & Scope

In regards to the research scope, findings are dependent on recent literature based on the current market and technical potential of forest biomass for energy in Australia. Discussions around liquid biofuels sourced from woody biomass are discussed briefly but are deemed outside scope. For the purpose of this paper nuclear is not considered a renewable energy alternative. From a geographical standpoint, references to Sweden, Finland and New Zealand are utilised, particularly in the context of the technical validity of forest biomass for energy purposes. Whilst the level of antipathy and distrust between two major stakeholders groups involved in native forest conflicts was well understood, the scale of protectionism of information was unforeseen. This was most obvious when contacting environmental NGOs and Industry, where each party had suspicions of the researcher's intentions. In one instance, the researcher was accused of being an industry supporter 'looking for inside information' - which made it challenging to represent all stakeholder viewpoints. Wickham (2012, 7th August, personal communication) explains that bioenergy to environmental NGOs (such as TWS & WWF) is a no go zone, do not want to know about it if it's relating to native forests.

1.6 Target Audience

This paper has several audiences. This paper targets actors within the current and potential Australian woody biomass for energy industry, energy producers, regional bioenergy associations and government department policy makers. The paper is designed to provide an insight into the opinions of Australian stakeholders involved in the forest biomass sector, highlight the drivers and barriers to the current sector and suggests possible avenues forward for meeting the potential of recognised plantation and farm based forest biomass for energy. This is not a paper against Australian environmental NGOs or the Australian Greens Party - it attempts to highlight NGOs and Greens opinions towards forest biomass for energy, and suggest avenues for the emergence of a viable and acceptable forest biomass energy sector.

1.7 Disposition

Chapter two begins with a literature analysis based on the relevant renewable energy sources which are envisaged to be part of a global low emission future. Attention centres in on bioenergy generation; specifically forest biomass for energy purposes. This section also introduces the key themes of understanding, acceptance, trust and legitimacy that underpin the work. Chapter three leads into a profile on Australia's renewable energy policy, specifically surrounding forest biomass for energy potential. Chapter four provides a case study on Australian forestry; focusing on the emerging Australian forest biomass market, divulging the historical rise of forest plantations in Australia and the conflicts of over native forests. This section outlines the industrial, political and economic status of the sector and identifying the key drivers and barriers for Australian forest biomass. Chapter five introduces the analytical framework utilised in the project and analyses the different stakeholder's perspectives towards utilising forest biomass for energy – key themes throughout this section involve identifying aspects of social acceptance, legitimacy and trust within the forest biomass for energy sector. This section also presents the empirical data collected from numerous stakeholders' interviews in the Australian biomass to energy scene. Chapter six provides a discussion surrounding the empirical data findings and summarizes the key tasks of interest in relation to the forest biomass for energy generation in Australia. Chapter six concludes by providing recommendations for gaining socio-political legitimacy in the emerging forest biomass for energy sector and project reflections.

2 Renewable Energy Solutions for a Global Low Emission Future

The point of departure for this chapter is an analysis of literature introducing the issue of climate change and international policies to tackle human induced climate change. Renewable energy alternatives are then explored with emphasis on bioenergy and specifically forest biomass for stationary energy.

2.1 The Transition towards Renewable Energy Sources

In 2011 the IPCC released the 'special report on renewable energy sources' (SRRES) which confirmed that consumption of fossil fuels account for a majority stake of global anthropogenic GHG emissions and that by 2010 CO_2 concentrations had increased 39 per cent over preindustrial levels[9] (Edenhofer et al., 2011). As suggested by Johansson and Salonen (2008), today's ultimate challenge is to create a productive economy that is independent of fossil fuels, ultimately alternative renewable energy sources are key to transitioning towards a low emission future.

Eckstein (2011) explains that the 2011 SRRES report was adopted by 194 governments and provides insight to several renewable energy scenarios. Edenhofer et al. (2011) claim that renewable energy (RE) is one of numerous options for lowering GHG emissions from the energy system while still satisfying the global demand for energy services. Edenhofer et al. (2011) continues that renewable energy (if implemented properly) can provide wider benefits than options such as fossil fuel switching or Carbon capture and storage (CCS). Additional benefits of renewable energy include contributing to social and economic development, energy access, secure energy supply, and reduced negative impacts on the environment and health.

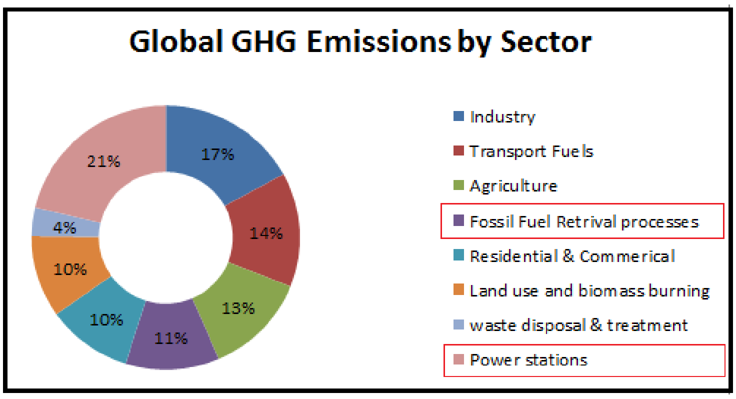

Figure 2-1 Global GHG emissions by sector 2007 – Highlights impact from Fossil fuel retrieval & power station operation for stationary energy generation (Whitaker, 2007)

As illustrated in Figure 2.1 above, the annual greenhouse gas emissions by sector is led by power station operations for electricity production. Flannery (2007) states that power plants that use coal to generate electricity are the most potent in terms of producing Greenhouse gas impact. As stated by Flannery (2007) these power plants utilise black coal or dry brown

[9] 2010 CO_2-e concentrations measured at over 390 ppm

coal and can process 500 tons of coal per hour - Eraring Power station[10] is Australia's largest electricity generating site with a capacity of 2880MW, burning 4.8 million tons of coal each year (Eraring-Energy, 2012). As illustrated in Figure 2.2 below, whilst fossil fuels are still providing the majority of total primary energy supply, advancements in alternative energy technology and investment in low emission energy substitutes have steadily been growing (Dow & Downing, 2007).

According to Eckstein (2011), in 2011 the IPCC stated that renewable energy sources including biomass, solar, geothermal, hydraulic, marine and wind energy are the key technologies and will be decisive in combating climate change. The most optimistic scenario within the recent 2011 SRREN report claims renewable energy sources could provide up to 77 per cent of global consumption by 2050, with the most pessimistic scenario set at only 15 per cent of 2050 demands (Eckstein, 2011). Although the Kyoto protocol has since lapsed, several states who had ratified the Kyoto protocol such as the European Union (EU) and Australia, have continued their commitment to reach their assigned goals of renewable energy by enforcing a domestic, binding renewable energy target. Through effective policy instruments and renewable energy visions, both the EU and Australia have committed to reducing their greenhouse gas emissions, approaching this challenge both in the form of improving efficiencies in current energy systems and also introducing renewable energy systems (European-Commision, 2012b).

The EU has been an avid supporter of harmonizing global climate change action and has been a leader in environmental policy implementation. The EU have acted on several environmental aspects which is demonstrated by both European directives such as the 2009 renewable energy directive (RED), along with being signatories in numerous multilateral environmental agreements such as the Stockholm convention (on Persistent Organic Pollutants such as dioxins) (Europa, 2012; European-Commision, 2012a). The European RED states a goal of 10 per cent transport fuel sourced from renewable energy by 2020, and 20 per cent of renewable energy by 2020 (European-Parliment, 2009). Australia upgraded the countries renewable energy target (RET) in 2009, which aims for 20 per cent of renewable energy by 2020 (DCCEE, 2010).

The EU RED and RET in Australia provides member states with the freedom to implement renewable energy technologies of their choice depending on their situation, along with encouraging technology development, information transfer between states and harmonization of the geographical region towards a common goal (European-Parliment, 2009). As stated by Sjølie and Solberg (2011, p. 1028) *"Adoption of the European Union's (EU) Renewable Energy Directive (RED), with a target of 20 per cent of overall gross energy consumption renewable by 2020, is currently one of the main driving forces for bioenergy consumption worldwide".*

[10] Eraring power station: Subcritical pulverised fuel fired power station, thermal efficiency at 36 per cent (Nunn, Cottrell, Urfer, Wibberley, & Scaife, 2002)

2.1.1 Which Renewable energy sources are in the mix?

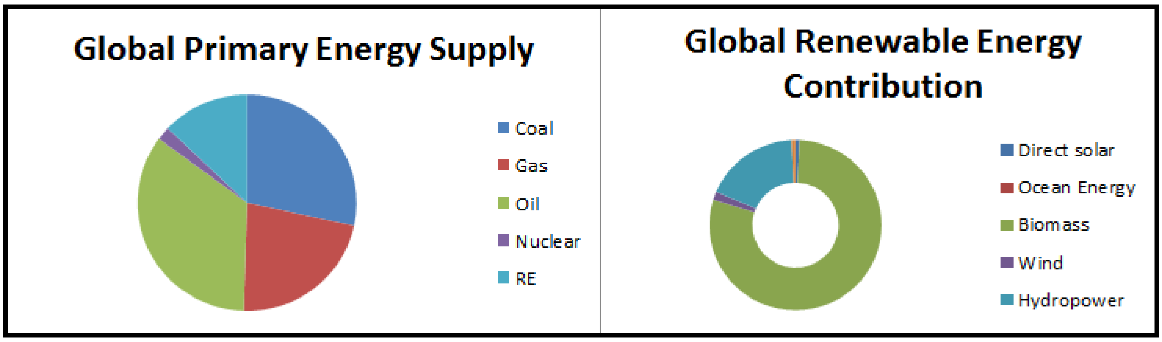

Figure 2-2 Total primary energy supply at a global scale & Renewable energy contribution (Edenhofer et al., 2011)

As stated by Eckstein (2011) and highlighted above in Figure 2.2, in 2010 renewable energy sources accounted for less than 13 per cent of global energy supply, with 85 per cent for fossil fuels (coal, oil and gas) and the remaining 2 per cent nuclear. On a global scale, 79 per cent of renewable energy is currently sourced from biomass, a further 17 per cent from hydropower and the remaining 4 per cent from direct solar, wind and geothermal. The key environmental advantage of increasing renewable energy technologies compared to energy produced from fossil fuels is the reduction in GHG emissions, providing energy of similar quality in a far less polluting fashion.

Whilst the environmental advantages of renewable energy are fairly clear, there are numerous positive and negative economic, social and political challenges which coincide with a shift to renewable energy implementation. This discussion alone would require another thesis investigation entirely, however financial viability for new technologies, current infrastructure to support fossil fuels, government subsidies for fossil fuelled energy, employment, social willingness to accept change, short term political gain over long term national interests and striving for continuous economic growth are just a few of the limiting factors for uninterrupted renewable energy integration.

Numerous renewable energy technologies have emerged globally with a continual increase in utilisation (Dow & Downing, 2007). Edenhofer et al. (2011) explains that the increased use of renewable energy technologies are due to various reasons, such as government policies, the declining cost of many renewable technologies, changes in the prices of fossil fuels and an increase of energy demand. The 2011 SRRES report by the IPCC recommends six key renewable technologies that can assist global governments in shifting towards a lower emission future with less reliance on fossil fuels (Edenhofer et al., 2011). Table 2.1 below outlines the renewable energy sources identified in the SRRES report and details global capacity and implementation.

Renewable Energy Source	Description	Global Capacity & Implementation 2010	
Direct Solar	Harness solar energy to produce electricity using: • photovoltaic (PV) • concentrating solar power (CSP) Production of thermal energy (heating or cooling via passive or active means)	• PV global capacity 40GW • PV 2010 addition 17GW • PV Global Leader: Germany	• CSP global capacity 1095MW - global leader: Spain 632MW • Solar heating global capacity 185GWth - global leader: China
Wind	Utilise kinetic energy of moving air - Production of electricity from large wind turbines located: • Land (onshore) • Sea or freshwater (offshore).	• Global capacity 198 GW • 2010 addition 38GW • Global Leader: China, USA, Germany	
Bioenergy	Umbrella term for production from a variety of energy carriers such as: • forest, agricultural and livestock residues • energy crops for liquid fuels • the organic component of municipal solid waste for biogas Directly used to produce electricity or heat, or used to create gaseous, liquid, or solid fuels.	Biomass combined heat and power (CHP) • Global capacity 62 GW • Global hot water/heating 270 GWth • Global Leaders: USA, EU (Germany, Sweden, UK), Japan & China.	Liquid Biofuels: • provided 2.7% of global road transport. • Global leader: EU
Geothermal	Accessible utilisation of thermal energy from the Earth's interior. Heat is extracted from geothermal reservoirs using wells or other means.	Geothermal power: • Global capacity 11 GW • 2010 addition 240 MW Global Leader: USA (3.1GW) & Iceland per capita (26% of all electricity)	
Marine	Potential, kinetic, thermal and chemical energy of seawater which can provide electricity, thermal energy, or potable water. Forms include: • barrages for tidal range • submarine turbines for tidal and ocean currents • heat exchangers for ocean thermal energy conversion • Harness energy of salinity gradients.	Tidal, wave, ocean: • Global capacity 520 MW • 2010 addition 6 MW (2MW wave, 4MW tidal) Global Leader: Least mature technology with Australia, Canada, France, Ireland, Japan, South Korea, India, New Zealand, Portugal, Spain, and the United States involved.	
Hydropower	Harness energy of water moving from higher to lower elevations, primarily to generate electricity which include: • dam projects with reservoirs, run-of-river & in-stream projects	• Global capacity 1010 GW • 2010 addition 30 GW • Global Leader: China, Canada & Brazil	

Table 2-1 Renewable energy technologies & global capacity 2010 (Dow & Downing, 2007; Edenhofer et al., 2011; Johansson & Salonen, 2008; REN21, 2011; Whitaker, 2007)

From a sustainability standpoint; environmental, social and economic aspects of the life cycle of a renewable energy source need to be considered equally. The environmental advantages of most renewable energy technologies over fossil fuels are relatively clear and include decreased GHG emissions from energy generation, less environmental degradation from sourcing fossil fuels and prevention of further damage to earth's life support systems from irreversible climate change. However, whilst REN21 (2011) indicates that there is strong global investment and growth in the renewable energy sector, Pollard (2012a) states that numerous alternative energy sources are at various stages along the development cycle and are still more expensive on the market (in the absence of penalties for externalities) than energy sourced from fossil fuel - therefore government subsidies are key to introducing such new technologies. Table 2.2 below outlines perceived sustainability issues relating to the six identified renewable energy sources.

Renewable Energy Source	Sustainability concerns
Direct Solar	- Solar energy is variable and unpredictable. - PV cells remain expensive; recent trend of price decreasing - Refined silicon in short supply - Perceived life time of PV cells
Wind	- Noise pollution - Health side effects - Unsightly when on-land - Wind is variable and unpredictable – electricity from wind output rarely exceeds 30% of capacity
Bioenergy	- Food VS. Fuel debate for liquid fuel production - Woody biomass fuels connected to unsustainable forest clear-felling - Combustible renewable fuel which generates GHG - Bioenergy term unclear & misunderstood - Logistics of bulky fuel is a cost barrier - Use depends on regional fuel supply & availability.
Geothermal	- Geographical dependence on earths subsurface heat - Transmission & distribution challenges
Marine	- Challenges to technology development due to issues such as corrosion, dragging of sea anchors, damage in storm weather. - Least mature renewable technology identified in table 2.2
Hydropower	- Environmental impacts of establishment & degrading ecosystems - Output subject to degree of snowmelt or annual available rainfall

Table 2-2 Sustainability profile of key Renewable energy sources (CHAF, 2009)

As stated by REN21 (2011) whilst total investment in renewable energy reached $211USD billion in 2010 (up from $160USD billion in 2009), there remain social, political, environmental, technical and economic issues which stand as barriers to future development and implementation of renewable energy technologies. Not only are there socio-economic issues embroiled in renewable energy implementation, but also competition between renewable energy sources to gain investment capital for further development and implementation. Although the renewable energy sector illustrates strong global growth (identified in Table 2.1), it is the belief of Johansson and Salonen (2008) that in the industrial society that we live in today it is not possible to run solely on renewable energy; they state that cutting demands on the earth's resources is pivotal in sustaining societies future.

2.1.2 Understanding, Acceptance, Trust and Legitimacy of renewable energy sources

A fundamental issue related to renewable technology integration is the understanding, acceptance, trust and perceived legitimacy of renewable energy sources by connected stakeholders. To investigate legitimacy issues in relation to renewable energy, and specifically forest biomass for energy in Australia, this paper closely follows an approach outlined by Aldrich and Fiol (1994). Figure 2.3 below highlights the key themes suggested by Aldrich and Fiol (1994) and focuses on legitimacy which encompasses understanding, acceptance and trust. The case for socio-political 'legitimacy' of a renewable energy source can be the key to unlocking its future potential – *"Low socio-political legitimacy is still a critical barrier to many potential business activities today" (Aldrich & Fiol, 1994, p. 661)*. If there are perceived disadvantages or negativity towards a certain renewable energy source then doubt, delay and a loss of legitimacy with key stakeholders such as policy makers, energy consumers and the wider public follows. Renewable energy sources such as wind, solar, hydropower, and to a lesser extent tidal and geothermal, arise from a single source and are therefore relatively straight forward to explain and comprehend. For example, a commercial wind turbine turns to create electricity when wind blows over its blades; it is visible, tangible and fathomable. However, in the instance of bioenergy, numerous technologies and feed stocks are incorporated under this term, complicating the ability to understand the topic. As stated by Aldrich and Fiol (1994) when knowledge about an industry is complex, it makes it hard for others to identify and relate to it. This lack of understanding and support does not provide incentives for investors and also increases the risk for investors to overcome.

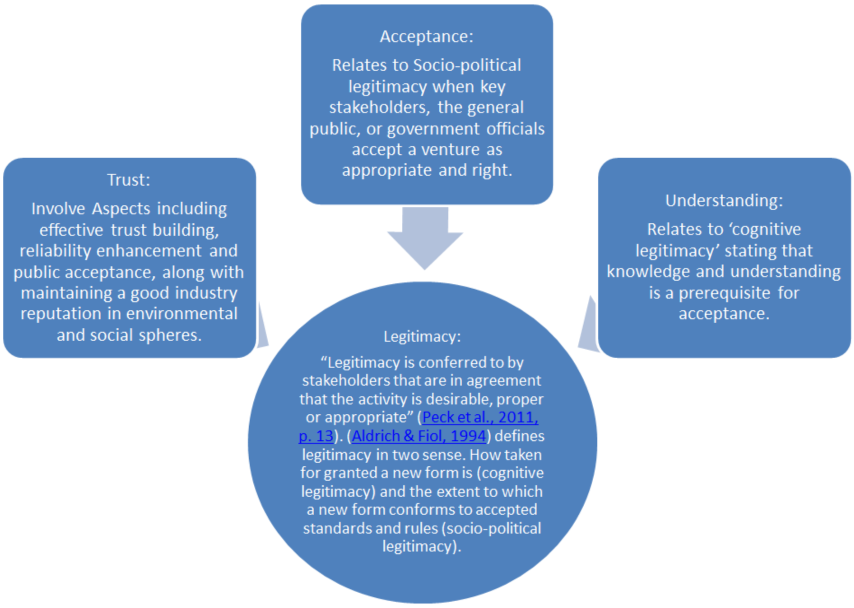

Figure 2-3 Understanding, acceptance, trust building and legitimacy - After Aldrich and Fiol (1994)

As stated by Peck et al. (2011) the progression of the bioenergy sector will require efforts to enhance market understanding and acceptance, political understanding and acceptance (evidence of tangible support and approval of the sector) and public/stakeholder understanding and acceptance (evidence of activities becoming trusted or 'taken for granted' by stakeholders in the general public). Building 'legitimacy' is stated by Peck et al. (2011) as a key pathway towards unlocking the potential of the bioenergy industry. As stated by Jonker et al. (2011, p. 21) *"acceptance of bioenergy by consumers and policymakers as a sustainable renewable energy source is a key element for further utilisation of bioenergy potential worldwide. In many countries, large parts of the domestic potentials are not utilised, which can be both an opportunity and threat for international biomass trading"*. Silveira (2005, p. 15) believes that increasing awareness of biomass potentials is of the upmost importance with emphasis on providing successful experiences in both industrialized and developing countries. Without understanding and acceptance, unlocking the potential of a new or unfamiliar technology becomes very difficult. Once a concept is understood, it is one step closer to becoming accepted, and with acceptance comes real opportunity.

2.2 International Bioenergy Implementation: Who, What & Where?

'Bios' is the Greek word for 'life' – Bioenergy is obtained from materials of organic origin; in regards to woody biomass it is derived from photosynthesis; naturally an efficient solar generator.

2.2.1 Bioenergy the Umbrella

Kaltschmitt and Thrän (2009) state that all bioenergy is obtained from biomass. Biomass includes all materials of organic origin, such as plants, animals and the resulting residues, by-products and waste products. The majority of this biomass originates primarily from agriculture and forestry, along with the various biomass-processing industries downstream (Kaltschmitt & Thrän, 2009). Bioenergy is used as an umbrella term for numerous forms of technology that has the ability to process organic material and transform it into an 'energy carrier'. As stated by CEC (2008, p. 5) *"the bioenergy industry is quite different to renewable energy generation, such as solar or wind generation, as it often involves a combination of complex processes to create usable energy".*

Bioenergy is a predictable and constant energy carrier and has the ability to complement the zero emission renewable technologies (such as wind and solar), displacing a significant amount of the current 'base load' from coal-fired generators (CEC, 2008). In addition to supplying a constant, predictable fuel source, combustion of biomass fuels also produces heat which can be used for industrial or district heating applications (Johansson & Salonen, 2008). Table 2.3 below outlines the most common bioenergy systems; it is worth noting that a key distinction between the systems is the final state the fuel is utilised. For example, biogas and liquid biofuels such as bioethanol can be used as transport fuels, whereas solid biomass is most commonly utilised for combined heat and power (CHP).

Bioenergy label	state	Utilization	Raw material & technology
Biofuel: Bioethanol & biodiesel	Liquid	Transport Fuel	- Sugar within Crop residue - Short rotation 'energy crops' - Collection of animal fats/oils for biodiesel
Biogas	Gaseous	Transport Fuel CHP	- Compost & sewage processed in anaerobic digester to produce methane - Landfill & sewage gas capture
Municipal Solid Waste for energy & urban biomass	Solid	CHP	- Domestic and commercial waste stream incineration - E.g. Urban timber residues
Agricultural residues for energy	Solid	CHP	- Collection of crop residue and secondary milling processes (e.g. Bagasse) for incineration
Forest biomass for energy	Solid	CHP Domestic heating	- Collection of forest harvest wastes & waste from forestry manufacturing industry for processing into wood chip/pellet/brick and incineration

Table 2-3 Major bioenergy feedstock's & implementation – further list of emerging technologies explored in Table 2.6 (Peck et al., 2011; SKM, 2011)

Numerous studies have expressed the technical potential of bioenergy to play a key role in shifting towards a world less dependent on fossil fuel energy generation, especially in the medium term as a transition fuel. Kaltschmitt and Thrän (2009) claim that bioenergy potential "*range between 20 per cent and over 100 per cent of present levels of primary energy consumption*", ELMIA (2012) concurs by stating the potential for bioenergy utilisation worldwide by 2050 is estimated to be 20-30 times higher than the current use. In a bid to embrace and unlock such potential, the International Energy Agency bioenergy division (IEA bioenergy) was set up in 1978 with a vision to 'achieve a substantial bioenergy contribution to future global energy demands by accelerating the production and use of environmentally sound, socially accepted and cost-competitive bioenergy'. Recent and on-going IEA tasks include task 32; biomass combustion and co-firing, task 38; GHG balances of biomass and bioenergy systems & task 43 biomass feed stocks for energy markets (IEA-Bioenergy, 2009).

Due to the fact that bioenergy is a limited energy resource, efficient utilisation of the renewable energy source is fundamental to optimizing energy output. With the current technology, bioenergy yields the highest CO_2 benefit and whilst it is possible to produce both electricity, heat and transport fuels it is more efficient to generate heat and electricity than automotive fuels from biomass (Johansson & Salonen, 2008). Biomass for energy generation can be broken down into modern and traditional biomass applications, there is currently a wide range of bioenergy technologies and 'technical maturity' varies significantly (Edenhofer et al., 2011). Edenhofer et al. (2011) explains that in 2008, renewable energy accounted for 12.9 per cent of global primary energy supply[11]. The largest renewable energy contributor was biomass providing 79 per cent of all global renewable production, with approximately 60 per cent of this biomass in the form of 'traditional biomass' used in cooking and heating applications in developing countries. However, the developing world needs access to functional modern energy carriers to replace traditional biomass systems to avoid negative social and environmental aspects such as health, inefficient function, gender equality and Greenhouse gas issue (Peck, personal communications, 18th July 2012). There has also been a rapid increase in the use of 'modern biomass', both in regards to the solid biomass global trade and also the availability of technologies for generating heat and power. Edenhofer et al. (2011) provides examples of available modern biomass technologies such as small and large scale boilers, domestic pellet-based heating systems and advanced biomass integrated gasification combined-cycle power plants. As stated by Sjølie and Solberg (2011, p. 1028) *"Adoption of the European Union's (EU) Renewable Energy Directive (RED), with a target of 20 per cent of overall gross energy consumption renewable by 2020, is currently one of the main driving forces for bioenergy consumption worldwide".*

Biogas can be sourced from numerous technologies, such as anaerobic digestion of organic food wastes and animal wastes along with the capture of landfill and sewage emissions. Biogas has been widely implemented throughout the EU such as Sweden – Skåne, a region in the southwest of Sweden, has a goal of converting the entire city bus fleet to biogas by 2015 (Wik, 2011). The biogas can also be utilised for combined heat and power production. Sweden is also an excellent example of utilising commercial and municipal solid waste (MSW) for incineration producing combined heat and power generation which complements the local district heating network.

Whilst 97 per cent of all biofuels are in the form of solid biomass, the past decade has seen a rapid increase in demand for liquid biofuels[12] (especially bioethanol) for transport use (Johansson & Salonen, 2008). However, from a socio-political standpoint the production of liquid biofuels from energy crops has also been widely questioned, resulting in numerous debates regarding 'food vs. fuel' debate[13], carbon debt[14] and 'Land use, Land use change and

[11] 2008 Total global energy supply 492 Exajoules (EJ) (Edenhofer et al., 2011)

[12] Whilst forest biomass for energy in Australia is well positioned to fit existing infrastructure, Australia has a large oil dependance and there is opportunity to embrace forest biomass for liquid fuel production. However, the integration of liquid fuels are outside the scope of this paper.

[13] Food vs Fuel: the competition of agricultural land for food crop production or energy crop (primarily liquid biofuels) production (Tilman et al., 2009)

[14] Carbon debt: The imbalance between the CO_2-e consumption profile of a particular country, group, person and the efforts to offset these activities – burning biomass releases GHG immediately, whilst 'repaying the carbon debt' takes decades to regrow new feed stocks (Tilman et al., 2009)

Forestry' (LULUCF)[15] (Johansson & Salonen, 2008; Junginger et al., 2011). The debate surrounding energy crops led to heavy criticism from international NGOs and have slowed the expansion of the liquid biofuel market somewhat (Tilman et al., 2009).

Energy crops refer to short rotation crops producing organic feedstock's containing sugar (for example sugarcane, corn, wheat or sugar beet) specifically for bioenergy generation, whereas agricultural residues are the by-products from agricultural activities such as cereal straw and canola stalk (CHAF, 2009). As explained by Tilman et al. (2009), it is to the benefit of farmers to leave substantial quantities of crop residues on the land as they provide several advantages to the soil including nitrogen and phosphorus (which maintain soil fertility) and assist in minimising erosion. However, even conservative removal rates of crop residue (no more than 50 per cent residue collection) can provide a sustainable biomass resource. Peck et al. (2011) claim that agricultural residues, both primary streams (E.g. cereal straw from harvesting) and secondary residues (E.g. rice husks from milling) have a global biomass resource potential of between 20 to 50 EJ per year by 2050. Solid by-products collected from agribusiness activities have a realistic potential to produce significant power and heat – whilst also providing environmental, social and economic benefits.

Whilst agricultural residue as a source of solid biomass to energy is an attractive prospect, Peck et al. (2011) suggest that forest biomass has a far greater potential and has begun to gather momentum globally. Johansson and Salonen (2008) explain that forest biomass for energy refers to residual by-products of forest wood production and processing, both primary harvest residues (branches and foliage) and secondary mill wastes (sawdust & bark); by 2050 forest biomass has a global biomass resource potential of between 30 to 150 EJ per year (Peck et al., 2011). As suggested by CHAF (2009), different types of woody biomass are used for combustion including wood pellets and woodchips. Each form of flammable biomass is treated as a separate fuel depending on the amount of leaf, bark and moisture content. The form of woody biomass also determines the ash content which varies significantly. As solid woody biomass for energy has such a strong technical potential for further expansion, the focus of this report is predominately centred upon exploring the possibility of unlocking the potential for forestry biomass for energy generation in Australia.

2.3 Forest Biomass for Energy – A Global snapshot

2.3.1 Defining Forest Biomass for Energy:

As stated by Johansson and Salonen (2008), residual products generated in the forestry sector for energy purposes, known as forest biomass, include primary sources from forest thinning's, post-harvest treetops and branches and reject quality forest timbers (also known as slash, logging residue and harvest waste). Secondary sources involve residues from sawmills such as saw dust, bark and shavings. The premise of forest biomass focuses on optimising efficiencies by utilising a waste by-product to provide an energy source - a parallel can be drawn with Liquefied Petroleum Gas (LPG) which was initially identified as a waste stream from crude oil refining and burnt in refinery flares, today LPG is a highly sort after, legitimate fuel source used for motor vehicle fuel, cooking and heating. Secondary residues in the form of shavings and sawdust are already utilised by other industries such as the wood

[15] LULUCF: activities including deforestation, afforestation and reforestation. Australian LULUCF GHG emissions for 2011 were 24.2 Mt CO2-e - consisting of net emissions of 45.9 Mt CO2-e from deforestation and sequestration of 21.7 Mt CO2-e from afforestation and reforestation (DCCEE, 2011a, p. 12)

product sector, using the raw products for 'board and panel' manufacturing – hence the emergence of the woody biomass industry has created competition for a once free raw waste material. Forest biomass utilisation and technology implementation varies greatly, from the traditional forms in developing countries utilising woody biomass and harvest waste for heating and cooking on a domestic scale, to the modern biomass systems which are developing for large scale energy generation and in some cases, fossil fuel replacement (Edenhofer et al., 2011). *"Forest fuels, energy forest and unused residual products are efficient in terms of energy, the environment and costs"* (Johansson & Salonen, 2008, p. 13).

In regards to traditional biomass, Silveira (2005) explains that biomass such as wood logs, woody harvest waste and animal wastes played an important part in civilisation's development process, including the early stages of industrialization. Throughout the past two centuries a pattern has emerged where the more industrialized a country becomes, the more dependent that country grows on fossil fuels, the Nordic countries appear to be an exception to this trend; placing a great deal of emphasis and investment in the sector over a long period of time. Today, numerous developing countries still rely heavily on solid biomass for energy; Ethiopia and Tanzania derive more than 90 per cent of their energy from biomass; most of this being harvested informally and only a small part is commercialized (Silveira, 2005).

Modern solid biomass systems have been gradually gaining momentum, with the majority of development and innovation taking place in the EU and North America. Silveira (2005) indicates that in the past decade, the number of countries exploring biomass opportunities for the delivery of energy services has increased rapidly. As explained by Johansson and Salonen (2008), forestry industries have assumed an increasingly important role, in the case of Sweden; one fifth of the total energy supply is sourced from forestry biofuel. However Silveira (2005, p. 9) suggests *"in many regions, the use of biomass still needs to become sustainable, this being true both where traditional and modern technologies are applied."*

Forest biomass relies on a transparent, reliable and consistent forest industry which, through harvest operations in native and plantation forests, provides the residue feedstock. Global forestry activities (particularly in native forests) have begun to receive greater attention and criticism from environmental NGOs and the wider public due to the detrimental impact on biodiversity and the intrinsic natural value of native forests. As stated by the WWF (2012), destruction of native forests takes place to meet the demand for timber and paper products, along with clearing for plantation establishment – extreme cases which have gained international attention can be illustrated by the illegal logging in regions such as the Amazon, the Congo Basin and Indonesia. In order for forest biomass to be accepted and supported as a legitimate renewable energy source, the form of bioenergy needs to prove it is not a catalyst to additional logging of native forests and is not a threat to forests of high ecological significance.

In the Australian context, as explained by spokeswoman for the Australian Greens Party Imogen Birley, a major initial constraint of utilising forest biomass from harvest residues, and claiming potential subsidies for such an action, is defining the type of forest in question and how it is managed (Birley, personal communications, 3rd August 2012). In the case of Australia, ABARES (2011) states that there are eight major native vegetation groups (including unique rainforest and tall eucalypts) along with additional plantation forests. Whilst focus on plantation forest harvest residue for biomass is growing due to the increased plantation harvest volume, native forest logging remains a player in today's Australian timber production. Hence, socio-political barriers have been forged due to the link between clear-felling native forests[16], unsustainable forestry practices for forestry products and the burning of native forest for energy generation.

Forest Biomass for Energy – Production of Wood Pellets

Modern forest residue biomass systems typically develop a rigid supply chain for the flow of solid biomass. As illustrated in Figure 2.4, these systems rely heavily on plantation forestry and the extended forest industry for biomass fuel and encompass numerous phases along the supply chain. Key phases include the efficient collection and transport of the harvest residues, processing the by-products into woodchip, further processing the woodchip to wood pellets with a low moisture content and finally transporting the biomass fuel (domestically or internationally) to its final destination for heat and/or electricity generation. Edenhofer et al. (2011) confirms that biomass to energy technologies have the ability to be applied in both centralised settings (primary energy generation such as co-firing) and decentralised settings (private industry thermal applications).

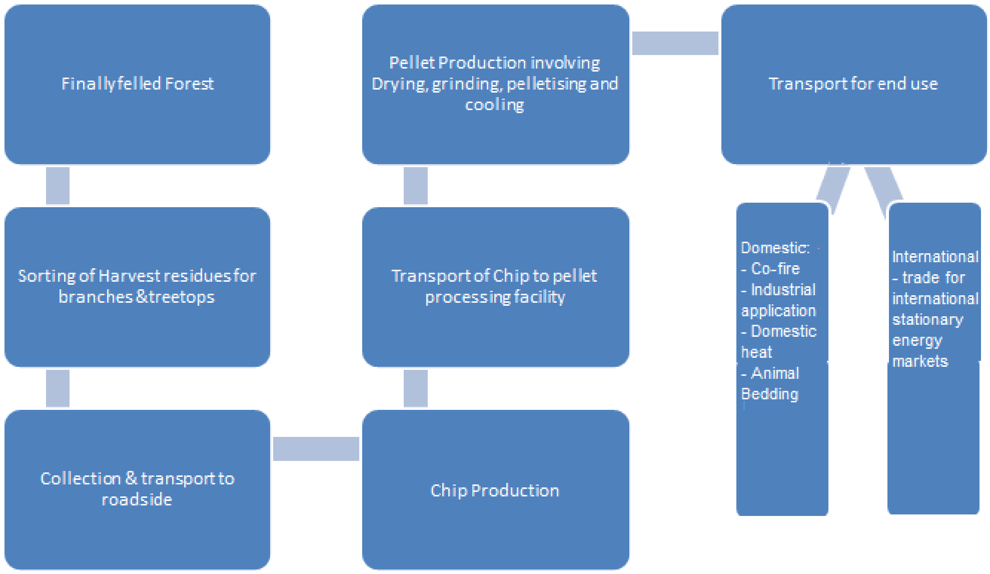

Figure 2-4 Supply Chain for pellet production from primary harvest residues (Hansen, Jein, Hayes, & Bateman, 2009; Johansson & Salonen, 2008)

Wood pellets have emerged as a typical form of solid forest biomass due to the low moisture content (8 to 10 per cent) and the higher energy density compared to most other processed solid biomass forms (Junginger et al., 2011). As stated by Zhang et al. (2010) pelletized biomass as a solid fuel source is more easily transported and handled, and has better properties for electricity generation than other forms of biomass. CEC (2010) also confirm that pellets provide a transformation of a moist and low bulk density biomass fuel (wood chip) to a more convenient, easier to handle, pre-processed fuel with a more attractive bulk

[16] Australian native forest are classified by type and structure. For the purpose of this paper native forests refers to areas of 'multiple use forest' which are available for timber harvest. Old Growth forests are defined as *"ecologically mature forests where the effects of past disturbances are now negligible"* (ABARES, 2011, p. 18)

density[17]. A summary of the benefits for densifying biomass to pellet are listed in the Table 2.4 below.

Expansion of the economic distances that the biomass can be transported for energy conversion
The pellets themselves have a high operational calorific value (the energy released as heat during combustion)
The pellets can be milled allowing dust firing in power plants
Co-firing using pellets can be at high biomass percentages. E.g. a power station in Belgium has been converted from coal to be exclusively fired on wood pellets.
Improves OH & S aspects compared to woodchips; decreases health risks (avoiding dampness which can create mold's and fungus) and improved safety (large piles of woodchip can spontaneously combust.)

Table 2-4 Benefits of densifying biomass to wood pellets (CEC, 2010; Peck, personal communications, 18th July 2012; Penfold, personal communications, 9th July 2012).

In regards to pellet production, Hansen et al. (2009) explain that raw material used for pellet production include secondary fuels such as sawdust produced as a by-product from sawmilling operations or the manufacturing of wooden structures. As stated by Johansson and Salonen (2008) primary forest fuels can encompass harvest residues (branches, treetops, damaged or diseased full trees), stumps, and small trees; wood from both deciduous and coniferous trees can be used for the pellet manufacturing. Whilst Finland utilise all of the aforementioned forest fuels, Sweden (and most other forest biomass producers) only utilise harvest residues on a major scale. In Appendix 8.3, the supply chain of the wood pellet manufacturing for biomass is demonstrated (Hansen et al., 2009).

CEC (2010) states that wood pellet consumption is currently 12 million tonnes per year and this figure is expected to climb to 30 million tonnes by 2020. Pellets are used for domestic district heating and industrial use, predominately in EU, North America and Japan is increasing its application. One of the most notable applications to date is the 'Avedøre unit 2'[18] in Denmark, initially designed for coal and currently operates on up to 70 per cent wood pellets & other woody biomass energy carriers (Dong-Energy, 2012). Jonker et al. (2011) explains that whilst such supply chains and infrastructure are well developed in regions such as North America, the EU and Japan, other jurisdictions including Australia, Argentina and South America are only just beginning to develop this sector.

2.3.2 Current Forest Biomass Technologies

As mentioned by CEC (2010) there is a wide range of new and emerging biomass technologies available for the stationary energy market, such technologies extend along the supply chain and include feed-stocks, pre-processing the biomass for transport and energy conversion, development of thermal conversion technologies to improve efficiency, technologies to allow high co-firing levels and multi-fuel operations. Below in Table 2.5 are numerous examples of modern technologies facilitating electricity or heat production from forest biomass.

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[17] In comparing bulk densities: Wood pellets equate to approximately 650 to 700tm3 whereas coal is 800 to 850tm3 (Melin, 2011)

[18] Avedøre unit 2: a 590MWe supercritical CHP facility in Avedøre, Denmark with electrical efficiency of 49 per cent (Dong-Energy, 2012)

Technology	Process
Torrefaction:	An evolving biomass fuel pre-treatment process. Whilst it is considered an expensive option, it reduces the moisture content of a pellet to 1 per cent, increasing its density and enhancing its calorific value to 20MJ/kg (CEC, 2010).
Centralized Co-firing:	Biomass co-firing has been utilized commercially both in Europe and the United States, with trials taking place in Australia. As stated by Zhang et al. (2010) there are no major technical obstacles to co-firing, although logistical and operational challenges may exist, primarily due to the differences in coal and biomass properties. A Finnish cogeneration plant installed in 2001 has a Circulating Fluidized Bed Combustion (CFBC) boiler with capacity of 550 MWth and an electrical capacity of 240 MWe. The plant has the ability to utilize a variety of fuels, from 100 per cent biomass to 100% coal (CEC, 2010).
Centralized Repowering:	Far less experience exists with 100% biomass-fired generation in prior coal Generation Stations, although it has been successfully implemented in Belgium and in the United States (Zhang et al., 2010). Large scale combustion boilers can utilize any of fixed bed, fluidized bed and dust combustion applications (Murray, 2010).
Decentralized Onsite thermal industrial application:	Numerous industrial operations both globally and within Australian utilize forest residue biomass to provide useful energy for private online use, most noticeably in the form of hot fluids and steam. Such examples include steam in pulp and paper mills, thermal oil in plywood factories, steam for processing food and kiln drying lumber at mill (CEC, 2010).
Gasification:	Converts solid biomass to combustible gas which can be used in spark ignition engines, for dual fuelling diesel generator sets, or at a larger scale in gas turbines. BIGCC (biomass integrated gasification combined cycle) is an extension of gasification technology and is an advanced technology to be utilized on a larger scale for co-generation of stationary energy (CEC, 2010).
District Heating:	An integrated aspect of an efficient heating system utilized heavily and championed in the EU. Whilst heating requirements in Australia vary, South Eastern Australia (with domestic heat demand during winter months) have no such heating systems. District heating is fired by wood pellet (or MSW) applications to provide heating for local houses and businesses (Peck, Personal communications, 18th July, 2012).
Domestic heating:	Small scale, domestic wood fired boilers for household used for water and space heating (CEC, 2010). Such applications are widely used in the EU and have begun to appear in South Eastern Australia, such as Pellet Fires Tasmania (Douglas, personal communication, 21st July 2012)
Fast Pyrolysis:	Produces a crude oil (bio-oil) which can be further processed into diesel, aviation fuel or petrol. The technology focuses on upgrading the bio-oil for transportation applications, however the use of bio-oil for power production has also been demonstrated. The developing pyrolysis in Australia with Mallee for the combined production of 'bio-char' and biogas has also been explored as second generation biofuels – biochar can provide additional benefits such as soil enrichment (CEC, 2010; SM, 2011)

Table 2-5 Modern technologies for utilising forest biomass

2.3.3 The 3 Pillars - Sustainability Aspects of Forest Biomass for Energy

From a sustainability standpoint, forest biomass like all energy carriers, have numerous positive and negative social, environmental and economic aspects related to its supply chain and energy generation processes. Forest biomass for energy is based on the premise of efficiently utilising a by-product or residue from existing forestry operations, without inflicting long term damage on sensitive native forest. Aspects such as employment, supporting regional community economies and trade are also involved in the debate. From a European perspective, bioenergy has provided an opportunity to address issues other than energy, such as decreasing populations in rural areas, employment in peripheral regions, and restructuring of agricultural policies including new uses for idle croplands (Silveira, 2005).

Social Aspects

Numerous social aspects relate to forest biomass for energy. As stated by Silveira (2005, p. 14), social understanding and awareness of the potential of bioenergy options such as forest biomass have the opportunity to foster regional development; through the creation of jobs along with the integration of forest biomass feedstock's into industrial processes leading to economic and environmental benefits. A critical mass of good examples of CHP bioenergy systems in various countries are fundamental to building such support (Silveira, 2005).

From an Australian perspective, CEC (2008) states that both during the construction phase and on an ongoing basis forest biomass provides employment along the supply chain in rural regions. Due to the distributed nature of biomass resources, bioenergy generators will tend to be relatively small and located near the communities they serve further supporting local decentralised, secure energy with decreased transmission and distribution losses (CEC, 2008). In areas of well managed plantations along with increased integration of farm forestry activities, Peck et al. (2011) states the development of nurseries, new supply chains and plantings can support regional communities. As stated by CEC (2011b), in 2010 8000 full time equivalent jobs existed in the Australian renewable energy sector, the bioenergy sector provided 2400 jobs alone (2200 ongoing employment and 200 installation) - more than any other renewable. However, negative social aspects from forest biomass have also been raised, Peck et al. (2011) suggests increasing plantation forests can have a detrimental effect upon rural jobs and commercial services due to the shift away from traditional farming practices.

Economic Aspects

The Economics surrounding forest biomass relate to both the domestic use and international export markets. As outlined in section 2.3.4, on an international scale numerous countries have solidified a supply chain based on woody biomass sourced from forest residues; such countries include Canada, USA, Finland, Sweden, Belgium, Holland, Denmark and the UK. These proactive countries have developed a viable economic model around the trade of forest biomass with numerous European countries importing forest biomass for renewable CHP production (Jonker et al., 2011; Junginger et al., 2011; Murray, 2010)

From an Australian domestic point of view, as explained in a 2012 report by the RIRDC the economics of forest harvest residues from Australian softwood plantation operations are not commercially viable with the current end value of woody biomass (Ximenes et al., 2012). Due to the bulky nature of woody biomass, the logistics in transporting forest biomass from source to final use is key to determining economic viability. As stated by Zhang et al. (2010, p. 539) *"pelletisation generally results in a higher-cost feedstock and requires energy inputs that may negatively impact the net benefit of biomass use."* As stated by Douglas (2012, 21st July, personal communications) positioning the pellet plants close to the source of forest residue is key to economic viability. Situating pellet plants near applications that require low grade heat (such as district heating or industry) is also essential.

Domestic trials of utilising woody biomass are currently taking place by Australian utility company Delta Electricity centring on the integrating farm forestry to grow Mallee eucalypts as a feedstock for stationary energy co-firing. As stated by McMullen (2012, 23rd July, personal communications), integrating farm forestry provides a win-win situation for farmers with environmental advantages such as salinity mitigation & shelterbelts. Economic modelling[19] predicts that 10 per cent Mallee planting can provide the same income as grain

[19] Performed by (FFI CRC) Future Farm Industries Cooperative Research Centre

production; both in terms of carbon sequestration and biomass feedstock production. Zhang et al. (2010) states that co-firing can be commercially viable within the right subsidy regimes; biomass co-firing (coal and biomass simultaneously) generally has higher fuel costs than 'coal-only' generation, but is favourable as it requires low capital expenditure by using existing facilities and can be applied to all types of utility coal boilers. In the Australian case, where coal is the predominately fuel source for stationary electricity and heat, co-firing provides a neat fit with existing infrastructure.

In regards to the economic aspects of international export trade of Australia forest biomass, global demand for large scale, reliable sources of wood pellet is increasing. Plantation Energy (PEA) began operations in 2009 with the objective to utilise Australian plantation harvest residues to process wood pellets for the EU and Japanese markets. PEA is further addressed in section 4.2.4.

Environmental Aspects

Whilst Renewable energy technologies are not reliant on finite fossil fuels for energy generation and emit far less GHG emissions than fossil fuelled energy generation, renewable energy sources do have an environmental impact along their life cycle. As mentioned previously, building understanding and acceptance of forest biomass for energy begins with honest and clear communication and marketing of the advantages, and weaknesses, of the alternative energy source; working to optimize potential by gaining broad stakeholder support.

When referring to the 'use' phase of renewable energy technologies; solar and wind, marine, hydropower and geothermal are all zero emission sources[20], in comparison to forest biomass which is a 'combustible renewable energy source' and produces GHG emissions (Demirbas, 2008; Massabié, 2008). *"Burning biomass in furnaces also produces* CO_2 *but since the fuel is from recently living material and if the material is regrown to replace what was cut, the* CO_2 *is regarded as being very quickly reincorporated in the new plant material and so this biomass is thus regarded as being a carbon neutral fuel" (CHAF, 2009, p. 18).*

In regards to the 'production' phase, technologies such as wind and solar require significant fossil fuels in the production (Massabié, 2008) – for this reason Hartmann (2004, p. 111) uses the examples of solar and wind to state *"it takes oil to make non-oil technologies"*. The production phase of dams for hydropower also has significant impacts on local ecosystems where valleys are flooded inflicting permanent land use change. The production phase of forest biomass has lesser environmental impact as forest biomass can be utilised as a direct replacement for previous fossil fuels such as coal and natural gas combined cycle. By using existing infrastructure, Zhang et al. (2010) states that repowering (100 per cent solid biomass wood pellets) and co-firing biomass with coal are both technically viable options. Further environmental impacts of forest biomass along the production phase involve the fuel utilised during residue extraction, transport and processing of the forest residues.

From an end of life perspective, forest biomass is a respectable option within the renewable energy mix. Solar panels currently have a life span of 20-30 years and they are required for disposal which is made difficult due to the hazardous substances contained within each panel (Massabié, 2008). Wind turbines and marine technology have varying life spans and require

[20] Zero emission sources: known as new renewables and have no fuel costs (Massabié, 2008)

on-going maintenance. In the case of forest biomass combustion to energy, ash is the major by-product from burning within the furnaces, which is far less hazardous than the residues produced from coal fired furnace (Zhang et al., 2010). The ash from woody biomass has been experimented as a fertiliser for plantation forest soils, further diverting waste away from landfill and contributing to the closure of nutrient cycles and the reduction of industrial fertiliser. Results from such an application have been contentious and are still being explored (Peck, personal communications, 18th July 2012).

Whilst forest biomass for energy does produce GHG emissions during combustion for energy and heat production, Dow and Downing (2007) explain that the CO_2 released from bioenergy is equal to the amount that is removed from the atmosphere during the plant/trees lifetime, so is therefore considered 'carbon neutral' and 'renewable'. Not only does bioenergy operate in a closed carbon cycle, CEC (2008) states that waste biomass resources emit fugitive GHG emissions, such as methane, if left to decompose. This methane has 21 times the impact of CO_2 and if this waste fuel is used for stationary energy generation, it eliminates or reduces these methane emissions and therefore provides additional GHG mitigation (CEC, 2008).

Forest biomass can either be processed into wood pellets or it can be used in its primary state as woodchip. Zhang et al. (2010) investigated the GHG emissions of substituting 100 per cent wood pellet, and also co-firing wood pellets with coal, in two coal generating stations in Ontario, Canada. Results indicated 100 per cent wood pellet utilisation (wood pellets with 10 per cent moister content (MC)) provided the greatest GHG benefit on a kilowatt-hour basis, reducing overall GHG emissions by 91 per cent from brown coal (lignite) and 78 per cent from Natural gas combined cycle (NGCC) systems. Zhang et al. (2010) indicates that compared to lignite, using 100 per cent pellets reduced NOx emissions by 40-47 per cent and SOx emissions by 76-81 per cent. Pollard (2012a) concurs by stating that filters or electrostatic precipitators remove particulate matter, with woody biomass producing low sulphur emissions when compared with other fuels. Further comparisons of solid woody biomass energy generation compared to coal are stated below:

- Green woody waste from harvest residue (leaf, bark, and stems as green woodchip) has a similar energy value as brown coal, roughly 2.7MWh/tonne (CHAF, 2009). (These elements of forest biomass are not the key focus of residue collection as they provide the most nutrients return to the forest soil).

- Bone dry Wood pellets, condensed saw dust and dried harvest waste have 8 to 10 per cent MC and obtain an energy value of 4.5-5MWh/tonne (double the energy value of brown coal) and a bulk density of 650 ton/m3. (CHAF, 2009; Melin, 2011)

- Torrefied wood pellets are wood and agricultural materials with MC of 1 to 5 per cent, they obtain a calorific value of up to 24 HHV and a bulk density of 700 ton/m3 (Melin, 2011).

Whilst there are noticeable advantages from utilising woody biomass for energy and heat production in regards to emissions, there are also several environmental downsides which have arisen, the major weaknesses are stated below.

- Transport and processing into wood pellets involve GHG emissions from numerous steps in the supply chain including trucking and shipping transport emissions.

- Native forest clearing has been linked to biomass production as native forest logging companies have explored the opportunity to utilise product for energy generation. Detrimental aspects of native forest logging are extensive and include loss of biodiversity values, forests inability to act as a carbon sink and intangible values of unique wilderness; 'pricing the priceless'.

- Negative environmental impacts from plantation establishment include fertiliser use, erosion, water diversion, poisons applications, monocultures and soil degradations.

- During the use phase, combustion of forest biomass produces GHG emissions and particulates which are not produced when compared to wind, solar, geothermal, tidal and hydropower.

2.3.4 World Woody biomass trade and key Players in the global field

As mentioned previously, the EU has championed numerous environmental policy initiatives (such as the 2009 renewable energy directive) that have mobilized the solid forest biomass trade – due to the greater bulk density wood pellets have been identified as the most effective energy carrier for raw forest residues. CEC (2010) confirms this by stating the main market for wood pellets is in western and northern Europe, spurred on by EU GHG reduction targets and subsequent subsidies and penalties. Furthermore, it is evident that the EU is determined to continue developing and unleashing the solid biomass market: "*In order to exploit the full potential of biomass, the community and member states should promote greater mobilization of existing timber reserves and development of new forestry systems" (European-Parliment, 2009, p. 19).*

Jonker et al. (2011) explains that over the past decade the production, consumption and trade of wood pellets have grown strongly. In 2009 more than 13 million tons of wood pellets were produced with the majority sourced from the EU, USA and Canada. Wood pellet consumption is the highest within the USA and EU; most noticeably Sweden, Denmark, Holland, Belgium and Germany. Jonker et al. (2011) continues by explaining that 'indirect' biomass to energy trade is also substantial, forest products traded for other primary purposes (such as roundwood for construction and woodchips for pulp and paper) can be used as secondary woody biomass fuels. Whilst wood consumption is typically regional, around 130 million cubic meters of roundwood and woodchip were traded in 2006 providing substantial indirect fuel. An overview of the countries involved in the global wood pellet market is depicted below in Table 2.6.

In discussions with board member of the world bioenergy association (WBA) Andrew Lang, he states Europe has a current demand of roughly 30 million tons (Mt) of woody biomass (25Mt of which is sourced from the EU), this figure is predicted to increase to 60 to 80Mt by 2030 (Lang, personal communications, June 20th 2012). However, the question remains, as the trend towards utilising and co-firing woody biomass continues to increase - where is this feedstock going to come from? Simon Penfold, a plantation industry professional states the Asian region including South Korea, Japan and Taiwan also appear to be eager to bridge the biomass gap, looking to source woody biomass from a reliable supplier. Canada already have contracts with Japan and appears to be the first inline to begin large scale imports to South Korea (Penfold, personal communications, 9th July 2012).

Country	Involvement	Actions
Belgium	Major Activity	Importer of wood pellets. Co-firing in large scale coal power plants Consumed ~1 million tonnes of wood pellet in 2009
Canada	Major Activity	Exporter of wood pellets to EU - exports to Japan & exploring trade with South Korea Produced 1.4 million tonnes in 2009. 8.3TWh electricity generated from solid biomass
Denmark	Major Activity	Importer of wood pellets, wood chips and fire wood. Industrial consumption for co-fired stationary energy Consumed ~1 million tonnes of wood pellet in 2009
Finland	Major Activity	Exporter of wood pellets - majority intra-EU trade 10.5TWh electricity generated from solid biomass Co-firing for Stationary energy and also Industrial application
Holland	Major Activity	Importer of wood pellets. Co-firing in large scale coal power plants consumed ~1 million tonnes of wood pellet in 2009
Sweden	Major Activity	Importer of wood pellets. Consumed 1.8 million tonnes of wood pellet in 2009, producing 7.5TWh electricity. Biomass overall produce 32% of all energy in Sweden (target 39% by 2020)
UK	Major Activity	Importer of wood pellets Numerous power plants converted for co-firing wood pellet
USA	Major Activity	Exporter; produced 1.8 million tonnes in 2009. Domestic consumption for heating houses Highest consumer of electricity generated from solid biomass of all OECD nations (41.8TWh), representing 10.5% of renewable energy supply
Austria	Minor Activity	Intra-Eu export. Domestic consumption for heating houses.
Australia	Minor Activity	Minor export activity to EU & pilot domestic implementation
Argentina	Minor Activity	Minor export activity to EU
China	Minor Activity	Minimal export activity; Large reserves of readily available waste feedstock. 2020 target of biomass to energy production
Germany	Minor Activity	Imports Domestic consumption for heating houses Consumed ~1 million tonnes of wood pellet in 2009 Exports wood pellets for industrial use (minimal large scale co-firing market)
Italy	Minor Activity	Intra-Eu importer. Domestic consumption for heating houses Consumed ~1 million tonnes of wood pellet in 2009
Japan	Minor Activity	Increasing Imports of wood pellets from Canadian West coast 2nd highest consumer of electricity generated from solid biomass of all OECD nations (15.1TWh), representing 13.9% of renewable energy supply
South Africa	Minor Activity	Minor export activity to EU
South Korea	Minor Activity	Exploring option of importing wood pellets from Canada & Australia

Table 2-6 Players in the global wood pellet biomass market (Jonker et al., 2011; Junginger et al., 2011; Lang, 2011; Murray, 2010; Peck et al., 2011)

As illustrated in Table 2.6 above, the major players in woody biomass include the Nordic region, North America, central EU, Asia and small inputs from Argentina, South Africa and Australia. The following statement from CEC (2010, p. 9) is a clear indication of the direction of international trade of solid biomass: *"OECD countries electricity generation from solid biomass grew from 93.1 TWh to 115.9 TWh between 1990 and 2006, yielding 1.4 per cent annual growth"*. As stated by Junginger et al. (2011), the first intercontinental trade took place in 1998 from Canada to Sweden; the Nordic countries have been utilising forest biomass for energy for several years and have been a key to mobilizing global trade. Sweden currently has one of the highest proportions of biomass contributing to the national energy mix; importing and exporting nearly 1 million tons of pellets per annum. A brief case study outlined in Appendix 8.4 illustrates the Swedish use of forest biomass to energy. Whilst Sweden is a leading example of implementing forest biomass to energy, Zaremba (2012) states that plantation forestry utilised for energy has received criticism for destroying Sweden's native forests and replacing them with monocultures; dead forests with short lifespans. Addressing such socio-political issues will be key to continuing Sweden's reliance on forest biomass for energy. From an Australian outlook, for Australian to develop and integrate forest biomass into its renewable energy mix and consider entering the global wood pellet exporter market, similar socio-political obstacles will need to be addressed.

3 Renewable Energy in Australia

Australia is a country rich in energy resources with a history reliant on fossil fuels for stationary energy generation – Recent policy towards addressing climate change and integrating renewable energy technologies are gaining momentum in Australia. The purpose of this chapter is to provide an analysis of literature highlighting Australia's energy generation, national policies in place to tackle climate change and the current emphasis on bioenergy in Australia.

3.1 Australia's Energy generation & Approach to Climate Change

As stated by BREE (2012b), Australia is the world's ninth largest energy producer, responsible for approximately 2.5 per cent of world energy generation. Australia is fortunate to have an abundance of high quality energy resources including coal, gas and uranium which are utilised for both domestic energy generation and exports. As stated by BREE (2012b) energy exports accounted for 33 per cent of the total value of Australia's commodity exports in 2010, with coal Australia's largest energy export earner, followed by crude oil and liquefied natural gas (LNG). As illustrated by IEA (2011) in Figure 3.1 below, Australia's 2009 primary energy supply was 131 million tons of oil equivalence and is dominated by fossil fuels.

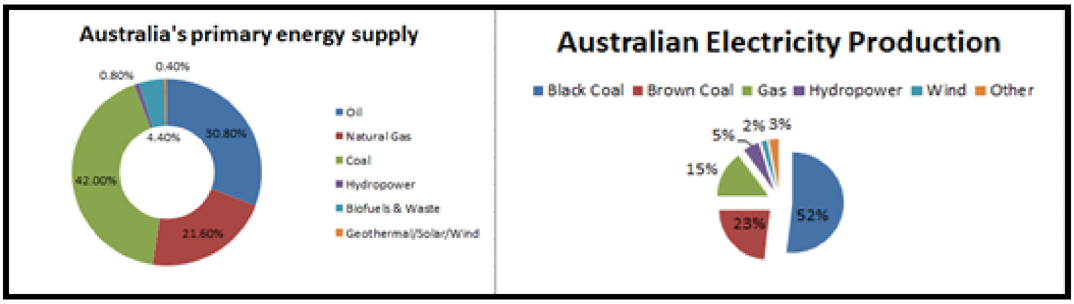

Figure 3-1 Left: Australia's Primary Energy Supply in 2009 IEA (2011). Right: Australia's 2010-2011 electricity production by source[21] *(BREE, 2012b)*

In regards to Australian electricity production (on the right of Figure 3.1), BREE (2012b) explains that the majority of Australia's electricity is produced using coal which accounts for approximately 75 per cent of total generation in 2009–2010. The remaining electricity is derived from gas (15 per cent) and renewable energy sources (7 to 8 per cent). The DCCEE (2011b) states that in 2011 the fossil fuel to renewables ratio shortened further, with 90.36 per cent of annual electricity production sourced from fossil fuels and 9.64 per cent from renewables.

As stated by Energy-Matters (2009), in 2006 the Australian coal industry received around $1.7Aud billion in subsidy support whereas renewable energy received $326Aud million. According to ELMIA (2012) the worldwide subsidies to fossil fuel consumption in 2009 amounted to ~300 billion USD, while for the same time period the global support for renewables was ~60 billion USD. These figures indicate that global government spending on promoting fossil fuels is still a priority; however it can also be seen as a promising sign for the future of renewable technology investment.

[21] Note zero domestic use of uranium for nuclear energy production in Australia

3.1.1 Australian Climate Change Stance

The climate change debate in Australia has been at the forefront of political debate for the best part of a decade, with the two major political parties holding extremely different viewpoints on how to approach climate change policy. This political rollercoaster towards introducing an effective strategy on combating climate change is demonstrated in Figure 3.2 below, key milestones over the past five years include ratifying Kyoto in 2007, expanding the renewable energy target (RET) in 2009 and introducing a carbon tax in 2012. Whilst Australia was a latecomer to the Kyoto Protocol, a national carbon tax of $23Aud per ton was introduced in July 2012, elevating Australia's global reputation as a committed OECD nation towards a low emission future. As stated by the DCCEE (2011d) a carbon price is projected to reduce electricity emissions 60 per cent below current levels by 2050. The DCCEE (2011d) predicts that over this transition time the Australian electricity sector will both move away from coal-fired generation and shift towards renewables (with renewable energy planned to increase from 10 per cent to 40 per cent of the generation mix by 2050).

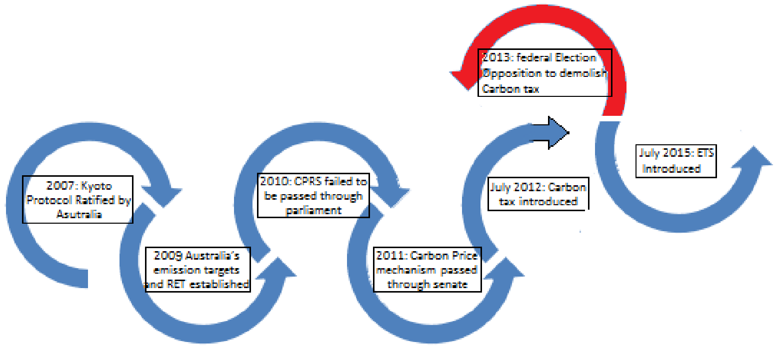

Figure 3-2 Australia's political milestones in addressing climate change & introducing a carbon tax

Australia is a national of 22.7 million people (0.3 per cent of the global population) and contributes a fraction (1.5 per cent) of the global GHG emissions – placing Australians as one of the highest per capita emitters in the world (ABS, 2010a, 2012). Whilst the renewable energy target was established and extended in 2009, heavy social, political, commercial and industrial criticism has been directed towards the introduction of a carbon tax in 2012. Such criticism has especially stemmed from the Australian Liberal Party and the mining sector which is responsible for 9 per cent of Australia's net energy consumption (BREE, 2012b). As highlighted in red in Figure 3.2, the leader of the federal opposition party (Tony Abbott) has openly stated the Australian Liberal Party will abandon the carbon tax if elected in 2013. The Australian Liberal Party have contributed to the highly publicised negativity towards the carbon tax by placing emphasis on issues such as increased electricity prices for households, loss of domestic jobs, carbon leakage and loss of competition for the domestic mining sector. As stated by federal climate change minister Greg Combet, "*Labour will hold Tony Abbott to account for his rank and deceitful fear campaign against the carbon tax*" (Morton, 2012, p. 6). McCormick (2012, 24th July, personal communications) explains that the Australian political climate surrounding environmental policy is destructive, based on two major parties and emphasis on short term gain. Australia and the EU have different approaches to renewable energy and carbon pricing; Australia has traditionally seen issues of climate change and renewable energy as a burden, compulsory, and something we 'have to do'. Whereas Sweden for example, have taken these issues on as an opportunity and made a real paradigm shift; they are developing new industries, technologies and jobs to be competitive in the future. A similar belief is mirrored by Harris (2012), claiming *"the environmental debate we (Australia) are* *having seems to be in a parallel universe to the rest of the world - either the planet is done for if we don't act, or the economy is done for if we do. We have a highly polarized debate and even more polarized reporting" (Harris 2012 p.1).*

3.2 Australia's RET and Renewable Technology Implementation

According to the DCCEE (2010), the Australian Government extended the renewable energy target (RET) scheme in 2009 *"which is designed to deliver on the Government's commitment to ensure that 20 per cent of Australia's electricity supply will come from renewable sources by 2020" (DCCEE, 2010, p. 1)*. The RET expanded on the previous scheme, the Mandatory Renewable Energy Target (MRET) which began in 2001. DCCEE (2011c) states that since the RET introduction, it has been enhanced and separated into two parts; the LRET & SRES[22]. Combined, the LRET and SRES are predicted to exceed the renewable energy target of 45 000 GWh in 2020 (DCCEE, 2011c). As of 2011, CEC (2011a) claims that Australia supplies 9.6 per cent of its electricity generated from renewable sources. Table 3.1 below illustrates the 2011 renewable electricity generation in Australia; most noticeably derived from hydropower (67 per cent), wind (22 per cent) and bioenergy (8.5 per cent). It is important to clarify that there is a difference between electricity and energy generation from renewable sources; a key aspect which can be incorrectly interchanged[23].

Australian Renewable Energy Source	Electricity Generation in 2011 (GWh)	% Contribution
Hydro	19,685	67.2%
Wind	6,432	21.9%
Bioenergy	2,500	8.5%
Solar PV	680	2.3%
Solar Thermal	4.4	0.015%
Marine	0.75	0.003%
Geothermal	0.5	0.002%

Table 3-1 2011 Renewable electricity generation in Australia (DCCEE, 2011b).

Whilst the contribution of Australian renewable energy continues to increase, the question remains: which alternative energy sources will contribute to Australia's future renewable energy mix? Figure 3.3 below illustrates Australia's long range projections of shifting towards a lower emission future. Whilst black and brown coal currently dominate the energy mix, by 2050 renewable energy supply is expected to increase to approximately 40 per cent with major contributions from geothermal and wind, and further contributions from hydropower, solar and biomass (DCCEE, 2011b). To allow these renewables to integrate into the Australian energy mix, investment into new technologies is essential, *"Investment in clean energy has eclipsed that of traditional energy over the last three years. Investors have started to see clean energy as a safe and lucrative sector to invest their capital" (DCCEE, 2011b, p. 15)*. As stated by Energy-Matters (2009), whilst the 2009 federal budget earmarked $4.5Aud billion towards clean energy, over half is expected to go towards low-emissions coal technologies (e.g. CCS).

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[22] The small scale renewable energy scheme (SRES) encompasses household and small businesses whom can claim 'small scale technology credits' for investing in domestic applications (e.g. solar panels). The large scale renewable energy target (LRET) focuses on large scale projects (e.g. wind and bioenergy) and will deliver the majority of the 2020 target

[23] Energy refers to the 'capacity to do work' and can provide electricity, heat and transportation fuels. Power refers to the rate of using energy or 'doing work'. Australian Bioelectricity sourced from biomass or biogas is burnt in a furnace at efficiencies of 33 per cent, bioenergy for heat used in industrial boilers have efficiencies of ~90 per cent (Peck, personal communications, 18th July 2012).

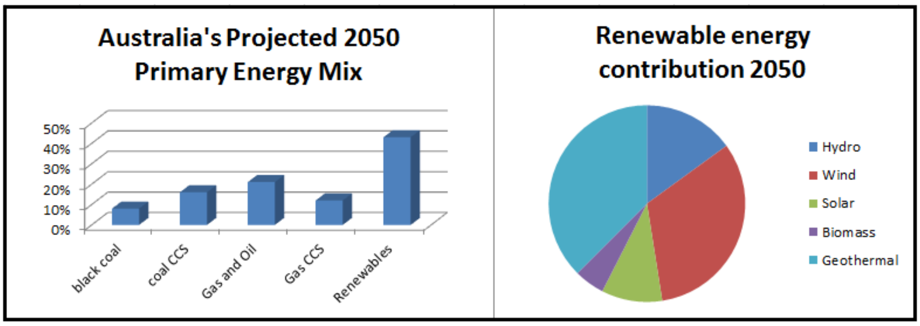

Figure 3-3 Australian Renewable energy mix projections in 2050 (DCCEE, 2011d)

3.2.1 Bioenergy: Contribution to Australia's Renewable Energy Mix

Bioenergy contributes 8.5 per cent to Australia's renewable electricity generation mix, equating to less than one per cent of the national electricity generation (DCCEE, 2011b). However, as stated in the Australian bioenergy roadmap published by the CEC, Figure 3.4 indicates that Australia has a goal of increasing bioenergy electricity generation to 3.7 per cent by 2020 (CEC, 2008). As stated by CEC (2008), resources to produce bioenergy are abundant in Australia and are currently either underutilised or a waste requiring disposal. Whilst the Australia electricity production from bioenergy may appear minimal, CEC (2010) states that bioenergy contributes 78 per cent of all renewable energy for heat, transport fuels, and industry co-firing and cogeneration - a significant figure which appears to be overlooked.

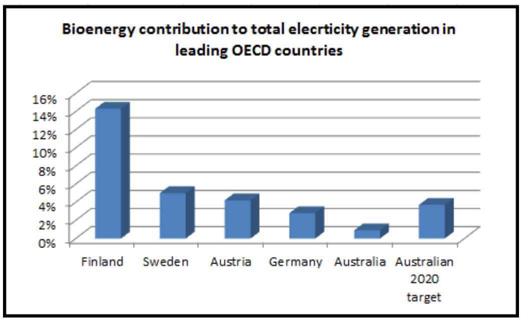

Figure 3-4 Australian bioenergy contribution the total electricity generation (CEC, 2008)

Peck (2011) suggests that whilst waste by-products are used efficiently for energy purposes through bagasse (agricultural wastes) and black liquor (pulp and paper industry), in general Australia does not efficiently utilise its waste for energy. According to CEC (2011a) bagasse refers to the combustion of sugar cane residue which is plentiful in North Eastern Australia and represents 61 per cent of Australia's bioenergy, black liquor is a waste product from the pulp and paper industry and represents a further 10 per cent. Landfill gas and sewage gas provide 21 per cent and 6 per cent respectively and wood wastes contribute a minor 1 per cent. Numerous Australia bioenergy applications such as bagasse and black liquor are accepted, trusted and recognised by the Australian government as legitimate renewable energy ventures and receive RECs for CHP applications which both power the plant's operations and feed electricity into the existing grid. Whilst bioenergy has strong perceived potential, the '2011 clean energy Australia report' claims bioenergy has grown only marginally in 2011, which has been the case for several years - with nine small projects coming online during the last two years (CEC, 2011a). Evidence in the form of research and industry reports proves that the CEC and RIRDC have been influential actors involved in acknowledging and attempting to gain support for numerous bioenergy technologies in Australia. However, bioenergy proponent Andrew Lang disagrees by claiming Australian major renewable organisations (e.g. CEC) don't provide bioenergy the major attention presently given to wind and solar PV (Lang, personal communications, 20th June 2012).

In regards to solid woody biomass for energy generation, agricultural waste in the form of bagasse is the clearly outstanding resource providing almost two thirds of Australia's entire bioenergy supply (CEC, 2011a). However, in the 2011 Clean Energy Australia report on renewable energy, other forms of solid biomass to energy, such as that from forestry activity, does not so much as get a mention as a potential future fuel source. Interestingly, in the CEC bioenergy roadmap; 'wood related wastes' are expected to provide 28 per cent of the bioenergy target for 2020 (CEC, 2008). Whilst there is a clear focus on modern, hi-tech renewable energy sources in Australia, solid biomass options such as forest biomass sourced from primary and secondary sources appear to be ignored as a viable bioenergy option. This is summarised by Lang (2011, p. 1) *"When heat and fuels produced from biomass are added to the electricity produced, bioenergy is the largest source of renewable energy at present in Australia – but puzzlingly almost totally ignored in policy and any media comment."*

3.2.2 Technical & Market Potential of Forest Biomass in Australia

The technical and market potential of forest biomass as an energy carrier in Australian has been widely documented. According to Penfold (2012, 9th July, personal communications), historically forest harvest residue was mainly left in the forest and burnt on the forest floor to avoid a build-up of fire fuel, reduce plantation reestablishment costs and enhance moisture retention - this was confirmed by Trushell (2012, 20th July, personal communications) stating that VicForests burn 60 tonnes per hectare of native forest harvest residue annually. Secondary mill wastes such as sawdust, fines and shavings also provide a fire hazard on-site and if not utilised require disposal. The following comments outline numerous viewpoints regarding the future potential of forest biomass in Australia:

- The Australian Bioenergy Roadmap suggested bioenergy can provide 11,000 GWh by 2020 and 72,000 GWh by 2050. With Wood-related wastes providing approximately 3000GWh by 2020 (excluding native forestry) (CEC, 2008, pp. 20-21).

- The Rural industries research and development (RIRDC) recently commissioned a report claiming today's available biomass provides enough feedstock to meet 30 per cent of Australian current electricity use (Lang, personal communication, June 20th 2012).

- *"Australia, by using current technology and off-the-shelf equipment, could by 2040 be producing 20 per cent of current base load electricity and a significant fraction of heat and transport fuels. We have the unutilised residues and wastes"* (Lang, 2011, p. 1).

- VAFI (2008, p. 8) states that "*the use of sustainably harvested forest biomass in residues to generate energy permanently eliminates atmospheric emissions that would otherwise have resulted from the use of fossil fuels. This resource is currently under-utilised and there is potential to expand biomass energy generation."* This viewpoint is centred on the optimisation and efficient use of by-products and waste, and industrial symbiosis[24].

[24] Industrial symbiosis: the navigation of distributing waste output from one industrial process to be the input for another.

- Large areas of hardwood plantations have been established over the past two decades in Australia due to the Managed Investment Scheme (MIS) explained in Appendix 8.5. The majority of planting took place on land previously used for livestock grazing, providing a positive environmental impact immediately benefiting both local land use and climate, along with providing a large source of biomass feedstock (Peck et al., 2011).

- Australia has an opportunity to utilise examples from around the globe to integrate bioenergy into the Australian renewable energy mix. Peck (2011) states that New Zealand is an excellent example of mobilising forest biomass and implementing regional applications, Australian regional networks such as CHAF, WAN and BREAZE are ideal actors to facilitate such regional integration (CHAF, 2009)

- Whilst potential for utilising native forest harvest waste has been calculated, Peck (2011) states that focus should centre on plantations harvest waste and integrated farm forestry, not native forests residues. This view was mirrored by Greaves and May (2012, p. 24) whom estimate that around 16 million cubic meters equivalent (m3e) in forest biomass (excluding native forestry operations) are currently available, which is expected to increase to 28 million m3e over the next 10-20 years. This data exceed 2009 projections by Peck et al. (2011) calculating just shy of 12 million m3e.

- McCormick (2012, 24th July, personal communications) states that there is also an opportunity to shift focus of forest biomass for liquid fuel potential - instead addressing Australia's energy security issues for Oil. Peck (2012, 18th July, personal communications) agrees by claiming that as advanced technologies for thermochemical transformation of biomass enter the market, forest-derived fuel will be increasingly used for vehicle fuels and systems compatible with natural gas (e.g. bio-syngas).

- Forest biomass provides a potential medium term solution as a transition fuel to assist Australia downgrade its reliance on coal – especially when wood pellets have the proven ability to be co-fired in existing coal fired power plant (CEC, 2008). If biomass was to be implemented in co-firing for stationary energy combined with CCS[25], then there would be the opportunity for such a system to become a negative emission power station. An effective CCS system can reduce CO_2 emissions by 90 per cent, a 15 per cent biomass content in the fuel stream would be sufficient to make the system a 'net remover of CO_2' from the atmosphere (Peck, personal communications, 18th July 2012).

- Delta electricity in NSW is performing a pilot project to integrate Mallee feedstock from private farm forestry to co-fire with coal. As stated by industry development officer at DPI NSW Bernie McMullen, integrating farm forestry with Endemic Mallee species can provide a biomass feedstock for energy purposes along with additional values including dry land salinity mitigation and shelter belts. Verve Energy in Western Australia also trailed an integrated wood processing pilot plant utilising Oil Mallee (Verve-Energy, 2012).

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[25] Interest in CCS has been expressed by both sides of Australian government. The Global carbon capture and storage institute was established in Australia in 2009 and is performing pilot projects and research (BREE, 2012a).

4 Australia's Forests: The emergence of forest biomass

The point of departure for this chapter is that forest biomass for energy clearly has technical and market potential to add to the Australian renewable energy mix. There are numerous existing Australian bioenergy examples such as bagasse being used efficiently for energy generation and international examples for utilising forest residues for energy generation. Yet forest biomass is not recognised by numerous stakeholders as a realistic renewable resource for the future – this chapter investigates why the potential of forest biomass is not embraced and concludes with highlighting key drivers and barriers to the sector.

4.1 Overview of Australian Forestry

Forest biomass relies on a robust, well regulated and expanding domestic forestry industry. In order to understand the complexities of utilising forest biomass for energy, first an understanding of Australia's forest industry must be explored. As stated by DAFF (2012) Australia contains 4 per cent of the world's forests which covers about 19 per cent of the continent and spans 149.4 million hectares. 99 per cent (147.4M hectares) of Australia's forests are native broadleaf dominated by varieties of eucalypt (78 per cent) along with acacia (10 per cent) and melaleuca (4 per cent). The remaining 1 per cent of Australian forests is made up of forest plantations containing both introduced softwood conifers and native hardwoods, plantation forestry in Australia begun as early as the 1870s and there are currently 2.02M hectares of plantation in Australia (ABARES, 2011). There are six tenure categories of forest ownership in Australia which include nature conservation reserves (15 per cent of forest area), multiple use public native forests (6 per cent of forest area which is permitted for timber harvest, managed by state government agency's) and private & leasehold forest together managing 70 per cent of all native forest tenure[26] (ABARES, 2011).

Hardwood - Eucalyptus		Softwood - Pinus	
%	Genius/Species & Common name	%	Genius/Species & Common name
21%	E. Globulus : Tasmania blue gum, southern blue gum	49%	P. Radiata : Monterey pine
2%	E. Gobulus and E. grandis: Flooded gum, rose gum, Blackbutt	5%	P. Elliottii : Slash pine
2%	E. Nitens: Shinning gum, Silver top,	3%	P. Penaster: Maritime pine
1%	E. Regnans: Mountain ash, Tasmanian oak, stringy gum	4%	P. Caribaea : Caribbean pine
1%	E. Dunnii Killarney Ash	3%	Araucaria : Bunya Pine (native to Australia)
7%	Unidentified hardwood	2%	Other softwood species
Hardwood used for pulpwood for paper products both domestic and overseas. Marginal sawn timber production		Softwood used for timber in construction and pulp for paper products	
Supply predicted to increase dramatically		Supply predicted to remain stable	

Table 4-1 Common plantation species in Australia (ABARES, 2007, p. 30)

Historically, Australia's plantations have been dominated by exotic softwood conifers such as pine, introduced pine plantations expanded rapidly in Australia and by 1960s there were approximately 200,000 hectares of pine plantation (ABARES, 2011). In recent times there has been a massive influx in hardwood Eucalypt plantations; currently 51 per cent of Australian plantation is softwood, 49 per cent native hardwood. A plantation is defined as

[26] The remaining tenure includes 'unresolved tenure (1 per cent) and other crown land (7%) (ABARES, 2011).

"intensively managed stands of trees of either native or exotic species, created by the regular placement of seedlings or seeds" (ABARES, 2007, p. 26) - Table 4.1 above outlines the major plantation trees harvested in Australia. According to DAFF (2012) in 2010 Australia harvested approximately 26 million cubic metres of logs from forests valued at around $1.8Aud billion. Of the 2010 harvest, 74 per cent of the total volume harvested was from plantations and the remaining 26 per cent from native forests which are managed by individual state governments (DAFF, 2012).

ABARES (2011) explains that Australia's total wood product trade deficit was $1.9Aud billion in 2010, with major exports[27] of wood products including woodchips, paper & paperboard, sawn wood and panels, with the majority of these exports Asia bound. Total imports of wood products to Australia in 2010 equate to $4.2Aus billion and are sourced from neighbouring countries such as New Zealand and increasingly China, including paper & paperboard, paper products and panels. A key driving force for expanding the Australian forestry industry has been in a bid to reduce Australia's timber deficit, however the challenge remains on where Australia should source its timber and wood products.

Australian timber supply can be sourced from three distinct avenues, the first is native forest timber, and whilst managed by state authorities the process threatens the unique Australian biodiversity and has been decreasing in production volume. Secondly, plantation forestry which has been increasing in production but is limited in the variety of timber species it can provide. The third option is imported timber; which can provide a replacement to hardwood timbers previously provided by Australian native forest; however imported timber has a potential risk of involving illegal logging, with issues relating to the transparency and sustainability standards along the products supply chain.

4.1.1 Historical Native Forest Clear-Felling & the Emergence of Australian Plantation Forestry

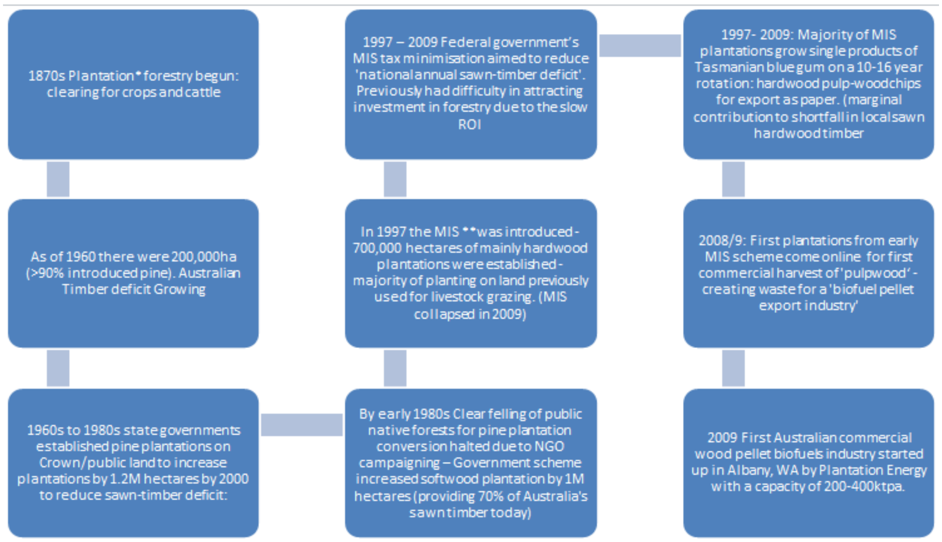
As stated by Lang (2012, June 20th, personal communication) during the mid-stages of the 20th century Australia's state governing bodies responsible for both energy and forestry were highly disjointed with minimal cohesion between boarders. Australian energy generation for heat and transport included wood used in locomotives, biomass utilised for water heating and cooking along with institution and industry boilers. Biomass was a mainstream energy carrier up until the late 1960s when larger machinery required greater quantities of fuel; and because the state forestry management structure was never replaced by a national scheme, policy from the states did not keep up with technology advancements. As greater quantities of woody biomass were required, increased forestry operations in native forests ensued. Meanwhile, during the 1960s there was a push by the state electricity services to move towards coal, gas and petrol and away from biomass to meet the growing electricity demand.

As stated in Figure 4.1 and explained by Peck et al. (2011), since the 1960's Australia has been experiencing a national annual sawn-timber deficit. From the domestic forestry point of view, in a bid to reduce Australia's sawn-timber deficit, between the periods of 1960 to 1980 numerous state governments established pine plantations on Crown (public) land to increase plantations to 1.2M hectares by 2000. Whilst the scheme did increase softwood plantation, it involved numerous cases of clearing public native forests which in turn attracted the attention of the public, numerous NGOs, and environmentalist groups. Lang (2012, June

[27] TotalAustralian timber product export: quating to $2.3Aud billion.

20th, personal communication) indicates that during the 1960s numerous environmental campaigns formed in this time period, rallying against major industrial proposals which threatened some of Australia's most pristine natural environments, such as the Hydropower schemes along the franklin river, mining in Kakadu and also clear felling of old growth forests and iconic native forest landscapes. The Australian Greens Party along with numerous environmental NGOs (e.g. ACF, TWS, WWF and Friends of the earth) have a passionate and strong stance against native forest clear felling in Australia and for increased protection of Australia's native forests.

As highlighted in Figure 4.1 below, protest campaigns enacted by environmental NGOs during the 1970s and 1980s to halt the clear felling of native forests for pine plantation establishment were effective and the government's softwood plantation scheme was ceased in the late 1980s. This historical protesting against the forestry industry and clear felling native forests spread social awareness of the negative impacts of clear-felling native forests on biodiversity, water diversion and the destruction of the local environment. Through large scale protests and media coverage, social understanding increased and therefore acceptance surrounding the detrimental impacts of forestry operations in native forests became established. Social illegitimacy towards unsustainable forestry activities and the timber industry in Australia was born.



*Plantation: intensively managed stands of trees of either native or exotic species, created by the regular placement of seeling's or seeds. (ABARE handbook 2007)
**MIS: Managed Investment Scheme – Collapsed 2008/2009 when Actual financial returns were 50% to 66% of what the prospectus companies were projecting/advertising.

Figure 4-1 The emergence of plantation forestry and forest biomass in Australia (DAFF, 2012), (ABARES, 2011) & (Peck et al., 2011)

Whilst the clearing of native forests for softwood plantations continued up until the 1980s and the continued logging of native forests for woodchip exports instilled widespread social criticism and resistance, the Australian government continued to search for a solution to decrease the annual sawn timber deficit. According to Peck et al. (2011) a new national goal was instated in the mid-1990s aiming to triple the Australian area of commercial tree crops by 2020, confirmed by Judith Ajani as the 'plantation 2020 vision' (Shannon, 2010). As stated by FWPRDC (2004) the Australian government and industry organisations shared a common goal to increase plantations capacity to 3 million hectares by 2020, providing the opportunity to both reduce Australia's timber deficit and supply domestic industries such as construction and pulp and paper along with bolstering exports (DAFF, 2012). Government recognised that achieving the plantation 2020 vision would not be possible through farm forestry plantings due to lack of uptake from farmers; hence in 1997 the 'managed investment scheme' (MIS) was established.

Previously, difficulty had been experienced in attracting investment in plantation forestry due to the slow Return on investment; the MIS policy intervention was designed to stimulate forestry investment by providing tax minimisation to attract new investors (Peck et al., 2011). The MIS model was successful in attracting private investors by providing 100 per cent tax deduction for expenditures and dividends incurred for plantation purchase and establishment (Peck et al., 2011). According to Penfold (2012, 9th July, personal communications), Australian plantations pre 1990 were predominately softwood for construction and could not attract investors due to the 30 year rotation. The MIS introduced hardwood plantation of *Eucalyptus Gobulus* (most commonly Southern Blue Gum) with short rotations of 8-12 years. This native hardwood is a poor sawn log timber which 'springs, bows and cups', but is an excellent pulp wood as it is white and does not require much bleaching for 'white paper production' (Penfold, personal communications, 9th July 2012). Export of hardwood chip direct to the Japanese market for 'white paper production' was also established. As stated by Peck et al. (2011) in the period between 1997 and 2008, the MIS played a role in planting 700,000 hectares of predominately Australian hardwood plantation. In 2009 the MIS scheme collapsed, as stated by Mark Poynter, spokesman for the institute of foresters Australia (IFA) *"the growth in plantation area has virtually ceased in the past 3 years, plantations are not increasing although the volume being harvested from them is increasing as those planted from the mid-1990s under MIS-schemes are maturing and becoming available for harvest*" (Poynter, personal communications, 11th July 2012). A detailed explaining into why the MIS was successful, why it collapsed and if it can be resurrected is found in Appendix 8.5.

With an increasing area and volume of plantation timber, Australia has begun to reduce its reliance on Sawn log timber from native hardwood forest. However, state owned government subsidiaries, such as VicForests and Forest Tasmania retained the responsibility to manage state owned native forest for logging operations. As explained by director of corporate affairs at VicForests Nathan Trushell, the majority of Australian softwood plantations provide sawn log for construction framing, whereas the majority of hardwood plantations are utilised for woodchip fibre export. Only a small quantity of plantation hardwood is utilised for high value sawn log. Therefore demand for hardwood sawn log timber, used for durable construction, furniture and flooring, can only be meet from sustainably managed native forests in Australia. As stated by Trushell (2012, 20th July, personal communications) one third of timber harvested from Victoria's native forests is used in hardwood products such as high quality furniture, flooring and building materials, with the remaining 2/3 of harvest utilised for pulp wood used for office paper. VicForests (2012) confirms that in a bid to move away from native forest harvesting, transitioning to a plantation-only timber in Victoria has been suggested. However, currently there are not enough plantations in Victoria to produce the volume required to meet demand for wood and wood products. *"A plantation-only strategy ignores the fact that different timbers have different properties and not all timber can be used for the same purposes" (VicForests, 2012, p. 2).* Furthermore, VAFI (2008) states that due to the variable growth habits of Australian eucalypts, even in the most productive forest types at least half of the standing volume is generally unsuitable for sawn timber production, in turn producing high volumes of harvest wastes. This is supported by Trushell (2012, 20th July, personal communications) claiming there is no proven case where a private commercial sawn log plantation, started up on agricultural land, is economically feasible.

"States in which native forest harvesting occurs have management processes backed by legislation and codes of forest practice designed to maintain environmental values and the productive capacity of forests" (DAFF, 2012, p. 58). According to ABARES (2011), since 1992 when the national forest policy statement was published, state governments have developed ten regional forest agreements (RFA) which encompass most of the native forest timber production areas located in four Australian state. ABARES (2011) confirm that RFAs are twenty year strategies for the sustainable management of the native forest and achieve accreditation of ecologically sustainable forest management (ESFM) systems which aim to:

- Reserve at least 15 per cent of the pre-1750 distribution of each forest type
- Reserve 60 per cent of the existing distribution of each forest type if vulnerable
- Reserve 60 per cent of existing old growth forest
- Reserve at least 90 per cent of high quality wilderness forests
- Reserve all remaining rare and endangered forest ecosystems.

According to Lang (2012, June 20th, personal communication), each state has an over-seeing body (e.g. Vic Forests, Forestry Tasmania) which manages and allocate areas to supply industry with volumes tendered for. Whilst David Pollard of AFPA and Martin Moroni of Forestry Tasmania express their support for RFAs, the Greens and NGOs have been critical of the agreements claiming that replanting native forests after clear felling is not natural. Lang (2012, June 20th, personal communication) concurs by stating there have been accusations about some areas that they are being seeded to a more homogenous species mix, as some species do not recover so well from clear felling. As stated by Moroni (2012, 25th July, personal communications) many Green groups seem to not trust the RFAs, this is explained by Hosking (2012, 24th August, personal communication) of the Wimmera agroforestry network (WAN) stating "*the industry has consistently breached its own Code of Forest Practice since instigated in the mid 1980's and has exploited the forests to the point that significant areas have had to be locked out of productive use due to over cutting by clear fell operations. The conservation movement cannot trust the native forest industry to stick to a sustainable pathway as the edge is always pushed through greed for continued exploitation of the forest beyond sustainable levels and more state subsidies".*

4.1.2 Australia's Timber Deficit Dilemma: Native Forests, Plantations & Imported timber products

Whilst Australia's plantations have increased in size and production over the past two decades to meet Australia's timber and wood product demands, reliance on native Australian forest along with importing wood products is still considerable. According to DAFF (2012), in 2009-10 26 per cent of the total volume harvested was from native forests. According to ABARES (2011) softwood plantations provide 75 per cent of the saw logs produced in Australia, yet such plantations comprise of 0.7 per cent of total forest area. Log supply from hardwood plantation is minimal and is expected to expand over the next two decades. Penfold (2012, 9th July, personal communications) indicates that Australian states have begun privatising or introducing Public Private Partnerships (PPP)[28] in selling off softwood plantations which were planted in the 1960s.

Poynter (2012, 11th July, personal communications) explains that about 40 to 45 per cent of the Australian plantation estate is comprised of MIS-plantings, the remaining plantation estate (over a million hectares) is mostly softwood (pines) which produces a range of products including sawn wood, poles, posts and pulp, and other engineered solid wood products. Softwood already provides approximately 80 per cent of Australia's sawn timber requirements and could provide more except that it is not preferred or suitable for many durable or decorative uses which have traditionally required native hardwood. In regards to Australian native forests, DAFF (2012) explains that 23 million hectares (16 per cent) of native forests are classified as nature conservation reserves which are recognised by the International Union for Conservation of Nature (IUCN) - this figure has risen from 11 per cent in 1998 (ABARES, 2011). ABARES (2007, p. 14) explains that old growth forests are classified as *"ecologically mature forests where the effects of past disturbances are now negligible"* - as of 2006, 74 per cent of Australian old growth forests are protected in nature conservation reserves (ABARES, 2007).

According to Poynter (2012, 11th July, personal communications), only about 5 per cent of Australia's public and privately-owned natural forests and woodlands are now being managed for timber supply, but there continues to be substantial pressure applied by environmental activism to totally eliminate the domestic native timber industry. Whilst a large portion of Australian native forests are protected under nature conservation reserves, ABARES (2011) states that 6 per cent of Australian native forest is classified as 'multiple use forest'. Most multiple-use public forests are available to the public for recreation and tourism and are also utilised for timber harvesting providing most of Australia's native timber products. Whilst small areas of native forest is continually logged, the Greens and numerous NGOs want to increase the protect zones of native forests. ABARES (2007) claim that some of the remaining old growth forest that is not protected in nature conservation reserves are still available for timber production. However, Pollard (2012a) claims that 90 per cent of Australia's timber production takes place in regrowth forests resulting from previous logging. These regrowth forests have provided the basis for sustainable timber production for generations and are strictly managed.

DAFF (2012) indicates that there is a decreasing trend in the expanse of multiple use forest, signalling a reduction in forestry activity in native forests. In the period between 2003 and 2008, the area of multiple-use public forests in which wood production is permitted, decreased from 11.4MHa to 9.4MHa. Furthermore, ABARES (2011, p. 49) states that over the past decade, the volume of plantation harvest logs increased by about 42 per cent, whilst the volume harvested from native forests decreased by 44 per cent. However, as stated by Trushell (2012, 20th July, personal communications) from an international NGO perspective, timber sourced from well managed native forests is more preferred than plantations. *"Australia is seen as a 'basket case' as native forestry is reduced and plantations are being increased"* (Trushell, personal communications, 20th July 2012).

"The volume of logs harvested from plantations has increased because larger proportions of plantation estates have reached harvest age. The decrease from native forests was caused by transfer of forests to nature

[28] Hancock (an American based timber investment management organisation (TIMO)) privatised the state owned Victorian softwood plantations in the late 1990s. The remaining state owned softwood plantations around Australia expected to be privatised in the near future (Penfold, personal communications, 9th July 2012).

conservation reserves" (ABARES, 2011, p. 49). However, Trushell (2012, 20th July, personal communications) believes there is no direct local substitute to natural, Australian hardwood forest timber. Such timber is not available from plantations and is a requirement for construction, furniture and flooring. Vicforests have bi-partisan support from both sides of government and with active support for 'sustainable natural forest management' they appear to be in a position to continue harvesting.

Reduced Forestry in Native forests leading to imported timber

Australia have a timber deficit of around $2bAud each year, native forests that are used for forestry operations make up 5 per cent of all Australian forests, timber produced from these native forests provide the construction industry with sawn log hardwood timber (along with pulp and paper, furniture and flooring). Whilst a small portion of native forest is clear felled each year under RFAs, there has been a push to reduce native forest clear felling and forestry by the Greens to protect Australian unique natural forests. However, according to Poynter (2012, 11th July, personal communications) without Australia's own domestic sawn hardwood industry Australia will be forced to import hardwoods. Those that are of equivalent quality to Australian native eucalypts are mostly sourced from tropical rainforests in developing countries where there are often considerable environmental issues – illegal logging and permanent deforestation. Australian are already importing a great deal of tropical timbers and a considerable portion is suspected of being from illegal rainforest clearing (Poynter, 2012, 11th July, personal communications).

With decreased native forestry operations and less supply of native hardwood timber, there is more pressure of plantation to provide Australia's timber. Pollard (2012a) confirms this by stating gradually state governments have reduced the areas of forest available for harvest which has led to supply uncertainties for log customers. *"In the long run they will contribute to the displacement of certified and sustainable logging practices by uncertified and unsustainable logging practices as supply gradually shifts from Australian sources to imported sources" (Pollard, 2012a, p. 5)*. VicForests (2012) confirm that substitutes generally come from tropical forests (e.g. 'Merbau' for decking) which have sustainability issues. As stated by Penfold (2012, 9th July, personal communications) when the native forests and plantations can't meet the demand of timber, Australia looks to imports from Indonesia, Malaysia, Burma, New Zealand and even Finland and Russia via Storaenzo. By 'locking up' native forests, more pressure builds up on less area to produce Australian sawn log timber for construction and reach the goal of decreasing the timber deficit (Penfold, personal communications, 9th July 2012). As stated by the Construction, Forestry, Mining and Energy Union (CFMEU), Australia is importing approximately one third of sawn log pine from New Zealand - almost 30 per cent of house framing timber in the Australian market is imported and priced below the cost of production (ABC, 2012). The (CFMEU) says hundreds of jobs in the timber industry could be lost and that there needs to be a bigger focus on preventing the flooding of the market with cheap imports (ABC, 2012).

4.1.3 Reliance on Australian Forest Products: Construction & Pulp and Paper Manufacturing

Whilst the forestry industry provides a potential source of forest biomass for energy, numerous industrial sectors rely on the Australian Forestry industry for raw material. The domestic construction sector along with pulp and paper product manufactures both have the opportunity to drive and expand the Australian forestry industry. These sectors also have strong prospects in increasing the utilisation of their wood wastes – either for private energy generation or providing a wood stock for biomass utilisation. As detailed in Appendix 8.6, the Australian construction industry utilises a great deal of softwood, and to a lesser extent hardwood timber and has a strong influence in the choice of building materials incorporated. As confirmed by Pollard (2012a) timber has a far lower energy footprint when compared to substitutes such as concrete and steel. Another major reason for integrating timber into buildings is the aesthetic element; *"a 'warm' timber is a nice material and often psychologically preferred to 'cold' steel"* (Hobday-North & Lacombe, personal communicatitons, 5th August 2012).

In regards to the domestic pulp and paper industry, Lang (2012, June 20th, personal communication) indicates that paper mills and pulp and paper manufacturing plants have been decreasing in Australia over the past few decades. Confirmed by Peck (2012, 20th July, personal communications) the continual closure of Australian domestic sawmills and pulp and paper manufacturing plants has led to a loss of 'value adding' in the industry. As stated by Judith Adjani in an interview with Hoy (2010), the Australian wood chipping industry emerged in the 1980s as an apparent efficient use of wastes from high value native sawn log timer. However, as the international demand for wood chip for pulp and paper increased, so did the quantity of wood chip produced. Today, 80 per cent of native forest harvest is chipped and exported for pulp and paper production, which is feeding the pulp and paper markets (Hoy, 2010). Lang (2012, June 20th, personal communication) confirms this trend by stating the amount of harvest at present is about 1,800,000 m3 with about 600,000 m3 to sawlog, 600,000m3 to pulp and 600,000m3 to export chip (ten years ago was ~900,000 m3 to sawlog). Ximenes et al. (2012) states the use for woodchip depends on the value of end use, therefore there may be a trend towards solid biomass (chips and pellets) competing with pulp and paper in the long run.

Judith Adjani, an advisor to the Australian Greens Party regarding the economics of forestry industry, states that the forestry industry today is facing a serious problem of over-supply in hard wood chips, this is because Australia have both a native forest resource and a very rapidly maturing hard wood plantation resource (in the form of MIS plantation). *"The native forest part of the industry, who's been displaced in this competition for the hard wood chip market, is scrambling for new product opportunities for the native forest resource"* (Hoy, 2010, p. 1). Birley (2012, 3rd August, personal communication) claims there is a decreasing demand for native forest woodchip and a shift towards hardwood plantation chip which has been led by the pulp and paper industry, this is supported by Flanagan (2007) claiming Japan has introduced a policy to only accept FSC certified pulp and woodchip - which is expected to increase demand for plantation pulp and decrease demand of native forest products.

4.2 A Snapshot of Forest Biomass for energy in Australia

For Australia to utilise forest biomass – the future of Australia's forest management and policy must first be defined. Australian Native forests are a contentious issue and conservationists have little trust of the forestry industry due to historical actions. However with trends towards plantations forestry and emerging technical potential, forest biomass remains feasible. The purpose of this section is to provide a snapshot of the current Australian forest biomass field – identifying key actions in industry, economic viability and political agenda.

4.2.1 Australia's Forest Industry & Initial Reservations Towards Utilising Forest Biomass

As illustrated earlier in this chapter, the native forest conflicts over the past few decades have spawned a heavy distrust between the native logging industry and the conservation movement. As stated by Hoy (2010), the proposition of utilising wood waste for energy from native forests, plantations or imported timber is a similar argument that was also presented by the native logging industry with respect to chip exporting through the 1970s and 1980s. Resource economist Judith Ajani explains that chip exporting was proposed to be *"just a sensible utilisation of the waste and we look at where the industry is today, Australia wide, 80 per cent of our native forest log cut is wood chipped primarily for export"* (Hoy, 2010, p. 1). The Risk of a similar fate to that of utilising woodchip as a waste product was identified by campaigners for native forestry and biomass was immediately seen as a potential avenue to supporting and prolonging the native forest logging Industry.

Whitehead (2012, 24th July, personal communication) a former forestry campaigner and member of NGO 'Beyond zero emissions' (BZE), stated that the logging and forestry industry attempted to get involved in forest biomass early. The native logging industry pushed hard for native biomass residues to be accepted as a renewable energy source and a risk was identified by activists and Australian Greens Party that biomass could be 'the logging industries new market to continue operations'. According to Trushell (2012, 20th July, personal communications), VicForests burn 60 tonnes per hectare of native forest harvest residue annually, a resource which could potentially be engaged. However, the Greens claim that *"waste burning is repeatedly used as a stalking horse to gain access to the RECs, in order to create a direct market for burning native woodchips as a means of keeping the native forestry industry viable"* (Birley, personal communication, 3rd August 2012). As indicated by Whitehead (2012, 24th July, personal communication) when forest biomass emerged as a threat to native forests it was immediately opposed by environmental NGOs and the Australia Greens Party - *"Native forestry has been fought and won by activists*" (Whitehead, personal communication, 24th July 2012). Andrew Lang of the world bioenergy association (WBA) believes that the Greens are committed to total closure of all native forest logging in every state, Lang explained that in personal discussions with the Greens leader, Christine Milne, Milne claimed that the Greens would not begin to promote bioenergy until this was accomplished (Lang, personal communications, 20th June 2012).

Whilst the Australian Greens Party has been criticised by industry associations and bioenergy representatives for holding a 'hard-line stance' against native forest biomass, this policy stems from their long term policy towards conserving Australia's native forests. A key reason for the Australian Greens passionate stance against native forestry is born from the Tasmanian old growth forests and decades of dispute between the Logging industry and environmental campaigners. This feud is outlined in Appendix 8.7 and is a key reason for social awareness around logging of Australian native forests. As stated by Birley (2012, 3rd August, Personal communications) the Australian Greens believe native forestry is toxic, a dinosaur industry which has been shedding jobs for years, is fundamentally unsustainable and relies on government subsidies to survive. A sentiment echoed by The Wilderness Society representative Vica Bailey, stating "*Native forest logging is effectively a dinosaur, it is a dying industry - The reality is the world now no longer wants native forest products." (Shannon, 2010, p. 1).* An overview of the Australian Greens Party goals for forests, plantations and wood products are identified in Table 4.2 below.

As the CEO of the AFPA, Pollard (2012a, p. 5) states *"the opposition to forest enterprise arises generally from the green/left part of the political spectrum"*. He claims that the initial target was the protection of old growth forests clear felling, which was followed by the wood chipping as a by-product of harvesting operations in native forests for export to Asia. The forest industry claims that forest activity provides numerous benefits, such as fire control and fuel reduction, establishment of forest roads and access for control of exotic fauna which have proven insufficient arguments against green/left opposition (Pollard, 2012a). Socio-political issues embroiled with forest biomass for energy stem from historical disputes involved in a long and drawn out debate regarding native forest logging operations in Australia. Ajani (2011) refers to the dispute as 'Australia's native forest conflict' which was spawned in the 1960s and continues to evolve today, ultimately playing a key role in impacting Australia's ability to explore the options of forest biomass for energy.

The Australian Greens Party – Measures towards achieving Forestry Goals
- End the export of woodchips and whole logs from native forests.
- End the logging of high conservation value native forests and wildlife habitats.
- End logging in native forests except, once export wood chipping from them is banned, in limited areas where small volumes of timber can be taken from defined areas (under strict conditions and for specialty purposes.)
- Prohibit the use of native forests for electricity generation.
- Nominate Australia's ancient forests for listing on the National/World Heritage registers.
- Abolish Regional Forest Agreements and replace the Commonwealth Regional Forest Agreements Act 2002 to ensure that forests, plantations and the wood productions industry are treated equally with other activities under environmental law.
- Implement a national wood products industry plan that will complete the transition from native forests to existing plantations, including retraining and other assistance for workers and the development of sustainable alternative fibre industries.

Table 4-2 Measures stated by the Australia Greens Party regarding how to meet their goals for forests, plantations and wood products (Schild, 2012)

4.2.2 Political: Exclusion of Native Forest Biomass to RET

In late 2011, an inquiry into the Australian forestry industry was published by the standing committee of Agriculture, Resources, Fisheries and Forestry; entitled 'Seeing the forest through the trees' (CARFF, 2011). Under recommendation 15 the paper stated *"under any version of the RET (or similar scheme), bioenergy sourced from native forest biomass should continue to qualify as renewable energy, where it is a true waste product and it does not become a driver for the harvesting of native forests" (CARFF, 2011, p. 118)*. Following the inquiry's release, the 'Renewable Energy (Electricity) Amendment Regulations 2011 (No.5)' was raised by the federal government's multi-party climate change committee (MPCCC) and backed by the Australian Greens Party. The proposed amendment stated that the regulations amend the previous renewable energy (electricity) regulations to exclude biomass from native forests as an eligible renewable energy resource. This amendment meant that the defined source of 'wood waste' would be altered and would no longer include products, by-products and waste associated with, or produced from, clearing or harvesting native forests (Australian-Government, 2011).

As stated in a letter from federal independent MP Rob Oakeshott to Australian federal MPs, Oakeshott tabled a notice to disallow the Renewable Energy (Electricity) Amendment regulation 2011 (no.5) (Oakeshott, 2012). Oakeshott explained the regulation seeks to remove wood waste that occurs as a consequence of accredited forestry in native and regrowth forestry from any eligibility under the Renewable Energy Target (RET). According to Lloyd (2012), Oakeshott claimed native forest residues should be eligible for RECs as a renewable energy source as long as principles of sustainable management were carriers out, the high value clause was adhered to and that forest biomass is harvested primarily for purposes other than 'energy generation'. Oakeshott claimed the debate what centred around utilising forest waste from sustainable harvests and that not one more native tree would be cut down in the process of optimising the waste resource potential (Lloyd, 2012). Such claims were disputed heavily by numerous environmental NGOs.

Oakeshott failed in his bid to disallow the regulation amendments and native forest residues are no longer eligible for claiming RECs under the RET. Interestingly, during the amendment process, Oakeshott (2012) defended himself against the Australian Greens Party and numerous environmental NGOs who opposed the use of native forest biomass for energy purposes. Oakeshott claimed *"The 'Australian Youth Climate Coalition', 'GetUp!' and others have widely circulated emails suggesting this disallowance will lead to an increase in native forests being burnt, will lead to more woodchips being made, that this is creating 'dead koala' power and generally arguing that this will lead to more forest destruction in Australia" (Oakeshott, 2012, p. 2).* As indicated by Birley (2012, 3rd August, Personal communications), a key concern of the Greens is that if native forest biomass was to begin earning RECs, the native forest logging industry would gain a 'lifeline' in a new profit stream in biomass. In response to the decision, the policy Director of the CEC clearly states their disappointment in a letter to the 'Renewable energy target team' stating "*rather than a blanket exclusion of biomass from native forests under the RET, exclusion should only extend to native forest biomass that cannot be verified as sourced from sustainably managed forests"* (Marsh, 2011, p. 2).

According to Pollard (2012a) *"the exclusion of native biomass from the RET was a political decision and brought in at the insistence of green/left interests in Parliament who object to the principle of natural forest harvesting" (Pollard, 2012a, p. 6).* The decision to exclude native biomass was based on the premise that including native forest biomass in the RET would encourage clearing large areas of native forest solely for biomass energy, an argument counted by the AFPA claiming harvesting native forests solely for renewable energy is neither economically attractive nor the best outcome for greenhouse gas mitigation (Pollard, 2012a). *"Sawlogs earn a far greater return for the land manager when used to produce structural or appearance-grade products than if sold as biomass fuel" (Pollard, 2012a, p. 7).* According to (Poynter, personal communications, 11th July 2012), there is a general expectation that the issue will be revisited if the Liberal-Nationals Coalition wins the next Federal Election, further detail on the Australian political debate surrounding forest biomass documented in Appendix 8.1

Current legislation and lacking social acceptance indicate that native forest residues and products cannot be utilised as a legitimate renewable energy source in Australia. Whilst protest and frustration directed at the recent legislation to excluded native forest biomass for RECs has taken place, opportunity lies on embracing plantation and integrated farm forestry biomass potential to establish a new emerging biomass sector.

4.2.3 Economics: Australian investigation into Plantation Forest residue biomass - RIRDC

Whilst VAFI (2008) confirms that there are substantial volumes of forest biomass produced from clear felling operations including; pulp logs, upper tree portion residues, thinning[29] and wood waste from the sawmilling process, the economic viability of the sector is still widely unknown. In a bid to address the issue of economic viability in Australian forest residue biomass, the Australian government's 'Rural industries research and development corporation' published a report in 2012 to determine the quantities of plantation forest biomass residues and to calculate a cost benefit analysis from extracting the plantation forest residue (Ximenes et al., 2012). The aforementioned report, titled 'determining biomass in residues following harvest in Pinus Radiata forests in NSW' focused on eight Pine plantation sites in Central NSW. As mentioned by Ximenes et al. (2012) findings concluded that whilst Australian plantations have significant volumes of biomass that must be managed or

[29] Thinnings: operations to promote regrowth in plantations

removed (for re-establishment, reduced fire-risk or to improve forest health), removal of available volumes of biomass is not cost effective currently.

The study acknowledged that some biomass is to be retained to ensure appropriate nutrient retention and to minimise soil erosion and compaction, this was approximated by Peck et al. (2011) to be approximately 30 per cent of harvest residue & by Greaves and May (2012) all foliage and 50 per cent of branches. Ximenes et al. (2012) explains that five biomass product components were identified during the study, with small branches and bole wood waste (section of the trunk from stump to the first limb) contributing more than three quarters of the biomass. The full proportional contribution is illustrated below in Figure 4.2.

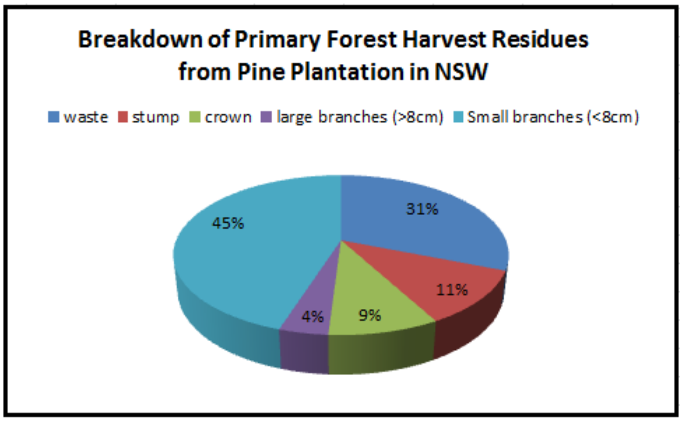


Figure 4-2 Forest Biomass harvest residue from Pine Plantation (Ximenes et al., 2012)

Ximenes et al. (2012) expresses the potential for a win-win situation, with the forest harvest residue to be collected and utilised in a sustainable manner to contribute to national clean energy targets and also reducing costs for plantation re-establishment. In turn, providing a secondary income for plantation forestry and potentially allowing of expansion of plantation forestry in Australia. However, according to Ximenes et al. (2012) the price of Australian biomass (woodchip) in 2012 ranged between $35-$55Aud per green metric tonne and due to the current renewable energy policies and extraction systems in place, the financial costs of biomass production outweighed financial benefits. A cost benefit analysis performed by Ximenes et al. (2012, p. 57) concluded that *"the financial costs of biomass production currently outweigh financial benefits by $21.31/green metric tonne."* Whilst this figure is not expected to change in the short term, predictions for the medium term (4 to 10 years) growth in biofuels are anticipated. Penfold (2012, 9th July, personal communications) states that trials have been performed in Australia with co-firing woodchip and coal, however this has caused issues with boiler operation and has even caused explosions due to aspects of bark and variable Moisture content (MC) hazards. Wood pellets have a more consistent MC for co-firing and reduce risk of damaging plant, however are more expensive and energy intensive to produce.

Whist the economics of large scale primary harvest residue collection is not currently viable, there appears to be opportunity for regional, medium scale forest biomass CHP integration in areas where feedstocks are plentiful and economically accessible.

4.2.4 Industry: Emerging operations

As stated by Penfold (2012, 9th July, personal communications) the small wood industry is a tough game as the sector is the relying on the domestic timber harvest and competing with the woodchip processing and additional wood waste competitors such as construction material (e.g. chipboard). Utilising forest residues comes down to the end use value of these by-products, relating to economies of scale, sourcing, logistics and economic viability (including RECs).

Plantation Energy (PEA)

As mentioned previously, Peck et al. (2011) states that the MIS model acted as a catalyst to stimulate a biofuels export industry in the form of plantation forest harvest residue. Whilst the MIS scheme collapsed in 2009 (Appendix 8.5), the significant increase in the quantity of Australian hardwood plantation provided the springboard for Australia's first 'denisified biomass fuel' (DBF) pellet manufacturer - Plantation energy (PEA). As explained by Denham-Capital and Plantation-Energy (2008, p. 1) PEA aimed to use harvest residues from sustainably managed plantation forests in Australia to produce wood pellets for international trade. According to Lang (2012, June 20th, personal communication) projections by PEA suggested that the figures ranged from 8 million m3 today (mostly from plantation material) and up to 10 to 12 Mm3 by 2013 when blue gum harvest is in 'full swing'.

PEA was responsible for commissioning Australia's first large scale wood pellet plant in Albany, Western Australia; specifically designed to utilise forest plantation waste. According to Denham-Capital and Plantation-Energy (2008) in 2008 Denham Capital[30] invested heavily in the PEA project to become the majority owner, the Albany plant was opened in mid-2009 (Peck et al., 2011). As stated by Denham-Capital and Plantation-Energy (2008) PEA's major market for fuel pellets was Europe, where the demand for wood pellets has increased rapidly since the adoption of the Kyoto protocol and EU RED. It was recognised by Denham Capital at the time of investment in 2008 that *"biomass pellets provide a low-cost and immediate solution to the GHG targets, the projected total demand for DBF pellets in the EU is estimated to be 60 million tons per annum by 2015 and plantation is well position to capture part of that market"* (Denham-Capital & Plantation-Energy, 2008, p. 1). This is confirmed by CEC (2010) claiming that due to the current European renewable energy objectives, bioenergy is a key source of energy for future production in Europe.

According to Peck et al. (2011) PEA strategically commissioned the biomass factory adjacent to the established wood chipping facility to streamline operations and reduce logistical costs. PEA began 2009 operations with an initial target of 150,000 tons in the first 12 months, building to a capacity of 250ktpa in future years ahead (Denham-Capital & Plantation-Energy, 2008). The Albany plant was scheduled to be the first of several pellet plants, with others in planned for Victoria (Heywood) and South Australia (Mt Gambier) (Hamilton, 2011a). As stated by CEC (2010) the opening of the Albany pellet factory followed with two immediate contracts with Belgium and Swiss utility companies. Peck et al. (2011) confirms a 3 year contact deal worth 40EU million with Europe's biggest power company GDF-Suez, the second deal worth 35EU million with Essent Trading, a Swiss energy trading company. Furthermore, in 2011 PEA signed an additional agreement with Japan to supply wood pellet to the growing Asian hub.

According to Peck et al. (2011), PEA planned to utilise forest harvest residues from thinning and harvest activity from plantations alone. Such forest harvest residue is derived from harvested roundwood with ~30 per cent of the timber becoming waste potential for biomass

[30] Denham capital: Global private equity firm who co-own Plantation energy

use. Peck et al. (2011) predicted that biomass from native, hardwood plantation waste is expected to increase from ~700ktpa in 2008 to ~2150ktpa in 2015 - modelling of plantation biomass potential are in line with sustainability practices, meaning that 30 per cent of all forest residues (excluding stumps) were to be left lying for ecological considerations such as returning nutrients to the soil and avoiding erosion. As stated by Ximenes et al. (2012) extracting forest residues is not detrimental to the local soil quality. There is an argument that removal of the fine harvest elements from the forest floor can reduce overall forest productivity in time, and therefore most foresters were happy to leave such residues.

According to Lang (2012, June 20th, personal communication) PEA mothballed in early 2012. Penfold (2012, 9th July, personal communications) explains that there were several reasons why PEA operations may have been discontinued; these include an increased Australian dollar, steep shipping costs (Albany couldn't fill 'distress cargo' and therefore full shipping costs were incurred to the EU), high production costs and ambitious Forecasts[31]. Penfold (2012, 9th July, personal communications) believes that PEA were 'on a good thing' and were simply 'before their time". This is illustrated by deals signed with Japan, with Asian regulations on woody biomass use not 'biting' until 2015. PEA was aiming to meet the market demand in the EU and Japan where a high end value for woody biomass exists. For an Australian domestic perspective, forest biomass as a fuel for stationary energy generation is currently not a mainstream option due to the lower end use value in Australia. However, commercial cases such as PEA allow infrastructure and knowledge to be developed in Australia and provide future opportunity for domestic biomass resource use.

Australian Industry Currently Operating with Primary Harvest Residues

In the wake of PEA, smaller scale Australian forest biomass operations and pilot projects currently exist. Hamilton (2011a) explained that as of 2011 there were five Australian domestic wood pellet producers operating in Western Australia, Tasmania, NSW and Queensland with additional operations such as Australian New Energy in the pipeline. HVP is the largest Plantation operator in Victoria owning 245,000 hectares of plantation, according to Turner (2011) research and operation trials over the past three years have taken place to investigate the economic viability and operation practicality of collecting primary harvest thinning's and residues for biomass utilisation. HVP have calculated the availability of 180,000 green tons per annum of harvest residue over six Victorian plantation locations and are *"continuing operational trials of collection and transport options in various forest types" (Turner, 2011, p. 13).*

One of the most notable operations taking place currently is occurring in NSW with Delta electricity (Delta) and the integration of farm forestry. As stated by Delta-Electricty (2010), Delta[32] has Australia's largest electricity generation capacity and since 2001 Delta has been co-firing 2 per cent woody biomass fuels with coal. In March 2010 Delta began a trial to plant and harvest Mallee eucalypts to use as renewable biomass fuel at one of their four power stations - 200,000 Mallee trees (which are endemic to parts of NSW) have been planted on numerous farms in the Forbes region. Delta`s funding to date has been for planting trials and co-firing trials not any large scale infrastructure. As stated by Delta-

[31] PEA aimed to utilise high bark content: 11 per cent of E. gobulus is bark and this bark was to be used in pellitisation which can be detrimental to machinery (especially when close to sea and bark has increased silica content) (Penfold, personal communications, 9th July 2012).

[32] Delta Electricity provides more than 5,000 MW of electricity from coal & gas along with hydropower and biomass. Delta operates four power plants in NSW.

Electricty (2011) this trial provides an opportunity to assess growth rates and other outcomes from growing Mallee as a biomass crop. In discussion with McMullen (2012, 23rd July, personal communications), DPI NSW performed workshops in 2012 to generate interest in integrating farm forestry on existing farm land. As stated by Peck et al. (2011) integrating farm forestry traditionally had been unsuccessful with a lack of uptake and interest, however the DPI NSW approach of having farmers offer land and receive returns on each 3 year harvest is gaining momentum (McMullen, personal communications, 23rd July 2012). Delta electricity has been cooperating with the DPI NSW to utilise feed stocks grown on farmland to co-fire electricity production in NSW. As stated by McMullen (2012, 23rd July, personal communications) *"This project is about integrating a small portion of Mallee into current farming operations, where they are diversifying income streams to insure them against drought as Mallee trees will still produce. This is one key driver to get farmers on board; economic modelling has predicted that 10 per cent Mallee planting will provide the same income as grain production both in terms of carbon sequestration and biomass feedstock production."*

Secondary Mill Waste Operations:

The use of 'secondary mill wastes' such as sawdust, fines and shavings are far more common due to the improved economies of scale and less transport requirements. Key advantage of forest biomass for energy is its thermal qualities and ability to produce steam for industrial applications at a high thermal efficiency and CO_2 benefit. Table 4.3 below outlines numerous regional, decentralised industrial processes which reduce 'pull' on energy grid and decrease transmission and distribution losses[33].

Commercial company	Australian State	Capacity MW	Technology	Forest Biomass & related feedstock's
Visy	Victoria	30	Water tube boiler	Wood waste & sludge
AKD Sawmill	Victoria	15	Thermal Oil Heater	Wood waste
Laminex	Queensland	24	Thermal Oil heater	Wood Waste
Nestle	Queensland	16	Water tube boiler	Wood waste & coffee waste
FEA	Tasmania	20	Water tube boiler	Wood wastes
Starwood	Tasmania	22	Water tube boiler	Biomass
Hyne & Son	NSW	15	Thermal Oil	Heater wood wastes

Table 4-3 Woody biomass fuelled energy systems throughout Industry in Australia (CEC, 2010, p. 25)

Numerous emerging pellet producers are also emerging focused on the domestic Australian heating market. As stated by Managing Director of 'Pellet Fires Tasmania' (PFT), the Tasmanian based firm distribute pellet fired domestic units along with manufacturing and retailing wood pellet fuels (Douglas, personal communications, 21st July 2012). Practical research for this paper included site visits to SEFE, whom are operating a pilot wood pellet plant utilising secondary native forest residue in Eden, NSW. The plant is providing small quantities of pellet for domestic heating and animal bedding with ambitions for utilising residue wastes as a fuel source to power the local mill, plans have been severely slowed with the inability to claim RECs for utilising native forest residues (Mitchell, personal communication, 30th July 2012). Australian New Energy (ANE), based in Geelong, Victoria, is beginning a pilot operation designed to utilise wood wastes for pellet production for both

[33] CHAF (2009) states that leakage of electricity from power lines over significant rural distances can be 10-15 per cent of the amount fed into the start of the line.

domestic heating use and potentially international export. ANE operations are unrelated to native forest biomass, focusing on diverting commercial and demolition wood wastes from landfill to provide a potential stationary energy service (Harwood, personal communication, 3rd August 2012). Furthermore, Lang (2012, June 20th, personal communication) claims that prior to the global financial crisis in 2008 there were three prospectus in the preliminary phases for large scale biomass for stationary energy generation - funding for projects never materialised.

It is evident that the Australia forest biomass sector is in an embryonic state with numerous domestic operations emerging. These operations vary in scale and include several pilot projects testing the viability of the renewable energy source – such initial operations contribute to the learning curve of developing and implementing forest biomass for energy purposes, both from a technical and reputational perspective.

4.3 Forest biomass for Energy in Australia – Drivers & Barriers

As stated throughout the literature analysis, the Australian forest biomass sector is faced with both restrictive forces to prevent further exploitation of native forests along with strong market potential to provide bioenergy. The following section identifies key themes from literature along with findings from stakeholder interviews to outline a range of drivers and barriers relating to the forest biomass sector in Australia.

4.3.1 Drivers of Forest Biomass for Energy

Biomass has the ability to provide base load power where other renewables cannot:

Andrew Lang, board member of the world bioenergy association (WBA) states that Australia needs renewables that are able to provide base load power to allow a reduction in fossil-fuelled sources. Australian base load power production is sourced from coal - in 2009/2010 75 per cent of Australia's total stationary electricity production was sourced from coal condensing thermal operations (BREE, 2012b). Lang continues explaining that biomass to energy is cost-effective, highly scalable and provides on-demand energy and has many other real or potential benefits including production of heat and transport fuels, and bio-chemicals. *"Australia needs this renewable energy option in the repertoire"* (Lang, personal communication, 20th June 2012). Sustainability Victoria's Kelly Wickham states that biomass provides a consistent feedstock and is complementary to the renewable mix, with Adrian Whitehead of BZE stating that biomass could provide sufficient backup for concentrated solar thermal and wind as it provides a consistent energy source. Andrew Lang of the WBA continues by stating it is about the mix of all renewables in their economic availability and provision of energy on demand and in reducing need for energy sourced from fossil fuels, and their emissions. Johansson and Salonen (2008, p. 25) *claims "a condition for bioenergy is being able to play an important role in the global energy transition; we can increase very substantially the production of biomass for energy purposes".* Such as expansion of woody biomass for energy in Australia can be related to both; the increasing volume of MIS plantation harvests, along with the gradual integration of farm forestry (e.g. Mallee plantings.)

Available biomass resource with high electrical and thermal potential:

Ange Nichols of the CEC states that it has been estimated there is enough woody biomass from forest industry activities in Australia to supply 3000 GWh of renewable electricity per year from existing waste streams without harvesting a single extra tree – this equates to 3 million tonnes (or approximately 6 million m3e) of forest biomass (CEC, 2011b; Marsh, 2011). The CEC's Bioenergy Roadmap highlights the potential for almost 11,000 GWh of new bioenergy in Australia by 2020 (CEC, 2008). Kelly Wickham at Sustainability Victoria states Bio-thermal generation provides options for decentralised applications such as commercial and industrial operations, Andrew Bray of environmental campaign group '100 per cent renewable' claims biomass is an efficient use of a waste product and a cheap resource. In regards to international export, Peck et al. (2011) explain that Australia has been identified to have a significant potential to increase biomass production in wood pellets with 4.5 million tonnes per year from harvested plantation waste alone by 2020, estimates by Greaves and May (2012) far exceed both CEC and Pecks et al. predictions. From an Australian perspective, Forest biomass for energy provides CO_2 benefits, fits well with simple and existing thermal technologies, complements the Australian energy profile, it has potential at all scales and there are numerous global examples of successful implementation from which to transfer knowledge (Peck, personal communications, July 18th 2012).

Increased cost competitiveness with introduced 2012 Carbon Price:

The Clean energy Councils Ange Nichols claims that generators that use biomass will become more cost competitive under the carbon price, at which point the additional incentive from the RET will no longer be needed. Climate change scientist Martin Moroni concurs by stating the carbon price has merit to give renewables a chance to increase. Andrew Lang explains that wood pellets and chip fuel for space and industry heat will provide cost-competitive heat with no tax liability. Simon Penfold concurs stating ANE will benefit from the carbon tax as emitters may find a commercial play both with a reduction in emissions and a positive return. The introduction of the Australian carbon price will see the price of electricity sourced from fossil fuels rise, *"this price rise will assist bioenergy generators who are not subject to the carbon tax to compete."* (Ximenes et al., 2012, p. 48).

Continued improvement in communication, management & standardisation of forest operations:

WBA board member Andrew Lang states that the beginning of any movement in forest biomass for energy is to have it acknowledged that there needs to be a supply of far better information, state regulations all need to be improved to prevent abuse and trusted management of forests to be performed by professionals. Imogen Birley of the Australian Greens Party claimed that an improved regulatory situation and sustainable plantation management was essential for forest biomass for energy. Furthermore, Johansson and Salonen (2008) states that in a bid to increase bioenergy usage, a key challenge is how to restrict the negative effects and socio-political concerns that the increased demand for bioenergy may create. As stated by Peck, Bennett, Bissett-Amess, Lenhart, and Mozaffarian (2009), enhancing system reliability through additional regulation and standardisation in the forestry industry has the ability to build trust and knowledge within the forest biomass sector – key aspects of gaining legitimacy identified by Aldrich and Fiol (1994). Recently, the CEC and RIRDC have illustrated their objections to expand the bioenergy and forest biomass sectors, focusing on the communication and awareness of bioenergy on the whole. In 2011 a broadcasting bioenergy workshop was conducted looking at branding, stakeholder engagement and creating communication strategies that could assist in putting bioenergy (in all its forms) on the agenda. As stated by Clean Energy Council policy officer Ange Nichols, *"the workshop was a success and the CEC is developing a bioenergy communications strategy using the learning's from the day"* (Nichols, personal communications, 19th July, 2012). Similarly, the RIRDC distributed a national survey in August 2012 designed to gain a greater understanding of the opinions towards bioenergy with a goal of assisting the Rural Industries Research and Development Corporation (RIRDC) to inform farmers, industry and government agencies about the best way to take part in Australia's bioenergy future.

Integrating Farm Forestry for generating biomass feedstock:

Integrating farm forestry into traditional Australian farming structures has been identified as an opportunity to increase woody biomass feedstocks whilst providing numerous environmental and economic advantages to famers. As stated by Peck et al. (2011), in the past Australian farmers willingness to engage in land use change via afforestation has been low due to perceived risks related to hurdle rates[34]. Integrating farm forestry involves planting native trees as both dual timber production and shelter belts, Peck et al. (2011) continues explaining that up to 10 per cent of a farm property can be strategically planted with trees resulting in improved productivity for existing farm activities such as grazing or grain production. Tilman et al. (2009) concurs by stating the introduction of perennial plants to farmland can increase wildlife habitat, improve water quality, and increase carbon sequestration in soils. Carnegie, Larkin, and McMullen (2012), the coordinators of a 2012 energy tree cropping workshop in NSW, claim that by planting less than 10 per cent of a farm property can provide a return on investment within 5 years - with sale of woody biomass covering the cost of establishment. Strategic plantings into dry land agricultural systems to be harvested on a short rotation has the ability to; produce renewable energy feedstock's, diversifying farm incomes and regional economies by complementing existing agricultural industries, plus provide salinity, biodiversity and erosion benefits. Bernie McMullen from the DPI NSW states that by integrating farm forestry with endemic Mallee species, carbon is stored in deep roots and provides an economically viable biomass feedstock which is unrelated to native forestry. Integrating farm forestry is also supported by NGO BZE, as stated by Adrian Whitehead private farms have the ability to integrate 5 per cent of all farm land with endemic species, producing both saw log and fast rotation fuels. Aptly put by Iestyn Hosking's of the Wimmera agroforestry network, *"smaller biomass plants could easily operate in most towns across the Wimmera region supplying all of the town's energy and exporting significant amounts as well. This could easily be fed by integrated timber production/shelter belts across the farming landscape"* (Hosking, personal communcations, 24th August, 2012).

4.3.2 Barriers & Constraints on Forest Biomass for Energy

Economic viability of Forest biomass for energy:

VicForests Nathan Trushell states that forest biomass is not currently economically viable and there is a need to find more "high value end users" for forest biomass fuels in order to increase implementation. Andrew Lang of the WBA confirms that accessing forest residues is expensive with CEC's Ange Nichols agreeing that economics are not currently viable – Simon Penfold of ANE adds that the economics are against a forest residues industry alone and confirmed that for the export market to succeed the decreasing value of the Australian dollar will be required to assist trade. However, this negative economic stance could be conveyed as 'static thinking' – as was the case in Scandinavia twenty years ago, there is a resource which exists and it is up to the sector to evolve to embrace such potential. Climate change scientist Martin Moroni suggests that there are large establishment costs for commercial use which has inhibited industry players - with current social unacceptance plus large establishment costs there is no movement in the forest biomass sector, 'returns are reasonable but marginal' therefore a big risk to investors. Bernie McMullen from DPI NSW also agrees with sentiment which is backed by RIRDC research. This issue of economic viability was addressed by Liz Hamilton formerly of the Victorian Department of Primary

[34] Minimum rate of return on the farm forestry investment required by the farm owner

industries and provides numerous national and federal avenues of investment of bioenergy projects (DPI, 2011) - these national funding schemes are listed in Appendix 8.8.

Everyone wants to be first to come second – Lack of industry confidence & collective action in the sector:

Martin Moroni of Forests Tasmania explains that because there are few actors producing biomass for energy, no one is willing to be the first one to invest due to the numerous associated risks involved. This sentiment was echoed by Peter Mitchell at SEFE. Such associated risks have been heightened by the performance of PEA and the recent exclusion of native forest biomass for RECs eligibility. Whilst incremental, scaled growth of the forest biomass sector in Australia could provide a feasible pathway of utilising woody biomass, a calculated and collective industry strategy for the emerging sector would be required. Building on Aldrich and Fiol (1994), sectors that take collective action and improve the reputation of an emerging industry are more likely to gain socio-political approval. According to Kelly Wickham of sustainability Victoria, Kelly Wickham and Liz Hamilton of DPI VIC together set up the Victorian Bioenergy Network which swelled to 650 members in the past three years. Liz Hamilton was credited with championing the growth of the network; however Liz Hamilton's role was terminated in 2012 as *'the bioenergy role was seen to be non-core to DPIs more central responsibilities'* (Wickham, personal communications, 7th August, 2012).

Lack of Social Acceptance & Community licence:

Martin Moroni of Forests Tasmania states numerous barriers surround forest biomass for energy such as social conscious where there is a need to influence social understanding and acceptance based on fact and technical advice, not emotive campaigning. Further barriers identified by Moroni include lacking legitimacy, misinformation and 'forest debate fatigue' which he claims exists when the public appear to be frustrated and 'over' the discussion as it has been going on so long. Andrew Bray of environmental campaign '100 per cent Renewables' claims that current understanding of bioenergy on the whole is a major constraint. By adapting the theory of Aldrich and Fiol (1994), it is clear that cognitive legitimacy in understanding forest biomass for energy is low with aspects of reliability and reputation of the industry also lacking. Director of ANE, Simon Penfold claims the Australian Greens Party have managed to capture hearts of urban Australia; urban Australia does not like the idea of native forest logging and therefore bioenergy has been linked with native forests. The CEO of AFPA David Pollard concurs claiming 'green opposition' is a key constraint, with Mark Poynter from the Institute of Forests Australia (IFA) stating the irrational fears spread by environmentalists *"who would have us believe that this is not just something that is attached as a by-product of existing industries, but a whole new rapacious industry that will quickly gobble up our forests and its wildlife"*. Kelly Wickham of Sustainability Victoria aptly states that a key barrier is a community licence to operate; people need to stop thinking native forests when referring to bioenergy - It is a feedstock which is vastly different to wind or solar: its stored solar energy. An example of such resistance towards forest biomass in Australia, was illustrated in an 'e-newsletter' distributed from an environmental NGO in 2012 in reference to the possibility of native forest biomass claiming RECs (EEG, 2012).

Scale of Forest biomass for Energy: Feedstock Supplies & Connectivity with the Grid:

Andrew Lang of the WBA states production of electricity requires scale and supply, which is very variable state to state. Ange Nichols at the CEC also claims there are related issues with feedstock supply. As explained by Peck (2012, 20th July, personal communications), scale issues with biomass feedstock supply are crucial – from a large scale perspective, co-firing wood pellets with coal in Australia would require an enormous quantity and consistent flow of woody biomass, such a supply simply does not exist domestically in Australia[35]. On a small and medium sized scale, whilst market potential may exist, there does not appear to be any evidence of 'incremental capacity building' within the field. From a small scale, regional approach, Andrew Lang explains that the Ballarat renewable energy organisation is promoting small scale, domestic heating units utilising wood pellets, olive pits and wheat waste. However, the expansion of pellet heating has been restrained by the cost of pellets, with current pellets coming from New Zealand. A further small scale example is the Royal children's hospital in Melbourne which installed a pellet fuelled boiler for heat production during a recent renovation. The installation was designed to meet the highest energy efficiency building standards, however sourcing a consistent supply of wood pellets has been challenging and the boiler has been underutilised. Ange Nichols of the CEC also identifies numerous issues with connecting to the grid, which is supported by Imogen Birley of the Australian Greens Party stating Australia's grid is conducive to centralised, base-load coal fired energy generation and not ideal for renewable energy sources[36].

Government Support:

Climate change scientist Martin Moroni states political ideology is a key barrier, claiming currently there is lacking government support to provide an attractive return on investment to investors, therefore there is nothing attracting investors to the forest biomass residue sector. Bernie McMullen at the DPI NSW also claims that lacking government support has made in-roads to the sector difficult. Imogen Birley of the Australian Greens states that government communication about bioenergy is rarely mentioned in discussions with the CEC, with Andrew Lang at the WBA claiming that CEC and government departments such as ABARE ignore bioenergy on the whole and don't consider forest biomass. Building on Aldrich and Fiol (1994), trade associations (such as the CEC) that represent industry to government agencies play a critical role in promoting cognitive legitimacy (understanding) and when an industries public image is threatened. Lang states attention is always given to the new technologies which are more appealing or 'high tech'.

In what looks like finger pointing, the CEC claim barriers include uncertainty in government policy and a lack of support from both government and supply industries which have impacted upon the bioenergy project deployment (CEC, 2011b). As proven by a letter sent from the CEC to the 'Renewable energy target team' in 2011, the policy director of the CEC clearly states their disappointment in the decision to exclude all native forest biomass from REC eligibility claiming it is 'a missed opportunity for bioenergy and will adversely impact jobs and investment in rural areas'. As explained by bioenergy proponent Andrew Lang, evidence of the lacking government support, interest and commitment towards bioenergy and forest biomass for energy was clearly illustrated when Liz Hamilton's role as DPI Victoria's senior bioenergy industry representative was discontinued in 2012. Aldrich and Fiol (1994) claims socio-political legitimacy refers to the process by which key stakeholders (e.g. government officials) accept a venture as appropriate and right given existing norms - in this case it appears that socio-political legitimacy for bioenergy in general is low.

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[35] Delta Electricty plans to replace up to 20 per cent of coal with biomass at its 4 power stations (Delta-Electricty, 2011). Wallerawang is one of Detla's 4 subcritical pulverised fuel fired power stations with a capacity of 1000MW (Nunn et al., 2002) – with an approximate consumption of 1.5million tonnes of coal per year and coals energy density at least double that of wood, a 20 per cent cofiring stategy at Wallerang alone would require approximately 300,000tpa.

[36] Denmark is a prime example of decentralising its grid system, introducing a national strategy to convert its grid over a 30 year period (Peck, personal communications, 18th July 2012).

Environmental impacts from sourcing Native Forests & plantation residues and eligibility of claiming RECs:

Representative of the Australian Greens Party, Imogen Birley claims that there should be no involvement with native forest logging providing residues as a renewable energy and claiming RECs, which is indicated in the recent legislation. Interestingly, Andrew Lang of the WBA believes that the Greens are committed to total closure of all native forest logging in every state - Lang continues that the Australian Greens leader, Christine Milne, said that the Greens would not begin to promote bioenergy until this was accomplished. BZE co-founder Adrian Whitehead agrees that the connection to native forestry is a key barrier. Lloyd (2012) explains that many forest campaigners were concerned with issues surrounding native forest biomass as depicted in Table 4.4.

More than 90 per cent of the state forest harvest is converted to wood chips today.
Allowing native forests to provide biomass to energy will provide a low value replacement for woodchips
Biomass harvesting was likely to involve intensified logging and heightened impacts on soil and biodiversity.
Giving subsidies to the logging industry would undermine opportunities for the development of clean energy technologies.

Table 4-4 Forest Campaigners concerns with Native Forest Biomass

Little understanding of International operations:

Climate change Scientist Martin Moroni states that decision makers and policy makers are isolated and do not understand the potential that is being harnessed in the EU – these decision makers might 'change their tune' if they visited the EU and understood what is possible. A sentiment echoed by WBA board member Andrew Lang and illustrated by 'overseas market trends' in a 2010 CEC report (CEC, 2010).

5 Findings & Analysis

The point of departure of this chapter is that the historical forestry disputes to protect Australian native forests has encompassed and overshadowed the emergence of forest biomass for energy purposes, and to an extent damaged the reputation of bioenergy on the whole. This chapter looks into the most prevalent stakeholders in the Australian forest biomass debate and attempts to identify why certain actors behave the way they do.

5.1 Introduction to Analytical Framework & Stakeholder Analysis

This analysis takes into account perspectives relating to institutional theories proposed by Aldrich and Fiol (1994); Dimaggio and Powell (1983); Oliver (1991) and focuses on the fundamental importance of a stakeholders legitimacy. The stakeholder salience theory proposed by Agle et al. (1997) has been applied to both identify and group the key actors in the forest biomass sector and Australian forestry sector, and to classify stakeholder 'attributes' possessed by each actor.

5.1.1 Stakeholder Salience Theory - Who is important and what are the 'mechanisms' that make them critical stakeholders?

Agle et al. (1997) provide an analytical framework which has been used as a platform to group the key stakeholders in the Australian forest biomass for energy field by attributes, which has assisted in judging their relative salience. The 'Stakeholder salience theory' proposes three key stakeholder attributes which form the basis for how decision makers of a given sector can give priority for competing stakeholder claims. Agle et al. (1997) states the attributes include power; a stakeholder's ability to influence the field, legitimacy; a stakeholder's relationship within the field, and urgency; a stakeholder's claim on the field. The number of attributes (power, legitimacy and urgency) and the relative degree that each stakeholder possesses determines the priority and importance of each stakeholder – the 'mix' of stakeholder attributes determines the type of stakeholder involved. As illustrated below in Figure 5.1 there are seven different stakeholder categories in the framework - a rationalization table explains the difference between each stakeholder typology and is found in Appendix 8.9.

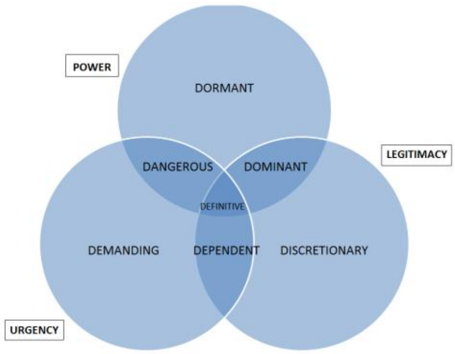

Figure 5-1 Stakeholder salience Theory: stakeholder typology after Agle et al. (1997)

Agle et al. (1997) focuses on 'who and what really counts' and begins by asking: 'What is at stake?' Australian Forest biomass for energy is an intertwined issue as it has two key issues at stake; the first aspect is Australia's native forest and is the key priority of the environmental

NGOs and the Australian Greens. The second aspect at stake is the Australian biomass sector which perceives that it holds the potential to assist Australia reach its renewable energy targets beside current leading technologies such as wind and solar. In regards to 'Who is at stake?', the following section outlines the key stakeholders linked to the development of bioenergy in the forest sector in Australia – emphasis lies on actors with at least two key stakeholder attributes, known as 'expectant' stakeholders and assess each key stakeholders stance.

Perspective 1: 'Conducting Forestry in Australia'

Highlighted within literature and interview discussions, the forestry sector in Australia displays an increasing trend towards plantation forestry along with state managed native forest logging under RFAs. Australia's timber deficit and in particular the use of native forest for timber harvest has been at the head of environmental debate in Australia for decades. The Australian Greens, environmental NGOs and forest activists perceive Australian native forests to be threatened; in turn these groups have developed hard-line strategies to protect Australia's native wilderness for future generations (see Table 4.2 Australian Greens Party goals towards forestry).

As identified in Table 5.1 the key stakeholders involved in 'development of bioenergy in the forest sector in Australia' are mapped out in accordance to conducting forestry in Australia. Table 5.1 illustrates that the Australian Greens and environmental NGOs display marked attributes of urgency to halt native logging along with an element of power to influence social awareness and educate their membership base; however the Greens and NGOs power to influence the political agenda surrounding conducting forestry is limited. In saying this, a hung parliament since 2010 has provided the Greens increased political power. As stated by Trushell (2012, 20th July, personal communications) Vicforests have bi-partisan support from both sides of government as there is no direct local substitute to natural, Australian hardwood forest timber. It appears that the stance taken by this stakeholder category is lacking legitimacy in regards to the hard-line stance it has taken towards conducting forestry in Australia; proposing a shift completely towards plantation forestry, halting all forms of native forestry and replacing RFA's.

Salience	Attributes	Stakeholder
0 Non-stakeholder	-	Large scale Australian Energy Producers with Pilot projects into biomass production: (E.g. Delta Energy)
1 Low: Dormant	Power	Plantation Companies (E.g. HVP)
2 Low: Discretionary	Legitimacy	Private Farmers Regional Shires, Councils & Groups (E.g. CHAF) Clean Energy Council Sustainability Victoria & Victorian Bioenergy Network
3 Low: Demanding	Urgency	Industry for potential implementation of Forest biomass (E.g. SEFE) Australian Biomass producers for Export Australian Bioenergy Associations & support Groups Union
4 Medium: Dominant	Power / Legitimacy	Government Departments (E.g. RIRDC, DAFF)
5 Medium: Dangerous	Power / Urgency	Australian Greens Party Environmental NGOs
6 Medium: Dependent	Urgency / Legitimacy	Australia Forest Product Association Institute of Foresters in Australia
7 High: Definitive	Power / Urgency / Legitimacy	State Management of Native Forests: E.G. VicForests

Table 5-1 Stakeholder typology for conducting Forestry in Australia - After Agle et al. (1997)

On the other hand, the Australian forest industry (represented by the AFPA and IFA), the forestry union and state owned forest managers (VicForests) believe native forests are and must be an integral aspect of forestry in Australia and that plantation provides a complementary timber source. These stakeholder groups have been critical of the Australian Greens for attempting to 'lock up' Australia's native forests. Both the Australian Forest Products Associations (AFPA) and Institute of Foresters (IFA) are classified 'dependent stakeholders' obtaining legitimacy in regards to their relationships with state government forestry departments and their knowledge about new forestry practices and technologies. This stakeholder group also obtains urgency in sourcing a new revenue stream for increasing supply of hardwood – urgency to enter the forest biomass for energy sector on a large scale can be dangerous to both the reputation of the Australia forest industry, and in turn impact on bioenergy proponents bid for an emerging renewable energy sector. Dominant stakeholders hold both power and legitimacy; government department RIRDC and DAFF has power to influence the forestry sector and legitimacy in regards to providing modern forestry alternatives such as selective logging practices for both native hardwood plantation saw logs and biomass feedstocks. Ultimately, the definitive decision maker are the state owned forest managers (VicForests) with attributes of urgency for continual permission from the federal government (DAFF) to access native forest for timber harvest, mild legitimacy in regards to their relationship and bi-partisan support with state government and power to provide areas of multiple use native forest to harvest contractors. However, state owned forest managers have poor reputations and low social acceptance from NGOs due to their historical clear felling of native forests and involvement in the 'native forest conflicts'.

Perspective 2: 'The Forest Biomass for Energy Sector'

As revealed in literature and interviews; bioenergy associations, foresters, the AFPA and the RIRDC recognise the technical and market potential of forest biomass and perceive the emergence of forest biomass for energy sector to be at risk. Table 5.2 illustrates the key stakeholders involved in the 'development of bioenergy in the forest sector in Australia' and maps out the actors involved in the emergence of forest biomass for energy. Table 5.2 illustrates that the bioenergy associations and proponents in Australia appear to have both attributes of urgency to embrace the forest biomass potential, along with mild levels of legitimacy; as they have accurate technical arguments, relationships with the CEC, RIRDC, and Sustainability Victoria, yet lack the reputation, exposure and publicity that other actors (e.g. Australian Greens) obtain. Such bioenergy associations are classified 'dependent stakeholders' as they lack the attribute of power and hence priority to influence decision makers and the wider community in the forest biomass for energy debate. In this instance this stakeholder group remains dependent upon power vested by the CEC.

In regards to the 'dominant stakeholders', this category includes industry group the CEC and government departments with vested interest in forest biomass such as the Rural Industries research and development corporation (RIRDC). This stakeholder group carries attributes of power with a real ability to influence and lead related actors, along with legitimacy to utilise their relationships within the field to play a key role in influencing the emergence of forest biomass for energy. This stakeholder group also encompasses large scale energy utility Delta Electricity. Whilst Delta has a low legitimacy as a coal fired power station, the utility company is currently carrying out a pilot project in conjunction with the DPI NSW looking to produce feedstock's from farm forestry Mallee biomass for co-firing existing boilers – Delta have the ability to provide industry leadership in the forest biomass field by enhancing understanding, awareness and reputation of both the farm forestry and forest biomass for energy.

Salience	Attributes	Stakeholder
1 Low: Dormant	Power	- State Management of Native Forests: E.G. VicForests - Unions
2 Low: Discretionary	Legitimacy	- Plantation Companies: E.g. HVP - Private Farmers - Regional Shires, Councils & Groups: E.g. CHAF
3 Low: Demanding	Urgency	- Australian Forest & Product Association (AFPA) - Industry for potential implementation of Forest biomass - Australian Biomass producers for Export
4 Medium: Dominant	Power / Legitimacy	- Large scale Australian Energy Producers with Pilot projects into biomass production: E.G. Delta Energy - Clean Energy Council - Government Departments: E.g. RIRDC
5 Medium: Dangerous	Power / Urgency	- Australian Greens - Environmental NGOs
6 Medium: Dependent	Urgency / Legitimacy	- Sustainability Victoria & Victorian Bioenergy Network - Australian Bioenergy Associations & support Groups
7 High: Definitive	Power / Urgency / Legitimacy	- Federal Government

Table 5-2 Stakeholder typology for the Forest biomass for energy sector - After (Agle et al., 1997)

On the other hand, the Australian Greens and environmental NGOs can be classified ‘dangerous stakeholders’ as they appear to obtain both power to influence members and political counterparts (such as the renewable energy amendment to exclude native forest residues from RET), along with urgency to act on disallowing native forest biomass (conservation of native forestry being a fundamental goal of the Australian Greens). This stakeholder group lacks the attribute of ‘legitimacy’, as stated by Moroni (2012, 25th July, personal communications); Penfold (2012, 9th July, personal communications) campaigning for not supporting the bioenergy industry or other biomass alternatives has been emotive, lacking technical arguments based on fact. Also, this stakeholder group does possess an element of socio-political legitimacy; with the ability to shape social acceptance of forest biomass through trust and reputation received from its supporter base – an underlying reason why forest biomass for energy is currently out of favour. By utilising attributes of power and urgency, the Greens and NGOs have been very effective at influencing public opinion – which has involved increased awareness of native forests and discrediting the forestry industry. This is proven by Penfold (2012, 9th July, personal communications) stating any process related to native forestry loses legitimacy. On the whole, the definitive party that controls all three attributes is the federal government who is responsible for Australia’s renewable energy mix to achieve the RET. Whilst the federal governments ‘renewable energy target team’ may control which renewables will be implemented over the next decade to reach the RET, the current short term, destructive political environmental does not provide great insurance nor confidence into what policies may arise in the near future.

Agle et al. (1997) indicates that stakeholder relationships relate to power dependence and in the case of the Australian forest biomass for energy, the sector is dependent on certain stakeholders acceptance (namely the Greens and environmental NGOs) to survive and thrive. In this instance the NGOs have skilfully captured the role of opinion maker. The Greens and environmental NGOs appear to paint a picture that they have a moral claim on the sector and perceive that the risks to Australian multiple use native forests are more important than developing a new form of bioenergy sector. Whilst the NGOs and Australian Greens have been successful in slowing the native forest logging industry, as an offshoot their activities have essentially halted the biomass sector as well. Building upon Agle et al. (1997, p. 863); influencing groups, such as the Australian Greens or NGOs, with power over a sector can constrain activities so severely that legitimacy claims cannot be met and the emerging forest biomass sector may not survive.

Developing bioenergy in the Forest Sector in Australia

The stakeholder salience framework has outlined the key actors and stakeholder attributes of two key perspectives; 'forest biomass for energy purposes' and 'conducting forestry in Australia'. As illustrated below in Figure 5.2, these two fundamental issues are linked by the common theme of 'developing bioenergy in the forest sector in Australia'. Both forest biomass for energy and Australian forestry contain themes of lacking understanding, socio-political legitimacy, reputation and trust which have been highlighted by Aldrich and Fiol (1994) as constraining factors to an emerging sector.

As identified in Figure 5.2, reputation is a key aspect of establishing socio-political legitimacy. As stated by Whitehead (2012, 24th July, personal communication), the Australian forest logging industry attempted to embrace forest biomass for energy on a large scale and early in the sectors development - this 'niche' was compounded by the potential for gaining subsides in the form of RECs. Utilising forest residues for energy generation was a potential new market for the Australian logging industry which could relieve the pressures of an increasingly competitive hardwood chip market, especially with MIS hardwood plantations coming online. Due to the perceived reputation that the Australian Greens and NGOs held for the Australian logging industry, the Greens moved urgently to oppose the forestry industries actions. As stated by the leader of the Australian Greens Party Christine Milne, such a loophole needed to be closed immediately and the Greens moved urgently to disallow native forest residues to claim RECs (Hoy, 2010).

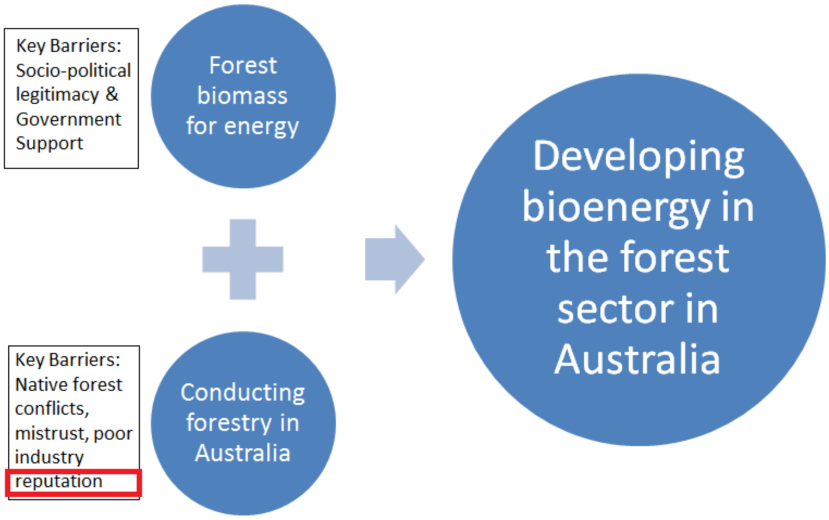

Figure 5-2 Illustrative mapping of the development of bioenergy in the forest sector

It is appears that the Australian forest logging organisation's attempted to enter the forest biomass for energy field as rapidly as they did, spoiled the sectors emergence for embracing wider forest residue opportunities. This can be seen as a strategic error by industry, attempting to 'run before they could walk'. The explicit aim of the Australian Greens and environmental NGOs is to halt native forest logging, which in turn has constrained the logging industry to diversify into forest biomass for energy generation and claiming RECs. This provides evidence that the new emerging biomass energy industry has to deal with the poor reputation of its forestry predecessor. As stated by Aldrich and Fiol (1994) trustworthiness within one context does not automatically serve as evidence of trustworthiness within a broader context, and this must be kept in mind as bioenergy in the forest sector is gradually explored.

5.1.2 Gaining (and losing) Legitimacy, Trust & Support

According to Dimaggio and Powell (1983, p. 150) *"organisations compete for not just resources and customers, but for political power and institutional legitimacy for social as well as economic fitness."* Furthermore, Agle et al. (1997) argues that legitimacy refers to the stakeholders relationships within a sector and involves being socially accepted – legitimate stakeholders are 'the ones that really count' and when combined with power they can obtain authority in the sector. Following the approach from Aldrich and Fiol (1994), Table 5.3 outlines strategies to enhance legitimacy in an emerging sectors development. Legitimacy can be raised in two dimensions, cognitive legitimacy 'knowledge about a new industry', and socio-political legitimacy referring to *"the process by which key stakeholders, the general public, key opinion leaders, or government officials accept a venture as appropriate and right, given existing norms" (Aldrich & Fiol, 1994, p. 648).*

Level of Analysis	Type of Legitimacy	
	Cognitive **development of a knowledge base**	**Socio-political** **Development of trust, reputation & perceptions of reliability**
Organisational	Via symbolic language and behaviours	By maintaining internally consistent stories and information
Intra-industry	By encouraging convergence around a dominant design	By mobilising to take collective action
Inter-industry	By promoting activity through third-party actors	As a reality by negotiating and compromising with other industries
Institutional	By creating linkages with established educational curricula	By organising collective marketing and lobbying efforts

Table 5-3 Strategies to promote new industry development - After Aldrich & Foil (1994)

As revealed in the literature and following interview material, the Australian forest biomass for energy field is fighting against two forces – the first is the natural legitimacy barriers (both cognitive and socio-political) experienced by all emerging industries, *"Low socio-political legitimacy is still a critical barrier to many potential business activities today"* (Aldrich & Fiol, 1994, p. 661). The second is the lack of credibility and acceptance which has stemmed from NGOs and the Australian Greens campaigning against forest biomass for energy, relating to the connection with the Australian forestry industry. Aldrich and Fiol (1994) states that socio-political legitimacy can be measured in three ways; assessing public acceptance of an industry, government subsidies to the industry and stature of its leaders. From the perspective of Australian forest biomass for energy, the stature of the leaders of the two key stakeholder groups vary greatly – the Australian Greens (Christine Milne and formerly Bob Brown) are far better recognised than that of Bioenergy Australia, boosting socio-political legitimacy. Furthermore, forest biomass appears to currently receives less attention from industry groups (e.g. CEC) compared to other renewables, with low levels of knowledge, understanding and acceptance from the general public (Birley, personal communications, 3rd August 2012; Lang, personal communications, 20th June 2012). Building upon Aldrich and Fiol (1994, p. 663), gaining the support and trust of stakeholders (e.g. CEC & Australian Greens) provides the basis to build a knowledge base regarding differentiated bioenergy forms such as plantation forest biomass.

Whilst distrust between the logging industry (supporting a forest biomass sector) and the conservation movement (supporting protection of native forests) originates from decades of dispute, campaigning by the Australian Greens and NGOs has hindered the legitimacy of forest biomass and hence the emergence of forest biomass in Australia. Aldrich and Fiol (1994) explain that there is an enormous variation in the time required for a sector to become established, with a portion of this time reflected by the early founders struggle to develop socio-political legitimacy. Whilst establishing trust and open communication streams are essential for developing socio-political legitimacy, Oliver (1991) outlines numerous strategic behaviours that organisations may employ in response to pressures toward conformity within the institutional environment. Due to the native forest conflicts and the distrust between the NGOs and forestry Industry, it appears that the Greens are not willing to 'compromise' on any aspects of native forest biomass, and the Forest industry do not appear likely to accept the Greens hard line stance on native forests and 'avoid' forest biomass by changing their goals for expanding the forest biomass sector. In this regard, the logging industry may be required to conform to items beyond their comfort zone, and the Australian Greens may be offered items that clash with their forestry goals of how to conduct Australian forestry.

5.2 Findings & Stakeholder Analysis

Five generic 'questions areas' were asked of stakeholders identified in section 5.1. They focus on the status of bioenergy in Australia, the perspectives towards forest biomass for energy and further clarify the issues of legitimacy of the Australian Forest Biomass for energy sector. The findings documented are sources of primary data from personal communication interviews - a full list of interviewees and professional profiles are found in Appendix 8.10.

5.2.1 Stakeholder Analysis: Bioenergy in Australia

Question Area 1: Do you consider that Australia can reach 20 per cent renewables by 2020? Where do you consider that the sources will come from, and will the contribution of Bioenergy play a larger or lesser role?

The majority of responses from interviewees regarding Australia's ability to reach the RET target by 2020 considered that Australia will meet its target. As stated by Ange Nichols of the CEC, the CEC has recently commissioned work which indicates the 20 per cent target can be met and most stakeholders were confident of this. However, in regards to how Australia will meet its target and whether or not bioenergy will play a role, the feedback was mixed. Numerous sources claimed that Wind and Solar PV will be the major contributors due to economics and acceptance, Imogen Birley of the Australian Greens Party claimed that *"Australia could actually meet the demand by Wind alone - Wind is cheap, commercially available, well understood and established"*. Responses towards bioenergy implementation varied, Andrew Lang, a proponent of bioenergy and board member of the World Bioenergy Association (WBA) claimed *"bioenergy is the only option for larger scale base load or on-demand electricity production along with the range of other energy forms and benefits."* Climate change scientist Martin Moroni added that bioenergy will increase, but today there are substantial 'disincentives', which need to be decreased so that the potential may be reached. Kelly Wickham of Sustainability Victoria, aptly states that *"whilst bioenergy could play a large role, reality says it won't due to a lack of understanding and knowledge of the opportunity resulting in a continued emphasis on wind, solar and perhaps, more so in the future, tidal."*

Whilst Solar and Wind are perceived as the most obvious renewable energy sources in Australia, environmental NGOs and the Australian Greens have had the power to capture support of urban Australians for protecting Australia's native forests, and in doing so have increasingly seen to it that forest biomass from any native forest source is disallowed. This increasing support has been encompassed by emotive campaigning and has successfully eroded socio-political legitimacy of bioenergy. With bioenergy out of favour, focus has shifted towards options of geothermal and tidal, despite the fact that these technologies are far less established technically and are not economically proven.

Question Area 2: Do you believe that bioenergy on the whole is a viable renewable energy source for Australia in the future? If not, why not? If so, then please explain.

In order to understand why the potential of Australian solid woody biomass is not being utilised and doesn't receive consideration along with Solar and Wind, the overall opinions of the stakeholders towards bioenergy were explored. Interesting, every interviewee claimed that bioenergy is a viable renewable energy source in Australia. Ange Nichols of the CEC, indicates that bioenergy is a mature, tested and reliable technology that can provide base load power, which differentiates it from other forms of variable renewable energy such as wind - if the existing barriers related to bioenergy are addressed (cost, feedstock supplies and grid connectivity), then bioenergy could play a big part in Australia's future energy mix. Kelly Wickham of Sustainability Victoria continues on this vein by explaining *"bioenergy is incredibly complementary to the renewable energy mix. The need to obtain a 'community licence' is essential to its implementation and certainties around sourcing material."*

Adrian Whitehead of NGO BZE states that BZE is *"comfortable with Biofuels if used to a minimum"* and that BZE supports bioenergy excluding utilising logs and residues from native forest. However, Imogen Birley of the Australian Greens Party claims that the Australian regulatory system is not as robust as some EU countries, which may impact the effectiveness of such bioenergy applications in Australia. In the words of Liz Hamilton, former bioenergy industry officer at DPI Victoria; *"when the wind don't blow and the water don't flow and the sun don't glow, then bioenergy is the go"* (Hamilton, 2011b). Those that understand the complexities of bioenergy, encompassing the ties to native forestry and the differentiated technologies involved, bioenergy is generally seen as an accepted, viable renewable. However, building understanding to developing a community licence remains a challenge for mobilization of bioenergy.

Question Area 3: Bioenergy is an umbrella term for several different technologies, including liquid fuels for transport (e.g. bioethanol, biodiesel), biogas from anaerobic digestion and solid biomass such as MSW to energy and forest harvest waste for CHP production. How would you describe the understanding of the different forms of bioenergy by the Australian public and by interest groups in the bioenergy debate? How would you describe the acceptance of bioenergy in Australia as a whole?

A key question in regards to the legitimacy of bioenergy in Australia relates to the understanding of bioenergy in general. Material gathered from interviews shows a marked consensus that the understanding and environmental literacy towards bioenergy in the Australian public is very low. Board member of the WBA Andrew Lang, explains that *"the public, journalists, commentators, politicians and environment groups understanding of the various bioenergy technologies, the economics and the several products is all really confused - almost no one has a sound understanding"*. The manager of Bioenergy Australia, a government-industry-research information and networking forum, Steve Schuck mirrors this view by stating *"generally the person in the street probably has little concept of energy generation technologies, and even less so on the intricacies of bioenergy"*. According to spokesman from environmental campaign '100 per cent Renewables' Andrew Bray, "*knowledge of bioenergy is minimal, just not out there at all"*. Andrew Bray continues by stating that whilst bioenergy means dozens of different things, *"numerous members of 100 per cent renewable would immediately link bioenergy to 'burning of old growth forests'.*

Ange Nichols of the CEC claims that *"unlike other forms of renewable energy, energy from biomass covers a whole range of different feed stocks. This complicates the Australian public's understanding of bioenergy – increasing this understanding is something the CEC is working on"*. Whilst Bernie McMullen of DPI NSW stated that understanding for biomass to energy is growing, Kelly

Wickham of Sustainability Victoria claimed that understanding is so low that it's not even on the radar - the government doesn't talk about it, and are more focused on the newer technologies which are an easier sell, like the recent tidal push, along with wind and solar. As stated by Aldrich and Fiol (1994) when knowledge about an industry is complex, it makes it hard others to identify and relate to it. The lack of product differentiation within bioenergy and the general low understanding is a barrier to legitimacy – wind turbines on the other hand; are easier to understand, and therefore gain social acceptance, and subsequently attract investors.

Through understanding comes acceptance, and it's the acceptance of bioenergy that has been a barrier to implementation in Australia to date. Findings from numerous sources that are supportive of the forest biomass for energy sector, explain that negative campaigning against bioenergy and forest biomass to energy by environmental NGOs have been the reason for inaction. Ignorance and lacking environmental literacy also plays a vital role as a constraint to forest biomass for energy - bioenergy advocate Andrew Lang explains that *"public acceptance of bioenergy is totally limited by the prevailing ignorance, which exists as a spin-off of misinformation campaigns by the various vested interest groups."* This sentiment was echoed by David Pollard at AFPA claiming *"there has been a concerted campaign by the Greens to discredit it, especially woody biomass"* along with ANE's Simon Penfold, stating that "*anything related to native forestry loses legitimacy"*. Whilst Imogen Birley of the Australian Greens claimed that there appears to be a growing awareness of bioenergy, Adrian Whitehead of environmental NGO BZE claims that "*there is little product differentiation for bioenergy or biomass - people accept and support numerous elements of bioenergy, but native forestry and liquid biofuels have got caught up as major constraints."*

5.2.2 Stakeholder Analysis: Forest harvest residue biomass

The following section delves into the direct opinions of the identified stakeholders regarding forest biomass for Energy. The following question areas attempt to shed light on how it may be possible to utilise forest biomass as a renewable energy source.

Question area 4: How would you describe your stance towards the use of 'forest harvest residues for energy purposes in Australia'? Do you have any difference in views regarding the use of primary forest harvest waste from forestry operations, such as treetops and branches; and secondary forest harvest waste from mills, such as sawdust?

When asked about the stance towards Forest residue biomass, the most common points of discussion with interviewees entailed historical issues around forestry management in Australia[37], native forest protection, efficient use of waste materials and economics of forest residues. As stated by Andrew Lang of WBA, *"I do have problems with the past unacknowledged bad record of native forest management in most states, however where there is properly managed harvest, and the residues are economically accessible, or where there are milling residues, or where there is a need for fuel reduction thinning around communities and along roadsides - to not allow the ability to use this for energy of any form, including electricity production is blind ideology".* This suggests that the logging industry has not acknowledged that its practices have been flawed, and that its reputation has been developed by its own 'set in its ways' behaviour.

Kelly Wickham of Sustainability Victoria approached the issue from an environmental perspective claiming *"when a definite residue is available and there is no additional impact on biodiversity*

[37] Provides evidence that the new sector has to bear the reputational burdens of its predecessors

value, then its fine". Imogen Birley states that The Australian Greens Party do not support native forest biomass what so ever. However, regarding plantation forest biomass Birley claimed "*in instances where plantations have been established in the right geographical locations and are sustainably managed, then the Greens have no problem with utilising biomass for energy generation*". A sentiment mirrored by members of Australian NGO representatives; Andrew Whitehead and Andrew Bray. From an economic perspective, Rob Douglas of Pellet Fires Tasmania claims that secondary harvest waste is an obvious choice for domestic pellet heater fuel with primary waste having other uses like power generation and industrial uses. However, director of ANE Simon Penfold states that the economics are against 'a forest residue play alone' claiming there needs to be a mix of low cost waste or very high energy sources to make it work.

As stated within the literature, the technical potential of forest biomass in Australia has been well documented, with aspects of forest biomass (e.g. plantation residues) supported by all stakeholders. Evidence from the EU has also indicated that innovation and experience makes industry development and economic viability more possible with time. Aldrich and Fiol (1994, p. 650) state trust and reliability are methods of attaining cooperation based on increasing familiarity and evidence – *"Gaining legitimacy is shaped by the interpersonal process of achieving trust in the organising process".*

Question 5: If you were to quantify your perspective towards forest harvest waste to energy, on a scale of 1 to 10; (1 being heavily against and 10 heavy in support), where would you be placed?

Figure 5.3 provides an overview of stakeholder's opinions towards forest biomass in Australia. Findings indicate that forest biomass from plantation and integrated farm forestry, excluding native forest biomass operations, is recognised and supported by all stakeholders interviewed. To leverage such support and increase social acceptance, it is largely dependent on the gained trust from NGOs and the Australian Greens, along with the transparent and robust integration of small and medium scale forest biomass implementation aimed at gaining reputation for the renewable energy technology. However, as stated by Birley (2012, 3rd August, Personal communications), trying to talk about a separate consideration of plantation residue biomass and native forest residues has been politically impossible, which indicates it is not realistic for the Greens to support plantation residues, when they have such an insistent stance against native forestry logging and residue use.

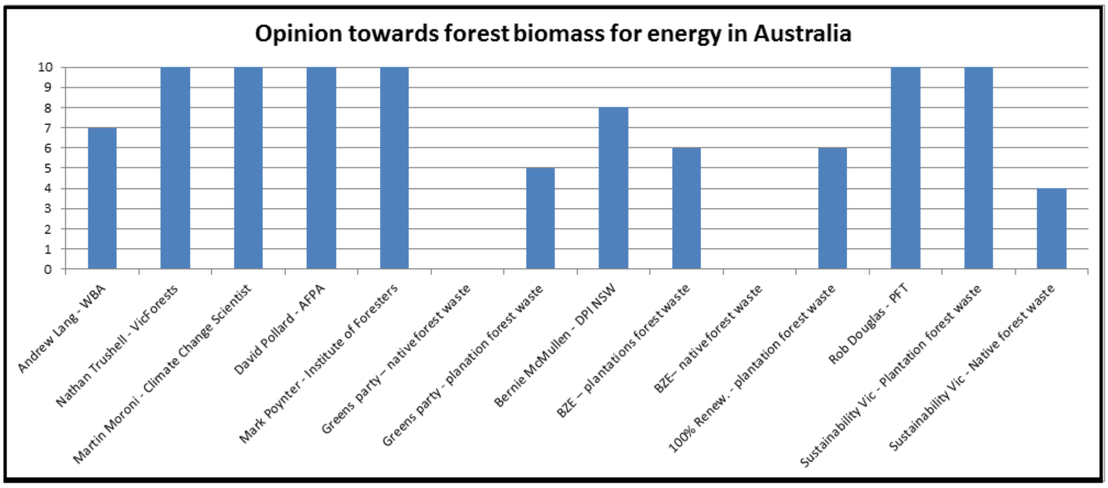

Figure 5-3 Collated results from Stakeholder opinion towards Forest biomass for energy

6 Discussion

Under the current circumstances, biomass sourced from 'multiple use native forest' is socially unacceptable and is ineligible for claiming financial support in the form of RECs. This thesis finds that ultimately this has come about because the Australian Greens Party and environmental NGOs perceives the future of native forests to be at stake. This stakeholder group's objective is to reduce native forest logging, which has also meant rejecting forest biomass for energy; even if it has meant jeopardising a potential bioenergy source. On the other hand, the attitude of the Australian forestry industry appears to be unwilling to admit to issues of unsustainable forestry practices in the past and it seems that they will not compromise on their approach to forestry in native Australian forests. Whilst the potential to embrace aspects of plantation and farm forestry biomass exist, the Australian Greens do not trust the Australian forestry industry, and have proven to be a more successful at capturing the hearts of the urban Australian political constituents, gaining socio-political legitimacy in the process. The following discussion looks at the research questions proposed in chapter 1 and highlights key themes and recommendations.

Task 1: Why and how is Australian forest biomass utilisation constrained by issues of social and political acceptance?

Why: The Reputation of the traditional logging industry in Australia and mistrust in the industry (after years of unsustainable native forestry practices) from the side of Australian Greens and environmental NGOs has led to reduced reliability, support and acceptance of forest biomass for energy. This has stemmed directly from the Greens and conservationists' goal of severely reducing native forest logging and increased conservation of Australia's multiple use native forests – depicted as Australia's unique natural native forest environment. In a spin-off from the Greens vision for conducting forestry in Australia (shifting towards a majority plantation industry), the emergence of the forest biomass sector has been heavily restricted. The Greens are committed to total closure of all native forest logging in every state and it appears that this stakeholder group will not begin to promote bioenergy until this is accomplished. With social unacceptance, bioenergy has become a politically controversial issue, hence little emphasis from government agencies to encourage and incentivise bioenergy investment. Despite this, numerous commercial ventures have recognised the potential of forest biomass in Australia and have begun developing operations, mostly as small scale pilot projects to test economic feasibility, under the radar to avoid being swept up in socio-political debate. The broad lack of understanding and acceptance is however a major hurdle, with little support expected for forest biomass for energy projects in the short term.

How: The Australian Greens and environmental NGOs have gained increasing support and membership over the past decade which has led to increased power, influence and exposure - Such support has been most evident in urban populations within cities, the Greens have been especially politically successful in appealing to the ideals of city voters in relation to a rural issue. Urgency has also been identified as a key attribute of these stakeholders as they attempt to quickly move on restricting any operations related to native forest logging in Australia. With the Australian Greens increased power and influence, and support from environmental NGOs, they have been able to communicate their visions and in turn gain the socio-political legitimacy to contribute to social acceptance of forest biomass. The recent amended legislation regarding native forest residues eligibility for RECs was seen as a threat to Australian native forests, as well as a threat to the Greens goals of increasing conservation reserves of native forests; hence these stakeholder groups rejected the fiscal support of native forests biomass for energy, along with significantly reducing social acceptance for forest biomass for energy by utilising their reputation to influencing their supporter base.

Task 2: Who are the key stakeholders involved in determining the legitimacy and acceptances of forest biomass, as a part of the renewable energy mix in Australia?

Government and industry departments including the CEC and RIRDC acknowledge the technical potential of utilising Australia's forest wastes as biomass for energy purposes, specifically focusing on plantation harvest residues and integrated farm forestry. These stakeholder groups have identified the advantages of developing a wide array of renewable energy forms, and whilst Australia is abundant in Wind and Solar, they see the opportunity to engage solid woody biomass as a transition renewable which is complementary to the current base load system. These stakeholders obtain both power and legitimacy; however do not have the ability to influence environmental NGOs and the Australian Greens. They do however have the ability to work with industries and regional think-tank's (such as CHAF, WAN and sustainability Victoria) to engage and develop small and medium scale, robust and viable forest biomass to energy systems which can build incremental understanding, acceptance and in time legitimacy. Actors such as Delta electricity also has the ability to lead from a commercial industry perspective, engaging woody biomass and improving awareness through integrated farm forestry. The Australian Greens and the environmental NGOs obtain power to influence social acceptance along with political influence during a hung parliament. This stakeholder group also obtains urgency to protect native Australian forests, and are currently have little regard for bioenergy focusing primarily of Solar and Wind technologies. Bioenergy, including forest biomass for energy, is out of favour due to the Australian native forest conflicts along with connections to international reputations surrounding the Food VS. Fuels debate. Whilst the Australian Greens and environmental NGOs have the power to influence social acceptance and building environmental literacy and understanding of bioenergy, it is highly unlikely that they will due to the past distrust surrounding Australian forestry.

Task 3: How and where can proponents of Australian Forest biomass for energy initially work to establish the social and political legitimacy required for the sector to emerge as a viable renewable energy source?

How: 'Forest debate fatigue' was described by Moroni (2012, 25th July, personal communications) where the public appear to be frustrated and 'over' the discussion as it has been going on so long. Whitehead (2012, 24th July, personal communication) believes that *"Native forestry has been fought and won by activists"*. Such evidence indicates a new operating paradigm surrounding both the Australian forest industry and forest biomass for energy, has been established - one that excludes support for biomass extraction from native forests for energy. Therefore, in order for the Australian forest biomass for energy sector to establish legitimacy, it will require an incremental and calculated approach which involves feedstock which are neutral and accepted by environmental NGOs and the Australian Greens. Whilst economic viability has been identified as a barrier, small scale regional approaches where feedstocks are plentiful provide a real opportunity for industry expansion. Incremental and cohesive industry development, logistics improvements and equipment evolution provide a pathway for a gradual learning curve to be followed, building momentum as innovation takes place.

Where: Regional application is where the establishment of socio-political legitimacy can bud from, such leadership from regional networks, municipalities and local champions are key to conveying the knowledge and understanding required to achieve the ultimate form of legitimacy; being 'taken for granted'. Robust integration of decentralised, regional biomass for energy applications have the ability to 'prove its worth' and gain social understanding, acceptance and support from local stakeholders - acting as an example of forest biomass that is neutrally perceived by the Australian Greens and NGOs, is economically viable and supported by the local community.

New Zealand provides a strong international case for regional implementation of forest biomass for energy with numerous projects focusing on CHP for schools and hospitals. From an Australian perspective, Andrew Lang is seen as a regional leader in the bioenergy space, and proposes an emerging regional approach to forest biomass. Lang (2012, June 20th, personal communication) places emphasis on the need to introduce forest biomass systems in areas where they are most applicable, for example Ballarat, where there is plentiful feedstock and a demand for combined heat and power. Groups such as CHAF (central highlands agribusiness forum) and BREAZE (Ballarat renewable energy and zero emissions) provide an excellent foundation for developing regional action on forest biomass for energy implementation where efficient. With CHAF and BREAZE understanding and supporting bioenergy, the opportunity to mobilize both agribusiness and plantation forest residue for CHP becomes feasible. Once acceptance and reliability is established, further investigation into additional bioenergy projects such as anaerobic digestion for biogas and MSW-to-energy to assist in reducing stress on Landfill can be explored. Both decreasing the regions environmental impact and gaining a reputation as a leader in practical bioenergy integration. As stated by Hosking (2012, 24th August, personal communications) of the Wimmera agroforestry network *"smaller biomass plants could easily operate in most towns across the Wimmera region supplying all of the town's energy and also exporting significant amounts."*

How can forest biomass energy develop sufficient legitimacy to allow it to contribute to Australia's future renewable energy mix?

All interviewed stakeholders agreed that the concept of utilising waste by-products from plantation and private farm forest harvest processes for biomass has potential as a viable renewable energy source – most actors specifically exclude native forest involvement. The Australian native forest conflicts and the historic mistrusting relationship between the Australian forestry industry and Australian Greens Party have ultimately led to an inability to negotiate or agree upon forest biomass use. In order to unlock the technical and market potential of Australian forest biomass, the legitimacy of 'neutral' forest biomass feedstock's (e.g. plantation residues and farm forestry) for energy purposes needs to be developed in the form of enhanced understanding, acceptance, reliability, trust and support.

In a bid to develop legitimacy around forest biomass, influential stakeholders such as the CEC and RIRDC first need to assist organisation such as Bioenergy Australia in developing bioenergy's credentials, reputation and positive exposure in Australia. By placing emphasis on cognitive legitimacy; improving education through product differentiation can assist in enhancing understanding and awareness of all forms of bioenergy, especially forest biomass from plantation and farm forestry sources. Secondly, the political climate in Australia remains a major hurdle to bioenergy projects with minimal support providing zero certainty for future investment. The Australian Greens have appeared to be successful in increasing their supporter base and have utilised their powerful position during the hung parliament to push their key policy agenda's. However, the integration of robust, small scale, regional forest biomass to energy applications in areas of plentiful and accepted forest biomass feedstock has the ability to build socio-political legitimacy by gaining reliability, trust and reputation of forest biomass. Regional development of small scale forest biomass for energy projects which have access to abundant and economically viable feedstock's, has the ability to gain a community licence and develop social acceptance on at a municipal level. By placing emphasis on clear product differentiation of bioenergy forms and developing robust examples of regional forest biomass for energy integration, then further discussions with the Australian Greens and environmental NGOs can take place to identify where bi-partisan support for bioenergy technologies exist, and how these stakeholders can possibly support 'acceptable aspects' of forest biomass without compromising their stance on native forests.

6.1 Recommendations

The following section outlines key recommendations based on the findings and analysis. The findings are aligned with developing the legitimacy of forest biomass for energy in Australia, based on enhancing understanding, acceptance and support for robust forest biomass for energy integration.

Establish a functional system within the sector to drive a regional approach

The appearance of the forest biomass industry requires incremental development and will take time to evolve, the first step lies with regional areas which have an abundance of feedstock which are neutral and accepted by NGOs and the Australian Greens. The following steps involve pioneering small scale projects, building political support for such projects and building relationships with other important actors in the value chain - such as government departments (e.g. RIRDC), energy and plantation companies (E.g. Delta & HVP Victoria) and local industries whom may have an interest in engaging in industrial symbiosis with heat requirements. Further actions to follow include engaging with environmental NGOs for suggestions towards improving the regional system; building strength, reliability and trust.

Differentiate bioenergy products to improve understanding & awareness

Adrian Whitehead of environmental NGO BZE claims that "*there is little product differentiation for bioenergy or biomass - people accept and support numerous elements of bioenergy, but native forestry and liquid biofuels have got caught up as major constraints.*" This has been recognised by the CEC, with a bioenergy workshop in 2011 focused on branding, stakeholder engagement and creating a communications strategy aimed to put bioenergy, in all its forms, on the agenda and to address a lack of understanding and awareness of the sector. This differentiation allows the clear separation of all forms of bioenergy, provides clarity between native forest biomass and alternative forms of woody biomass, and enhances understanding and awareness of the available technologies. An excellent example of the benefits of product differentiation is bagasse. There are numerous Bagasse biomass projects operating throughout Queensland, which utilise agricultural wastes from sugarcane residues which are accepted and taken for granted in Australia. Forest Biomass has the ability to 'piggyback' the similar technology of utilising plantation and farm forestry wastes to provide a legitimate feedstock for regional implementation.

Encourage integrated private farm forestry & plantation residue trials

Integrating farm forestry is an area where environmental NGO (BZE) & Australian Greens agree with woody biomass for energy, and provides an opportunity to capitalise on this lack of resistance between stakeholders. As stated earlier, DPI NSW and Delta electricity are working at increasing engagement of forest forestry providing economic modelling for farmers converting land for forestry. Iestyn Hoskings of the Wimmera agroforestry network claims smaller biomass plants could easily operate in most towns across the Wimmera region supplying all of the town's energy and exporting significant amounts as well. This could easily be fed by integrated timber production and shelter belts across the farming landscape. However, there is a 10-15 year lag time from starting planting to harvesting of thinning's, which could be supplemented or replaced with the use of agricultural by-products (e.g. straw) in large volumes, gradually being replaced by wood waste over time. In terms of Plantation forestry for harvest residue generation, PEA has provided lessons to be learnt for large scale biomass wood pellet production. Continued pilot operations performed by commercial ventures such as 'HVP Victoria' have the opportunity to continue working at improving economic viability of the forest harvest residue supply chain in Australia.

International information transfer

There are numerous examples provided by international applications of forest biomass. From a regional perspective, New Zealand provides a strong example of small to medium scale forest biomass integration. On a larger scale, Andrew Lang suggests part of a solution can be to export to global markets to develop forest biomass infrastructure in Australia - whilst this has commenced through PEA, a strong Australian dollar has dramatically slowed further advances in forest biomass exports. Australia's primary forest residues and secondary mill wastes systems are not developed or economically viable to provide such large quantities as yet; however Sweden and Finland have been developing and improving their domestic forest biomass supply chain for the past twenty years and provide examples of what is possible with long term policy.

6.2 Reflections:

This research project has been an evolving process. An underlying theme within the context of the paper has been the importance of the historical native forest conflicts, which has shaped the current public opinion, social acceptance and legitimacy of operations involving native forest products. For this reason, attention on Australian forestry has been a much larger aspect than previously anticipated involving aspects of Australia's timber deficit, trends towards plantations involving the MIS, state managed native forests utilising RFA's and logging practices. Initially, the scope of the project was to encompass the emerging Australian exporting wood pellet market as an element of Australia's forest biomass sector. Whilst the global demand for biomass wood pellet is still growing, the unsuccessful venture of PEA is the only attempt to-date of producing large scale forest biomass wood pellets in Australia. Due to the unfavourable export conditions (high Australian dollar), along with poor socio-political legitimacy of forest biomass appears to have all but halted large scale wood pellet exports. In regards to the choice of theory and analysis, Agle et al. (1997) provides an ideal framework for identifying key stakeholder attributes within the forest biomass space in Australia - Aldrich and Fiol (1994) provided the greatest assistance in identifying the importance of institutional legitimacy in an emerging industry.

7 Conclusion

The objective of this investigation was to seek clarity into the views and attitudes towards forest biomass for energy purposes in Australia, identifying the key stakeholders involved in both driving, and the factors constraining the renewable energy source. Australia has an active renewable energy target which aims to achieve 20 per cent renewable energy by the year 2020, currently solar PV and wind is receiving the greatest attention, support, and investment to meet the future RET. Bioenergy blankets numerous technologies and energy carriers; forest biomass energy is one form of bioenergy where the technical and market potential, along with the environmental and social benefits has been documented by bioenergy proponents and forestry associations alike. Woody biomass' potential to provide a transition fuel which fits to Australia's existing energy infrastructure with the ability for co-firing is a key driving force.

However, forest biomass for energy to-date has received little support or attention from the federal government, or CEC 'clean energy Australia 2011 outlook' in contributing to Australia's future renewable energy mix. The fundamental constraining factor of forest biomass lies with the historical distrust which has arisen from the native forest conflicts between the Australian Greens Party and Australian forestry industry. Over many decades the source of this distrust sprouts from the Australian forestry industries support for clear-felling of native forests and its claim in the 1980s to utilise 'saw log wastes' for woodchip production – a by-product which has evolved into an enormous export market with over three quarters of Australian native forest log cut wood chipped primarily for export. The Australian Greens and supporting environmental NGOs perceive forest biomass as 'woodchip waste case' all over again, and hence have taken a strong stance to oppose and discredit any operations related to supporting native forestry. This was proven by the leader of the Australian Greens Party claiming they would not promote bioenergy until all native forest logging was closed.

As identified in the findings and analysis, the Australian Greens and environmental NGOs have successfully captured the hearts and support of urban Australia surrounding the protection of Australia's native forests; "the bush". The Greens have gained increasing political and social support over the past decade which has provided increased publicity, exposure and reputation – such support has resulted in enhanced power and urgency to influence their supporters' awareness and understanding regarding key policy objectives; such as bringing a halt to native forestry in Australia. In a bid to disallow the Australian forestry industry from utilising native forest residues, the Greens and NGOs utilised emotive campaigning to discredit bioenergy - such campaigning appeared not to be based on a technical argument against bioenergy, yet it was effective in influencing social understanding, awareness and reputation of forest biomass. Whilst results indicate that the Greens and NGOs accept forest biomass when sourced from sustainably managed plantation of farm forestry residues, the ability to differentiate support for plantation residues and native forest residues is 'politically impossible'. Therefore it is clear that the Greens and NGOs see the protection of native forests more of a priority than assisting the emergence of 'certain aspects' of forest biomass, preferring to focus their attention on alternative technologies such as solar. It is clear that the NGOs and Greens will not support any operations involved with native forestry and will continue to discredit any future attempts to utilise native residues – therefore for forest biomass to emerge, native forestry must essentially remain out of the equation.

Bioenergy proponents and the Australian forestry industry that support the emergence of the forest biomass for energy sector have struggled to gain socio-political legitimacy and support. Findings and Analysis have painted a picture uncovering the key reasons for why the potential of forest biomass has yet to be mobilized. The first reason is the Australian forestry sectors involvement and insistent support for extraction from all forest types; the Australian Greens and environmental NGOs do not appear to have so much against bioenergy or plantation harvest residue per se; however they do not want to support any operations which involved native forestry. The historical reputation of the forestry sector which has been forged by the Australian Greens and environmental NGOs has ingrained distrust, and perception of a lack of reliability in any operations the forestry sector is involved in. The second reason involves the exposure, reputation and general awareness of 'Bioenergy Australia' – a government, industry and research information forum, which has the ability to spread knowledge, understanding and awareness about the numerous forms of bioenergy along with communicating and pushing the bioenergy agenda to key industry associations such as the clean energy council. Whilst Bioenergy Australia provides strong technical and market cases, they lack the power to influence government in supporting the bioenergy agenda along with lacking legitimate exposure through leaders or full support from government subsidies.

This is a story of two sides, two environmental issues at stake, and two valid perspectives. The Australian Greens have a hard-line stance on native forest with a key focus on native forests protection - forest biomass for energy is not a priority. Furthermore, forest biomass for energy is perceived as a potential 'foot in the door' for destructive practices, akin to clear felling for woodchip production. The forestry industry won't admit to their dubious past of developing a full scale woodchip market from native forest wastes and will not accept that native forests residues is an ineligible renewable energy source. The ingrained distrust between the two sides has led to neither side budging on policy, overshadowing and slowing the case for forest biomass for energy.

Forest biomass for energy purposes in Australia has clear environmental and social benefits and can provide a meaningful contribution to the Australian renewable energy mix alongside solar and wind. However, this debate has been overshadowed by the disputes over utilising native forest wastes which has discredited bioenergy and damaged social acceptance. For a forest biomass to energy sector to emerge in Australia, it appears that the approach needs to involve a significant shift away from native forest residues. Key recommendations are twofold; firstly, bioenergy proponents such as Bioenergy Australia with assistance from the CEC need to develop cognitive legitimacy in terms of understanding via product differentiation of bioenergy, enhancing knowledge of different bioenergy technologies and making a clear divide from native forestry involvement. Secondly, integrating small and medium scale, regional forest biomass applications where wood waste feedstocks are readily available and economically viable. A regional approach for forest biomass can be supplemented by other forms of bioenergy (e.g. agricultural wastes and integration of farm forestry), developing a community licence and socio-political legitimacy through enhanced awareness, trust and reliability. If there is to be a future for bioenergy from forests in Australia, then a shift in Australia's public perception needs to occur, slowly building the necessary trust that Australia can still protect the Australian "bush" by using forest biomass for energy purposes. This requires working with local and regional communities to build gradual understanding, acceptance and trust of forest biomass for energy - From little things, big things grow.

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8 Appendix

8.1 Human induced Climate Change and the Search for Legitimate Renewable Energy Alternatives

Until recently the combustion of fossil fuels such as oil, coal and natural gas has traditionally provided the means to quench the human population's thirst for energy. It has been widely publicised that burning fossil fuels for energy, heat and transport generate numerous greenhouse gases emission (GHG) such as those recognised by the Intergovernmental panel for climate change (IPCC) listed in Table 8.1 below. These greenhouse gases have varying potency, or global warming potentials (GWP), are very long-lived in the atmosphere and have the ability to increases the 'mean global temperature', a phenomenon known as global warming (Dow & Downing, 2007). Hartmann (2004) uses the analogy that fossil fuels are 'reserves of ancient sunlight', allowing energy to be produced from oil, coal and gas which is ~300 million years in the making, releasing the stored carbon sinks from the earth subsurface to the atmosphere.

UNFCCC: Kyoto Gas	Key emission sources	Global Warming Potential	Lifespan in the atmosphere
Carbon dioxide (CO2)	Electricity generation	1:1	5-200yrs
Methane (CH4)	Landfill & Wastewater treatment	1:21	12
Nitrous oxide (N2O)	Internal combustion engines	1:310	120
Hydro fluorocarbons (HFCs)	Refrigerants (HFC- 134)	1:1000	11
Per fluorocarbons (PFCs)	Refrigerants (C_4F_8)	1:8700	3200
Sulphur hexafluoride (SF6)	Electrical Switchgear	1:23900	3200

Table 8-1 GHG gases require monitoring & measuring by the UNFCCC – GWP values refer to a 100 year time period. (UNFCCC (2012a) & (Dow & Downing, 2007)

Symptoms and potential risks of human induced climate change were first seriously flagged in 1988 when the World Meteorological Organisation (WMO) and United Nations Environmental Program (UNEP) established the IPCC (Dow & Downing, 2007). Dow and Downing (2007) explain that in 1992 the Rio de Janeiro earth summit adopted the United Nations Framework Convention on Climate Change (UNFCCC), which included signatories of 150 nations along with the European community, and revealed an overlying objective of stabilising GHG concentrations in the atmosphere at 'a level' which would prevent dangerous human induced interference with the climate system.

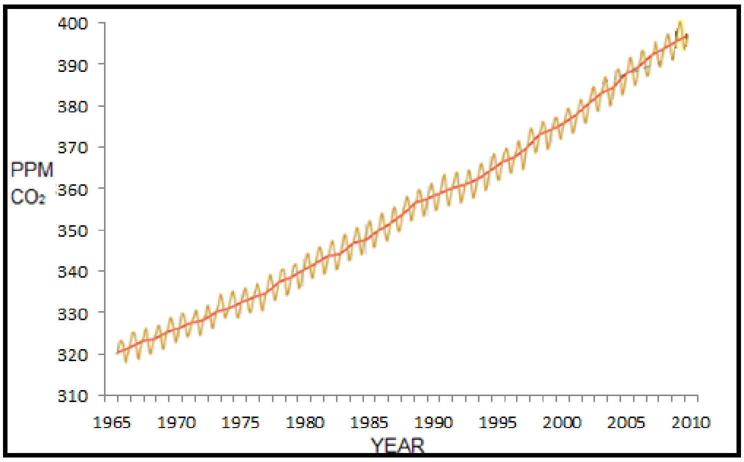


Figure 8-1Depiction of the Keeling curve taken at the Mauna Loa Observatory in Hawaii[38] *(Encyclopedia-Britannica, 2012)*

There is general consensus in the climate science community that mankind has been contributing to accelerated global warming and this is indicated by the IPCC fourth assessment report in 2007 claiming *"most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increased in anthropogenic greenhouse gas concentrations" (IPCC, 2007, p. 10).* Findings, such as the Keeling curve (Figure 8.1) provide evidence of human induced climate change, along with numerous models predicting the detrimental impact on ecosystems, biodiversity, fresh water supply, food security, sea level rising, disease and culture. Whilst the perceived risks are great, the question of how climate change will 'exactly' impact the vital earth's life support systems remains uncertain (Flannery, 2007). Attempts at introducing a binding international agreements for curbing climate change began on the right foot with the Kyoto Protocol in 1997, discussions at succeeding gatherings known as 'conference of the parties' (COP) have taken place annually since 1995. Recently, COP15 in Copenhagen and COP16 Durban have failed to unite industrialised and developing nations in an on-going strategy for long term stabilisation of GHG concentrations (UNFCCC, 2012b).

[38] Annual variations coinciding with the northern hemisphere seasons, with CO2 levels decreasing in the spring with greater photosynthesis & CO2 levels increasing in Autumn

8.2 Australia's political climate & forest biomass for energy policy

Australian Federal Governmental – Uncertain future of support towards bioenergy

The Australian Greens Party has been building a strong membership base over the past decade and to their credit, are strategically well placed in Australian federal politics for continued growth and success. However, Poynter (2012, 11th July, personal communications) states that current political circumstances indicate that the Australian Greens will suffer a hit at the next Federal Election, and the current government will be replaced by a Liberal-National Coalition which is traditionally more supportive of rural industries and doesn't govern as much for the inner city elites who have largely been captured by environmental activism. As stated by Pollard (2012b, 17th July, personal communications), bioenergy will probably play bigger role especially after 2013 election which is expected to bring in a conservative government. Government policy is unpredictable and likely to change on a short term basis, which gives no confidence to investors to put money into sector which may lose backing in the short-term. The case for both the Carbon Tax and eligibility of RECs for native forestry residue.

The Australian Greens approach to forest biomass

As stated by Iestyn Hosking of WAN (Wimmera agroforestry network), there is a "need for the Greens Party policy to move past the Native Forest Logging issue that keeps driving this rejection of biomass. The forest industry has and will continue to also shoot itself in the foot by bringing back in the native forest logging". Both sides of the argument need to consider the statements and policies they keep putting up and what the ongoing consequences may be, the distrust between the groups appear so ingrained that negotiation or agreement appears bleak.

Poynter (2012, 11th July, personal communications) indicates that it would take political resolve to embrace native forest harvest waste and resist the relentless campaigning against by the Australian Greens. In discussion with Australian Greens representative Imogen Birley, the issue of separating the source of the timber harvest residues for awarding RECs is complicated by plantation, native and imported logging origins. The Greens concern is that if RECs were to be awarded to native forest logging, a 'renewable energy subsidy' would essentially be provided to native forest loggers, extending the industries lifespan, an industry that the Greens want to see ended. The Greens also disagree with exporting native forest woodchip to Asia, which in some cases is import back as paper products such as toilet paper. The Green have proposed an alternative option for timber production in Australia, one of which is more heavily reliant on plantation and utilises an extremely stringent standard for sourcing selected native forest for high value timber production.

8.3 Forest Harvest residue collection

In Table 8.2 below, Johansson and Salonen (2008) illustrate the most common form of harvest residue collection along with areas for increased efficiency:

Typical handling of harvest residues	Areas for improved efficiency
specific felling so branches and tops end up in piles on tractor tracks	Key expense: Improve felling techniques, less piles and larger pile sizes equate to more effective off road transport
Residues collected and transported by a tractor and 'converted forwarder'	Key expense: Assess type of machinery for more efficient transport, increase staff training, consider 'bundling' in cutting area.
Residues placed in piles near forest road/highway and covered to avoid snow and rain moisture	Consider the placement of felled residue piles to reduce off-road transport to forest road/highway
On forest road/highway the residues are split with chipping cutter or crusher to produce woodchips. Chips are forwarded straight into containers, requiring large chip volumes to fill containers.	Chip onto the ground and have additional self-loading chip vehicle with 'crane mounted bucket.'
Woodchips are transported to a terminal for processing to pellets	Key expense: If travelling short distances, consider 'cutter vehicle' with trailer, which can chip and transport

Table 8-2 Typical steps in handling harvest residues & transporting wood pellets (Johansson & Salonen, 2008)

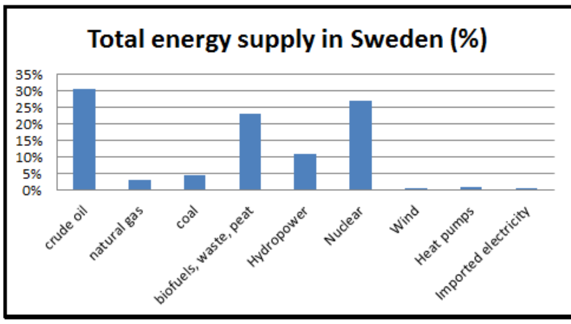
Once raw forest residue material is received at the pellet manufacturing terminal, the raw biomass goes through numerous processes as illustrated below in Table 8.3.

Process	Description
Drying	Required to reduce the moisture content of the raw biomass material to 10 per cent, raw material with a moisture content above 15 per cent will not pelletize.
Grinding	Involves reducing the woodchips to 'wood-flour' which is of a homogenous texture.
Pressing	Entails exposing the wood-flour to steam, heating the reduced forest residue mix to approximately 70C releasing the natural lignin from the wood which acts as 'the glue' to bind the pellets together. Lignin, an organic polymer in the cell walls of plants, binds the pellets together - recycled wood often has a low lignin content. The warmed wood-flour is then pressed with a large rolling press and broken into suitable lengths (between 6mm and 25mm in diameter).
Cooling	Cooling of the pallets takes place which increases the durability of the pellets (Hansen et al., 2009).

Table 8-3 Wood Pellet Production Process (Hansen et al., 2009, p. 13)

8.4 Case study: Sweden forest biomass to energy

As stated by Johansson and Salonen (2008), Sweden is thinly populated with 9 million inhabitants, yet is densely forested. Sweden has a high heat requirement due to the Northern hemisphere winter which provides a strong base for effective combined heat and power from the vast bioenergy resources available. S.E.A. (2011a) confirms that ~30 per cent of the Swedish energy supply is sourced from biomass, waste and peat, which classifies Sweden as one of the highest proportions of bioenergy in EU. Johansson and Salonen (2008) continues that further targets have were identified in 2006 by the commission for oil dependence, setting goals to utilise 40 per cent more bioenergy to heat the countries dwellings by 2020. Whilst production of bioenergy from Swedish forests has been increasing, so have the net standing forest. It is the Swedish energy agencies belief that availability in the future will not be able to meet the entire energy demand, however can substantially contribute to the renewable energy mix. The biomass fuels used in the Swedish energy systems include wood fuels (wood logs, bark, chips and energy forest which are largely regional), black liquors (from pulp and paper production), peat, waste (industrial and domestic) and ethanol. As stated in Figure 8.2, approximately 45 per cent of by-products from forestry operations are used for energy purposes.



Forestry Products	% Feeling	Processing	% Overall Forest Biomass for energy
Saw logs & Woodchip	43%	Sawlog & woodchip mill wastes	4%
Pulpwood	43%	Papermill wastes	23%
Branches & Treetops	6%	District heating incineration	6%
Defective logs & waste	8%	Firewood	8%
			45%

Figure 8-2: Left- Swedish total energy supply 2010 (S.E.A., 2011a) & Right- Biomass for Energy purposes from annual felling in Swedish forests (Johansson & Salonen, 2008)

From a socio-political standpoint, Zaremba (2012) explains that Swedes have a deep connection with their native forests and that forests are ingrained in the Swedish culture. Active forestry has attempted to reach a balance between the environment and production, and where bioenergy is integrated with the extensive forestry industry. *"Environmental targets permeate all of the activities, and there is a fairly strong consensus of opinion that land can be used in a sustainable manner" (Johansson & Salonen, 2008, p. 9)*. Provided that biomass fuels are produced and transported sustainably, biomass fuels will be one of the most important tools for coming to grips with energy and current environmental issues. However, Johansson and Salonen (2008) states that in a bid to increase bioenergy usage, a key challenge is how to restrict the negative effects and socio-political concerns that the increased demand for bioenergy may create.

A recent feature article in a Swedish newspaper (DN.se), demonstrated that even in Sweden, a country with strong social environmental literacy and reputation for political commitment towards environmental responsibility, can experience socio-political backlash towards bioenergy and the related impacts of clear-felling forestry operations on the local environment and rural communities (Zaremba, 2012).

8.5 Managed Investment Scheme Overview

Why was it successful?

Peck et al. (2011) states that in the period between 1997 and 2008, the MIS played a role in planting 700,000 hectares of predominately Australian hardwood plantation. The majority of plantations were planted on land previously used for livestock grazing providing an added value of positive land use change. This Equates to 70,000 hectares of plantation forestry per year for 10 years (ABARES, 2011). Peck et al. (2011) claimed that the MIS is a direct example of successful rapid mobilization of a large scale bioenergy supply chain, however in 2008 severe financial setbacks were experienced and a number of large companies involved in the MIS failed. Failures occurred due to unrealistic claims regarding potential plantation revenues, for example financial cases advertised for plantation forestry were claimed to be 'misleading' where actual financial returns were 50 per cent to 66 per cent of what the prospectus companies projected. This collapse also coincided with South East Australia's worst drought in a century which hampered productivity.

In discussions with Ian Henry, a Certified Financial Planner who advised clients on the appropriateness of MIS investments in meeting their individual financial goals whilst falling within the boundaries of their risk profile, explained that during the early 2000s the Australians stock market was extremely strong and financial advisors were suggesting 'diversification' as a statement of advice. Diversification involved spreading a portfolio across stocks, deposits, property and 'alternatives' (which include investment in forestry, renewables, etc.) which in theory will decrease risk. Independent research from leading professionals within government departments also endorsed the MIS through 'Great Southern' which didn't only encompass plantations, but also Cattle (export to China), organic olives and vineyards. This 'due diligence' suggested that numerous agents were confident in the MIS scheme yielding strong returns. Whilst the 100 per cent tax concession available should have been seen as a 'bonus', it was seen as the major driver and successful investors invested heavily in the scheme to receive tax rewards (Henry, personal communication, 12th July 2012).

Ian Henry was introduced to the MIS in 2005 when it was thriving. He stated that numerous agents failed to mention to their clients that all 'MIS agents' would claim a 5 per cent fee for promoting MIS and an additional 5 per cent marketing fee for every investment. An influencing factor was that this fee was paid from Great Southern's balance sheet and not by the investor, contributing to high expenses (Henry, personal communication, 12th July 2012).

Why did it collapse?

When asked of why the MIS failed, Henry (2012, 12th July, personal communication) explained that Great Southern were incredibly inefficient in their operations. Whilst they had large initial capital, it appears that management became greedy, overspending on overheads (for example of between $4-8MAud per annum on fertiliser alone) and providing generous commission fees to agents promoting MIS.

Henry (2012, 12th July, personal communication) continued that up until 2005 Great Southern was debt free and ranked 104 by capitalisation on the ASX, however began utilising an Australian bank more heavily as the scheme matured. A key factor in the MIS plantation contracts was that MIS operators had 12 months to plant out the plantations. In the later stages of the MIS scheme, Great southern relied on the next year's investments to plant the current year's projects. In 2009 after the Global financial crisis, less people had money to invest for tax deductions, therefore money for projects dried up and debts were not able to be paid back to the bank. In 2009, not only was Great Southern forced into administration, but it had not planted the 2009 years projects – a move that infuriated investors. Penfold (2012, 9th July, personal communications) agreed that that the MIS failed in 2008/2009 due to inefficient operations; however the MIS did achieve the growth of another 1M hectares in the process and whilst numerous investors lost their capital, the scheme cannot be seen as abject failure.

The MIS today - Attempting recovery and first harvest reward

According to Henry (2012, 12th July, personal communication) early investors in the MIS have received returns on investments once plots have met harvest age. The majority of the MIS investments were 10 to 12 year rotation wood chipping for pulp and paper, named 'renewable fibre projects'. Peck et al. (2011) agrees that the first plantations from early in the MIS scheme begun their first commercial harvests in 2008. The majority of plantations grow single products of Tasmanian blue gum ranging from an 8 to16 year rotation, and are utilised for hardwood pulp-woodchips for paper product production and export.

Henry (2012, 12th July, personal communication) indicates that high value timber (HVT) investments were also viable longer term options and will not return for 20 to 25 years, such HVT include hardwood timber for furniture and robust building applications and many of such projects have been abandoned and written off by investors. Peck et al. (2011) confirms that currently the native hardwood is only making a marginal contribution to the shortfall in local sawn hardwood timber. In addition to pulp and sawlog, fragrance oils and carbon plantations are also in use. An offshoot of this increased forestry activity is that the planation harvest waste created from maintenance, harvest and mill waste have provide a potential biofuel for wood pellet production and a new export industry.

According to Penfold (2012, 9th July, personal communications), once the MIS had failed, timber investment management organisations (TIMOs) swooped in and bought out plantations at distressed prices. These TIMOs are experienced, smart players whom have a strategy for dealing with softwood plantations on a ROI of 30 years at 9 per cent per annum. Below in Table 8.4, is an example of the ratio of which initial MIS 'high value timber' Teak plantations were retained by new plantation managers proving numerous MIS plantations were established in unviable locations. As suggested by Lowell-Capital (2011), reasons for management ceasing existing plantations include poor stocking, declining survival, poor growth and exceedingly high maintenance costs. As stated by VicForests (2012) plantation establishment in Victoria dropped from 10240 hectares in 2008 to 2949ha in 2009, this was in direct reaction to the MIS. Trushell (2012, 20th July, personal communications) states it is predicted that on third of all MIS ventures will be sold and returned to agriculture as TIMOs keep only the best options.

Region	High Value timber species	# of Plantation Properties	Plantation Rejection (properties)	Plantation Maintained (properties)
North Queensland	Teak	33	19	14

Table 8-4 MIS Queensland Teak plantations management post collapse (Lowell-Capital, 2011)

8.6 Case Study: Australian Building and Construction Sector

Hobday-North and Lacombe (2012, 5th August, personal communications) indicates that timber has numerous advantages as a sustainable building material. Embedded energy in timber for construction has the ability to act as a carbon sink, and has a lesser environmental impact along its lifecycle compared to alternative building materials. VAFI (2008, p. 8) concurs by stating *"because energy rating schemes and environmental assessments are often not based on full life-cycle assessments for products, the comparative environmental advantages of wood products are often not fully recognised."*

Hobday-North and Lacombe (2012, 5th August, personal communications) are employed in the Australian building and architecture fields and explain that whilst the construction industry is extremely cost driven, there are emerging trends towards timber construction materials. A residential building typically utilises a pine frame (sourced from softwood plantation), and is a traditional method of construction up to 3 stories. The major change is taking place in commercial style building systems with the introduction of engineered structural timber systems that directly compete with steel and concrete structures. Timber is starting to be used to build up to 15 story residential apartment blocks. Lang (2012, June 20th, personal communication) confirms that the largest residential timber building in world is currently being built in Melbourne, Australia.

Hobday-North and Lacombe (2012, 5th August, personal communications) explains if a timber is to be decorative and polished, a native hardwood is generally more appealing and harder wearing than a soft wood. A key driver for integrating hardwood timber into buildings is the aesthetic element "a 'warm' timber is a nice material and often psychologically preferred to 'cold' steel". The main hardwoods from plantation are Blue gum, Blackbutt and Spotted gum but demand exceeds supply. For heavy duty structural timber (e.g. use as roof beams, lintels) kiln dried hardwood (KDHW) are used. When asked about sourcing Australian timber compared to imported timber, Hobday-North and Lacombe (2012, 5th August, personal communications) responded that *"none of the construction projects I've been involved in have a specific requirement to use Australian timber - ultimately it is down to the ethics and knowledge of the Client and Architect."*

In a bid to understand the origin of commercial construction timber in Australia, discussions with a Melbourne based commercial construction company[39] and their timber supplier was carried out. The Australian firm focuses the majority of work with Universities, Schools and multi-unit residential projects. As stated by contract administrator Williams (2012, 11th July, personal communication) ninety per cent of the timber purchased is Radiata pine and plywoods, with only minimal hardwoods purchases. Pine framing, the largest volume of timber sales, is mainly sourced from Australian producers; the pine framing comes from plantations in South East Australia. Baltic pine framing is also sourced from Europe through Storaenso Australia. The imported Baltic pine is mainly larger stud lengths as the local producers have difficulty in producing enough to supply the Australian market. Hardwood supplies are sourced from Australian producers in Victoria and Tasmania, some of this timber is from sustainably managed native forests and some from plantation. Hardwood decking (e.g. Merbau) is also imported from Malaysia and Indonesia, which is only sourced from legally logged and certified suppliers, of which the timber supplier is FSC certified.

[39] Australian SME construction firm Anonymous.

8.7 Case study: Tasmanian Old Growth Forests & Gunn's Ltd

Decades of distrust between the native forest logging industry & environmental NGOs. Source: (Austin, 2011; Flanagan, 2007; Manning, 2012; Manning & Darby, 2010).

Gunn's Limited (Ltd) is one of Australia's oldest timber companies. Gunn's and numerous conservationists, the Australian Greens Party and NGOs have been involved in a bitter and long lasting debate spanning decades in regards to protecting some of Australia's most unique native old growth forest, which has been Clear felled by Gunn's Ltd since the company began operations in the 1880s. Gunn's became a public listed company in the late 1980s and gained a monopoly on forestry in Tasmania, at the same time ties between the Tasmanian government, Tasmanian forestry management and Gunn's also become extremely cohesive. Further clear felling of native forests, large scale burning of harvest waste, introduction of monoculture pine plantations with use of fertilisers and poisons with major focus lying on wood chipping exports (not sawn logs) to Japan, all combined to attract public disapproval. By the mid-2000s Gunn's share price was valued at ~$12Aud. Numerous NGOs, the Greens Party and public protests battled long and hard against the conglomerate which was Gunn's and the Tasmanian government, to conserve native Tasmanian forest and bring a halt to native forest logging. The federal governments at this time supported such native forest operations at the time and did not interject.

After bitter disputes over 2 decades, Gunn's reputation along with global demand for native forest woodchips began to disintegrate; in early 2012 the share price had reduced to $0.16Aud. In 2010, a new CEO was introduced to direct Gunn's in a new direction and immediately announced Gunn's would stop all native forestry operations. This decision was to the disappointment of Forests Tasmania, who provided the allowances for forestry in Crown land. The Greens and NGOs supported Gunn's decision to stop native forestry and are keen to stop Forests Tasmania granting other logging companies the ability to clear fell the remaining Tasmanian old growth forests. Interestingly, Gunn's has moved in a new direction claiming plantation forestry of softwood and hardwood is its key focus, numerous assets involved in native forest logging has been sold (two mills bought out by millionaire environmentalists to turn mills to eco-tourism resorts) and current focus is on a new Pulp mill site in Northern Tasmania, Bell bay. This new mill has been funded by Swedish company who is linked to high environmental credibility – it is forecast that Gunn's new Bell bay pulp mill will make $100 million a year – roughly 8-9 per cent of the mill's total forecast revenue - by selling into the national electricity market and earning RECs. By burning the wood residues or 'black liquor', the mill will generate 180 megawatts of renewable bioenergy, of which 100 megawatts will be sold into the grid.

This bitter argument which has taken place in Tasmania appears to be a relevant factor in establishing the distrust between the Greens, environmental NGOs and the native forestry logging industry. The disregard shown by previous Tasmanian government, Forests Tasmania and Gunn's Ltd to the local landscape, biodiversity, and preserving unique old growth forests for future generations is still very recent and raw to the public whom have witnessed this argument play out. Establishment of trust in such protection of native forests needs to be gained by the public before native forest residue can be considered for utilisation as Biomass. This long term argument has been going on for the past few decades, with similar feuds taking place other states such as Victoria, and appears to be the foundation for the lack of trust for the Australian forestry industry. As an offshoot to this debate in Tasmania, it has become a key constraint to the rejection of forest biomass by environmental NGOs.

8.8 Funding opportunities for Biomass projects in Australia

RET: Large-scale Renewable Energy Target, (LRET) – Eligibility involves power stations that must generate their electricity from approved sources such as wood waste, agricultural waste, bagasse (sugar cane waste), black liquor (a by-product of the paper-making process), or landfill gas. Large scale Generation certificates (LSGCs) can be created and traded in a domestic market overseen by the clean renewable energy regulator; current price of $39Aud/MWhr (Ximenes et al., 2012).
Clean Energy Future Administered by AusIndustry. Assistance to Australia manufacturing businesses to identify and implement technologies that will improve energy efficiency.
Regional Development Australia Fund, (RDAF) Administered by the Department of Regional Australia, Regional Development and Local Government. Assistance to project in rural Australia
Rural Industries Research & Development Corporation. Administered By the Rural Industries Research & Development Corporation, (RIRDC). Research & Development assistance to projects in rural Australia.
Commercialisation Australia, (CA) Administered by the Department of Innovation, Industry, Science and Research. A competitive, merit-based assistance program offering funding and resources to accelerate the business building process for Australian companies, entrepreneurs, researchers and inventors
The First Biomass Fund - Administered by First Climate. First Climate presents a fund which offers an opportunity for investors to achieve high returns and contribute to fighting climate change
The Clean Energy Finance Corporation (CEFC), which offers loans, equity or financing to commercialise and apply renewable energy, or low emissions and energy efficient technologies - those which would otherwise not find a market promoter (Pollard, 2012a).
Carbon Farming Initiative (CFI), provides opportunities for farmers and land managers to gain tradable carbon credit units through projects that store carbon or reduce greenhouse emissions on the land (Pollard, 2012a).

Source: (Hamilton & Scott, 2011)

8.9 Stakeholder Salience Theory: Rationalization Table after Agle et al. (1997) & Peck (personal communications, 18th July 2012)

	Power	Legitimacy	Urgency	Description of stakeholder attributes and behaviour	Description of relevance of such s'holders to manage-ment
Latent	*Latent stakeholders possess one category of salience – these are passive stance stakeholders*				*Latent stakeholders should be noted but are accorded low mgt priority.*
Dormant	P			Powerful but 'sleeping'. No immediate pressing desire to interfere with project, no direct or recognised stake. *Power can be coercive (e.g. military), utilitarian (e.g. money) or symbolic (e.g. media power)*	Management should remain aware of such stakeholders as they may have the means to obtain other attributes.
Discretionary		L		Legitimate recognised place in the project, but no great concerns and low power. *Legitimacy can be held at a social, organisation or individual level or form.*	Not able to directly influence but can obtain support of powerful actors if aroused. Key focus for CSR work!
Demanding			U	Noisy but 'without power' to push their claim and no recognised or accepted stake – where unable or unwilling to acquire power or legitimacy, they remain an irritation. *Urgency is the degree to which stakeholder claims warrant immediate attention.*	Not able to influence but may seek to 'legitimise' itself – for example by adopting Discretionary s'holder, or lobbying a Dormant s'holder.
Expectant	*Expectant stakeholders possess two categories of salience – active stance stakeholders. Expectant stakeholders can obtain definitive status by obtaining a missing attribute.*				*Expectant stakeholders should be accorded moderate mgt priority.*
Dominant	P	L		Powerful and legitimate stakeholders with assured influence on the firm	The expectations of these stakeholders should be important to managers – formal mechanisms often in place.
Dependent		L	U	Urgent legitimate claims on the firm, but little or no power to enforce their will.	Dependent upon internal management recognition or power vested by other stakeholders - most likely to be represented through the guardianship of other s'holders
Dangerous	P		U	Characterised by urgency and power that however lack legitimacy rendering them coercive and possibly even violent	The use of coercive power often associated with illegitimate status.
Definitive	*P*	*L*	*U*	*Definitive stakeholders possess all three categories of salience – priority stakeholders for management*	*Clear & immediate management mandate. Attend to, and give priority to the claims of these stakeholders*

8.10 Interviewee Profiles

8.10.1 List of Interviewees and Professional Profiles:

Name	Organisation/Industry	Profile
Birley, Imogen	The Australian Greens Party	Office of Senator Christine Milne (leader of the Australian Greens Party) (Birley, personal communications, 3rd August 2012)
Bray, Andrew	100 per cent renewable	Communication coordinator at environmental campaign/ NGO (Bray, personal communications, 19th July 2012)
Henry, Ian	Ian Henry financial services	Certified Financial Planner (Henry, personal communications, 12th July 2012)
Hobday-North, Sarah & Lacombe, Stefan	NOWarchitecture & McCorkell Constructions	Urban Design / Architect Contract Administrator - property and construction (Hobday-North & Lacombe, personal communications, 5th August 2012)
Lang, Andrew	WBA & Director of SMARTimbers Cooperative	Forester and board member of the world bioenergy association. (Lang, personal communications, 20th June 2012)
McMullen, Bernie	DPI NSW	Industry Development Officer & representative for 'energy tree cropping workshops 2012' (McMullen, personal communications, 23rd July 2012)
Moroni, Martin	Forests Tasmania - manager of Sustainability Branch as a Carbon Scientist	PhD in Agricultural Science with experience as a Climate Change Scientist working with the forest carbon cycle. (Moroni, personal communications, 25th July 2012)
Nichols, Ange	Clean energy council	Policy Officer (Nichols, personal communications, 19th July 2012)
Pollard, David	Australian Forest Product Association	Chief Executive Officer (Pollard, personal communications, 17th July 2012)
Poynter, Mark	Institute of foresters in Australia & director 'FNRS' (Forest and natural resource services).	Professional forester with over 30 years' experience. A voluntary media spokesperson since 2006 with the Institute of Foresters in Australia. (Poynter, personal communications, 11th July 2012)
Schuck, Steve	Bioenergy Australia - government-industry-research information & networking forum	Manager of Bioenergy Australia (Schuck, personal communications, 29th July 2012)
Simon Penfold	Australian new energy	A director of ANE with 30 years' experience in the Australian forest plantation industry (Penfold, personal communications, 9th July 2012)
Trushell, Nathan	VicForests	Director of Corporate affairs (Trushell, personal communications, 20th July 2012)
Whitehead, Adrian	Beyond zero emissions BZE	Founding partner of environmental NGO BZE. (Whitehead, personal communications, 24th July 2012)
Wickham, Kelly	Sustainability Victoria – state based waste management and resource efficiency department	Project Advisor - Waste Infrastructure and EMS Coordinator (Wickham, personal communications, 7th August 2012)
Williams, David	Anonymous Australian Construction firm.	Contact administrator (Williams, personal communications, 11th July 2012)

8.10.2 Industry Site Visits & Interviews

Organisation	Name	Profile
Australian New Energy (ANE)	Bruce Harwood is a director of ANE and member of locally based Geelong Environmental Council Simon Penfold is a director of ANE with 30 years' experience in the Australian forest plantation industry	ANE proposes to become a major wood pellet exporter in Australia by diverting domestic, commercial and industrial wood waste from landfill for wood pellet production. ANE has recognised that the EU and Asian countries are becoming aware of the great benefits of the renewable & affordable energy source in the form of Wood pellets. (Harwood, personal communication, 3rd August 2012)
South East Fibre Exports (SEFE)	Peter Mitchell: general manager & member of Australian bioenergy association	South East Fibre Exports is Australia's oldest woodchip mill and is situated in Eden, NSW. SEFE is an exporter of native hardwood and plantation softwood woodchip to the paper manufactures of Asia. (Mitchell, personal communication, 30th July 2012)
Pellet Fires Tasmania (PFTas)	Rob Douglas: Managing director of PFTas & involved with pellet manufacturer 'Island bio-energy'	Pellet Fires Tasmania has been trading for 10 years and was initially set up to develop the domestic pellet heating market. The retail business located near Hobart, Tasmania and has diversified and expanded to sell wood heating, electric, gas, solar and pellet heating. (Douglas, person communication, 21st July 2012)