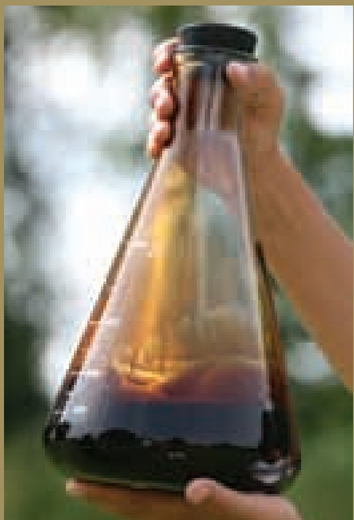
Australian Government

Rural Industries Research and Development Corporation

BIOENERGY Australia

Carbon Trading and Renewable Energy

A discussion paper on carbon credits and bioenergy developments for forestry and agriculture



RIRDC New ideas for rural Australia

ISBN 1 74151 773 7
ISSN 1440-6845
Publication No. 08/184

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Published in November 2008
Printed by Union Offset Printing, Canberra, Australia

RIRDC Shaping the future

Foreword

Global demand for alternative feedstocks for fuels, electricity, chemicals and a range of commercial products has grown dramatically in the early years of the 21st century. This demand is driven by the high price of petroleum, government policies to promote alternatives and reduced dependence on foreign oil, as well as growing efforts to reduce net emissions of carbon dioxide and other greenhouse gases. This paper provides a broad discussion on both carbon management and biomass energy as they relate to the forestry and agriculture sectors.

Analysis in this report indicates that the Carbon Pollution Reduction Scheme (CPRS) in Australia will provide a price signal for investors in regards to carbon pollution, but that at a modest carbon price the CPRS will not provide the stimulus to generate significant investment in bioenergy projects. In the authors view, targeted policy for bioenergy development in parallel to the CPRS is therefore crucial to see Australia achieve deeper cuts in carbon dioxide emissions and make a transition to a low carbon economy.

The importance of this report is that it provides information that will be useful in informing debate about the interactions between bioenergy production and emissions trading. This is highly relevant given the expanding emphasis on bioenergy production and the development of emissions trading schemes in Australia and internationally.

This project was funded jointly by RIRDC and Bioenergy Australia.

This report, an addition to RIRDC's diverse range of over 1800 research publications, forms part of our Bioenergy, Biofuels and Energy R&D program, which aims to meet Australia's research and development needs for the development of sustainable and profitable bioenergy and bioproducts industries and to develop an energy cross-sectoral R&D plan.

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and Development Corporation

Acknowledgements

This discussion paper was originally developed to support discussion at the Bioenergy Australia workshop in Canberra on 26 June 2008. New Forests would like to thank the contributions made by several independent reviewers which led to improvements in the original paper.

Subsequent to the workshop the paper was revised for publication to include recently released information in relation to design of the Carbon Pollution Reduction Scheme. This also provided an opportunity to improve the paper through incorporation of additional comments from the following experts:

- Dr Annette Cowie, Department of Primary Industries NSW
- Dr Kes McCormick, International Institute for Industrial Environmental Economics (IIIEE), Lund University, Sweden
- Dr Stephen Schuck, Bioenergy Australia
- Colin Stucley, Enecon Pty Ltd

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The forestry and agriculture sectors will play a key role in the mitigation of climate change. PIcture of a biomass chipper.

Executive Summary

Purpose

This report was commissioned by the Rural Industries Research and Development Corporation and Bioenergy Australia, with the aim of providing a broad discussion on both carbon management and biomass energy as they relate to the forestry and agriculture sectors. The report is targeted at practitioners within the forestry and agriculture sectors as well as the policy makers within government who are currently making policy decisions in relation to emissions trading and renewable energy.

Background

The forestry and agriculture sectors will play a key role in the mitigation of climate change. Both sectors contribute significantly to the global profile of greenhouse gas emissions and, particularly in Australia, both forestry and agriculture are significantly threatened by climate change. There is potential for on-farm activities to reduce agricultural emissions and increase sequestration of carbon in biomass. The development of biomass energy crops will provide opportunities for diversification of farm operations in conjunction with ongoing food production.

Trees and other plants are solar batteries, taking the energy from sunlight and storing it in chemical form that can be used to generate electricity, heat and liquid fuels. In addition to providing an alternative energy source which can be used to displace fossil fuels, the standing crop acts as a reservoir for carbon (particularly in the case of tree crops). As a result there is interaction between the policy framework for bioenergy development and for emissions trading.

Carbon credits

The Kyoto Protocol provides a framework for emissions trading that includes both the forestry and agriculture sectors. However, while forestry is generally incorporated in scheme design through the inclusion of afforestation and reforestation, the majority of regulatory frameworks for emissions trading do not currently include agriculture. Government proposals for design of the Australian Carbon Pollution Reduction Scheme include forestry (A/R) from scheme commencement (through an opt-in mechanism) but do not include agriculture until 2013 at the earliest. This is consistent with the design of the NSW Greenhouse Gas Abatement Scheme, and the proposals for the New Zealand ETS.

Bioenergy policies

The Australian government implemented the Mandatory Renewable Energy Target (MRET) scheme in 2001 with the goal of supplying an additional 2% of total energy supply from renewable energy by 2010. The current government has set a revised target of 20% of energy supply from renewables by 2020, representing an additional 45,000 GWh of generation at that time. Both the MRET and corresponding State based schemes have restrictions on the types of biomass that are eligible for production of renewable energy. This has significantly restricted the potential production of bioenergy from wood sourced from managed forests and is a contributor to the high cost of production.

Economics of bioenergy

The key drivers for production of bioenergy are the relative price of fossil fuels, cost of feedstock (50-80% of the variable cost), conversion efficiencies, and the policy framework stimulating demand.

Renewable energy certificates (RECs) created under the MRET scheme are currently trading at about $45 per MWh, which in combination with the current electricity price of between $35 and $55 per MWh indicates that an energy price of $80 to $100 per MWh is required to meet the commercial cost of supplying bioenergy in Australia.

Scale of operations has a significant impact on the cost of production, as does the source of feedstock. Cost of production may vary from as little as $60 per MWh for large scale plants using bagasse as a feedstock, up to as much as $180 per MWh for smaller plants sourcing feedstock from dedicated bioenergy crops.

Interactions between bioenergy and carbon markets

There is considerable opportunity to combine both bioenergy production and carbon credits within forestry systems, leading to lower cost of production through cross-subsidisation. Carbon credits could be registered for the sequestration in the standing crop and RECs created from the production of bioenergy, either as a single product from the crop or as part of an integrated operation producing other higher value wood products.

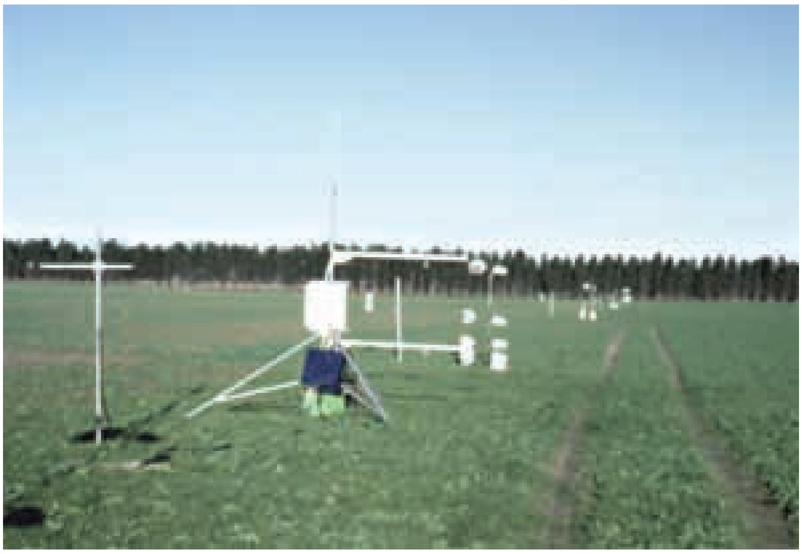
The Australian Government has indicated that the MRET scheme and the CPRS will operate in parallel, at least until the carbon price under the CPRS provides a price point on its own sufficient to stimulate investment in bioenergy. The marginal abatement cost curve for emissions reduction indicates that this will not occur until the carbon price is greater than about $65 per tonne CO_2e (which is unlikely to be achieved in the short to medium term).

Conclusions

The development of a robust and efficient bioenergy industry will provide a range of benefits to Australia in addition to achieving emissions abatement, including the creation of new jobs and development of technologies and services that can potentially be exported. Experience from other sectors indicates that the cost of production will reduce significantly as the industry matures, thereby increasing the competitiveness of bioenergy against other energy sources and reducing the need for complementary measures such as MRET.

Targeted policy for bioenergy development in parallel to the CPRS is crucial to see Australia achieve deeper cuts in carbon dioxide emissions and make the transition to a low carbon economy.

Introduction



Forestry and agriculture are economic activities based on the management of land to produce food, fibre and, increasingly, fuel.

Forestry and agriculture are economic activities based on the management of land to produce food, fibre and, increasingly, fuel. Growing recognition of the need to address climate change has generated interest in expanding the role of forestry and agricultural management in climate change mitigation and adaptation processes. Two key aspects of management are the potential of carbon sequestration and carbon conservation and the use of biomass and biofuel as alternative energy sources. This paper seeks to provide a broad discussion on both carbon management and biomass energy as they relate to the forestry and agriculture sectors. It serves as a background discussion paper for the Bioenergy Australia workshop in Canberra, 26 June 2008, highlighting key information and trends and identifying key points for discussion.

In context, Australia is uniquely situated with respect to climate change because it has:

- High per capita income,
- A large per capita land mass and natural resource base,
- High per capita greenhouse gas emissions (approximately 27 tonnes per capita per year),
- A greenhouse balance that is heavily related to land use change and forestry (land use change and deforestation account for 20% of emissions),
- Significant exports of both fossil energy and products with high embodied fossil energy,
- A substantial exposure to the effects of climate change, both in terms of natural ecosystems like the Great Barrier Reef, but also commercial systems like agriculture.

It has been estimated that as much as one third of the forest and woodland vegetation in Australia (approximately 80 million ha) has been cleared in the past 200 years[1]. While much of this conversion is for agricultural purposes, cleared land can degrade over time, leading to many of Australia's environmental problems, such as salinisation, acidification and erosion.

New land use opportunities are emerging through increased interest in renewable energy. While much of the renewable energy development in Australia to date has been wind power, there have been a number of examples of biomass energy from urban waste, agricultural waste, combustion of forestry waste in coal-fired power plants and pilots of forestry-based biomass energy. Ethanol production from sugar and starch industry wastes has also been established. The capacity to integrate energy production systems with the agriculture and forestry sector has significant potential but has been hampered by low domestic energy prices and a higher cost structure for most bioenergy than for wind power. However, Australia has a world-class scientific and technical foundation for its forestry and agricultural management systems. Expanding the purpose of the forestry and agriculture sector to help to address the challenge of climate change is an important goal for Australia and the world.

[1] State of the Forest Report 2003. http://www.daff.gov.au/brs/forest-veg/nfi/state-forests-report/2003

Forests are an important part of the global carbon cycle.

Land-Based Systems and Climate Pollution Reduction

Forestry Systems

Forests are an important part of the global carbon cycle. In fact, the flux of carbon in and out of terrestrial ecosystems each year is much larger than that related to fossil fuel combustion. The systematic loss of forest cover worldwide over the past 150 years has also contributed about one-third of global greenhouse gas emissions[2]. Even today, loss of forest cover contributes about 20% of global carbon dioxide emissions to the atmosphere[3].

Forests are also significantly threatened by climate change. While there may be some short-term gains in forest productivity due to elevated carbon dioxide levels in the atmosphere, the longer term prognosis is negative. Shifts in climatic conditions can lead to more "disturbance events" such as windstorms, wildfire, insect and disease epidemics, flooding and desertification. Forests that evolved under particular climatic conditions may be unable to adapt to either warmer winter conditions or increases in summer drought.

For these reasons, forests are seen as a key element in the global effort to address climate change. The United Nations Intergovernmental Panel on Climate Change has noted that forests play at least two important roles in the carbon cycle:

1. Forests grow by absorbing carbon dioxide, and reforestation and improved forest management can sequester substantial carbon from the atmosphere.
2. Trees are basically solar batteries, absorbing sunlight and storing it as chemical energy in wood. This chemical energy can be used for direct combustion in bio-energy, as a reductant for mineral smelting or as a basis for liquid fuels like biodiesel or ethanol.

Additionally, wood products are one of the lowest embodied energy building materials, requiring one-tenth the energy of steel or concrete and one-hundredth the energy of aluminum for a given usage. This

2. Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.) (2007) "Chapter 7. CouplingsBetween Changes in the Climate System and Biogeochemistry" Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press. ISBN 978-0-521-88009-1.

3. See above

line of thinking is not directly related to forestry opportunities within an emissions trading context (although relevant to the discussion of harvested wood products below), so the first two roles are focused on here.

Agricultural Systems

Agriculture has a potentially large role to play in climate mitigation strategies, although it generally has not received a prominent position in global negotiations and domestic policies to date. This is partially a result of the highly disparate nature of on-farm activities that could be valued through carbon markets and the established layers of legislation, incentives and tax structures that are already in place related to agricultural land use (for example, Property Vegetation Plans in Australia).

The Australian agricultural sector contributes 93.1 million tonnes of carbon dioxide equivalent, which is 16.5% of Australia's greenhouse gas emissions[4], the second largest sector behind stationary energy. When the use of energy (on-site power, electricity and transportation) is added to primary production activities, the sector actually becomes the largest contributor with 27.6% of emissions[5]. This underscores the importance of agriculture being involved in the emissions trading debate from a mitigation perspective. Another obvious point of intersection is growth in demand for bioenergy.

As such, the important roles for agriculture related to climate change include the following:

1. Several on-farm activities could reduce greenhouse gas emissions or increase carbon sequestration, resulting in carbon credits that could be traded in domestic and international markets.

A focus on energy production would result in new crop types and/or use of agricultural waste that can further developments in the bioenergy sector and provide new income streams for farmers alongside ongoing food production.

In the context of carbon credits, it is important to note that bioenergy provides a permanent emission reduction when it is used to replace fossil fuels. Biomass is already recognised in Australian and European legislation for renewable energy. Similarly, activities within the agricultural sector that result in an avoided emission (e.g. reduced enteric fermentation, reductions in emissions from fertilisers) result in a permanent emission reduction. In contrast, the mitigation effect of carbon sequestered in forests and agricultural soils can be reduced if forests are removed (and not replanted) or there is a change in agricultural practices (e.g. reversion to conventional cropping). As a result of this issue, known as "permanence," additional maintenance obligations are typically imposed on forestry sequestration projects and will presumably also be applied to agricultural sequestration projects in the future.

Table 1 – Forestry and agriculture opportunities

	Forests	Agriculture
Carbon Credits	Opportunities well defined for reforestation/ afforestation, while mechanisms for conservation and improved forest management/reduced logging are still developing. The definition of "woody" material, used in Kyoto Protocol language to define vegetation eligible for carbon sequestration, may become more inclusive over time, leading to the integration of short-cycle wheatbelt crops that may not currently apply under Article 3.3, for example.	Not generally included in regulatory emission trading frameworks, but methodologies and opportunities developing in the voluntary marketplace. Kyoto Protocol national accounting rules for agriculture may form the basis of agriculture carbon credits in global markets.
Bioenergy systems	Forests can generate carbon credits from stock change as trees grow and then potentially add renewable energy credits if biomass is used for energy production; this new investment strategy is in early stages of development and needs to be supported by appropriate legislation for the relevant carbon trades.	Many opportunities for feedstock production (soy, palm oil, grains, new woody crops), using agricultural waste (burning biomass, cellulosic processing) and gas capture (manure management) but limited understanding of how these activities generate carbon credits or renewable energy certificates. The interaction between energy and food production is a key consideration in relation to the use of feedstocks such as soy, palm oil and grains.

4. AGO (2006) "Agriculture Sector Greenhouse Gas Emissions Projections 2006" Department of Environment and Heritage http://www.greenhouse.gov.au/projections/
5. Allen Consulting Group (2006) "Emissions Trading and the Land: Issues and Implications for Australian Agriculture" Report to the National Farmers Federation http://www.nff.org.au/pages/pub/ACG_Emissions%20Trading_April%202006.pdf

Carbon Credits

Significant progress has been made over the last 5 to 10 years in the legal, technical and commercial aspects of incorporating forestry, and to a lesser extent agriculture, in emissions trading regimes. The experience of a number of regulatory systems can be drawn upon to develop future projects in the forestry and agriculture sectors. The following is a summary review of this experience to date.

International Schemes

The Kyoto Protocol

The Kyoto Protocol to the UN Framework Convention on Climate Change, negotiated in Kyoto, Japan, in November 1997[6], was the first international treaty to establish binding national government commitments to specific greenhouse gas emissions limits for industrialised (Annex 1) countries.

The Protocol was groundbreaking in establishing the rules for an international market in greenhouse gas emissions. Land use, land use change and forestry (LULUCF) were among the most hard-fought elements of the Protocol, and final agreements were only completed at the Conference of Parties (COP) 9 in Milan in 2003. While limiting the role of forest sinks, the rules provided a basis to move forward with the operational and commercial development of these new provisions.

Article 3.3

Article 3.3 of the Kyoto Protocol requires Annex 1 countries to track afforestation, reforestation and deforestation processes. The change in carbon stocks associated with these processes during the first commitment period (2008-2012) is added or subtracted from the Assigned Amount (agreed emissions limit) of the country. Australia has established reforestation projects on previously non-forested areas of over 1 million hectares since 1990 (the baseline year of the Kyoto Protocol), and the carbon sequestration in those forests will be added to the Assigned Amount of Australia[7]. The Protocol uses stock change accounting, which converts biomass to carbon stock, and then calculates the net increase (or decrease from fire, harvesting, etc.) over a given period of time. Therefore, areas of immature plantation forest will contribute positively to the emissions balance of Annex 1 countries as the trees grow. Australia will be required to face international scrutiny of its forestry carbon accounting systems to ensure that appropriate best practice guidance is utilised[8].

Article 3.4

The Kyoto Protocol also makes provisions for countries to use stock change accounting related to improved forest management and other land-based sources and sinks. This could include reducing carbon stock losses to fire, extending growth or “rotation

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6. The complete text of the Kyoto Protocol and the Marrakech Accords can be found at http://www.unfccc.int.

7. Note that it is unclear how or if landowners will be compensated or held liable for post-1990 plantings or deforestation that impacts Australia’s national accounting. New Zealand has recently introduced legislation that will devolve credits and liabilities to landowners who engage in reforestation on Kyoto compliant land (and penalties for deforestation on compliant land).

8. The Intergovernmental Panel on Climate Change has published a report on good practice guidelines for land use, land use change, and forestry. The report can be found at http://www.ipcc-nggip.iges.or.jp/public/gpglulucf/gpglulucf.htm.

periods" in production forests and increasing soil carbon in agricultural areas. Countries negotiated a ceiling on the use of Article 3.4, so that massive increases in carbon stock in the extensive forests of Russia, the United States or Canada, for example, could not be used to avoid making emission reductions in other sectors. Because of this ceiling, Article 3.4 provisions may not lead to direct tonne for tonne crediting in the national accounts. Countries must declare in advance which provisions of Article 3.4 they will utilise. This requires careful consideration, as countries that trigger elements of Article 3.4 may introduce the risk that there will be carbon stock losses instead of gains, for example if a warmer, drier climate leads to increases in fire frequency or severity. Australia has elected not to include Article 3.4 in its accounts for the first commitment period.

The Clean Development Mechanism

While developing countries (or non-Annex 1 countries) were not required to take on fixed emissions limitations, they are able to benefit from the Kyoto Protocol via the Clean Development Mechanism (CDM). This Flexibility Mechanism allows Annex 1 countries to invest in emissions reductions projects in developing countries as a means of meeting their emissions reductions limits. Forestry was controversial in the CDM, and final negotiations led to a cap on forestry credits imported by any country to 1% of their Assigned Amount. Again, the credits are only to come from reforestation or afforestation projects. To address the risk of non-permanence in these credits, the CDM rules require that forestry credits are non-permanent, and only defer obligations for a period of 5 to 60 years. These credits are known as tCERs (Temporary Certified Emissions Reductions, 5 years) and lCERs (long-term Certified Emissions Reductions, up to 60 years), depending on the period of obligation to retain the carbon stock.

Implementation of forestry projects has been limited due to the complexity of the project accreditation process and low demand for temporary credits. Forestry projects currently represent just 0.5% of the CDM project pipeline (Figure 1)[9]. Bioenergy projects with approved CDM methodologies include biomass energy from agriculture and forestry residues, forestry biomass, biodiesel and bagasse power generation. These are captured in the renewables category in Figure 1, although only one quarter of the renewables projects are related to biomass energy (compared with 42% hydro, 21% wind and 11% biogas flaring).

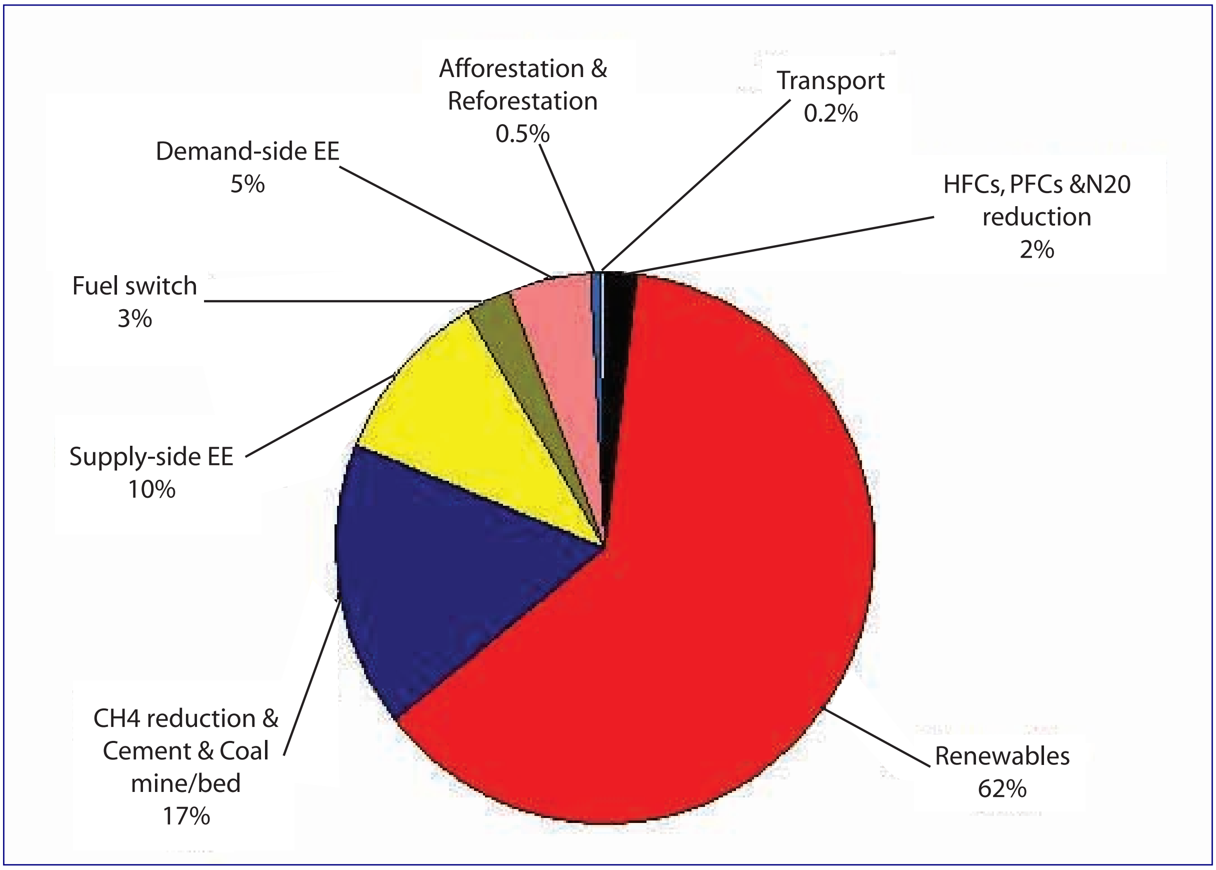

Figure 1 – CDM Pipeline by Project Type

9. Capacity Development for CDM (2008) "CDM Projects by Type" http://www.cdmpipeline.org/cdm-projects-type.htm UNEP RISO Center

National and Regional Schemes and Regulations

As part of its commitment to the Kyoto Protocol, the Australian Government intends to regulate the actual emissions activities of much of business in Australia via the Carbon Pollution Reduction Scheme (CPRS).

Proposed Australian CPRS

The Australian Government has announced the establishment of an emissions trading scheme as part of its framework for meeting the challenge of climate change. Design of the ETS is currently in progress, with the detailed design to be finalised by the end of 2008, and the scheme to start no later than 2010. A key element of the design and consultation process is a review by Professor Ross Garnaut of the impacts of climate change on Australia's environment and economy[10]. The draft report from this review was delivered on 30 June 2008 with a final report due by 30 September 2008. In addition the Australian Government has prepared a Green Paper[11] on scheme design (released July 2008) and a discussion paper relating to the inclusion of reforestation in the CPRS (released August 2008).

The Green Paper proposes that agriculture will not be included as a covered sector at the commencement of the CPRS, but that the Government is disposed to eventually include agriculture once practical and cost effective methods for estimating and reporting emissions have been developed. In contrast, the Government has proposed that forestry will be included from scheme commencement on an opt-in basis, but only for forestry activities that are recognised in Australia's Kyoto Protocol accounts. This excludes forests established prior to 1990 and forests established on land that was forested on 1 January 1990. Under the rules as currently proposed the greatest incentive for participation is provided for newly established forests, while there is very limited incentive for inclusion of existing Kyoto eligible forests.

New South Wales, Australia—Greenhouse Gas Abatement Scheme

It can be expected that the Australian CPRS will, in part, build forestry rules based on the experience of the New South Wales Greenhouse Gas Abatement Scheme (GGAS). The Government of New South Wales (NSW) has been an international leader in actions to address greenhouse gas emissions. The state passed legislation in November 2002 that introduced the NSW Greenhouse Gas Abatement Scheme (GGAS) in January 2003[12]. The 5% per capita reduction in emissions was implemented in stages from 2003 to 2007. This policy created a requirement for reductions increasing from 1 million tonnes in 2003 to 20 million tonnes in 2007. The scheme will now effectively be integrated into the Australian CPRS, and transitional arrangements are now under negotiation.

Sequestration of carbon in agricultural soils and emission reduction activities within the agriculture sector are not included as eligible abatement activities under the GGAS. The GGAS is somewhat unique in embracing the use of forestry offsets.

The rules require that Abatement Certificate Providers (ACPs) be registered with the regulator (the Independent Pricing and Regulatory Tribunal of NSW – IPART). ACPs register forestry areas and the tonnes of sequestration based on the report of an independent verifier appointed by IPART. The ACPs must sign a Maintenance Obligation Deed agreeing to retain the carbon stock for 100 years, and a land title restriction is used to ensure compliance.

The carbon accounting rules are set out in a carbon accounting protocol (*Greenhouse Gas Benchmark Rule Carbon Sequestration No. 5*) and comply with the Australian Standard (*AS4978 – Carbon Accounting for Greenhouse Sinks*)[13].

The NSW market appears to work effectively, with a growing range of participants bringing a variety of offsets to the market, and a weekly pricing of offsets being circulated by the Australian Financial Markets Association[14] and Next Generation Energy Solutions[15].

However, the market price of the NGAC collapsed in 2007, as key actors released large banks of certificates due to uncertainty on whether they will be accepted in the CPRS.

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10. See www.garnautreview.org.au
11. See www.climatechange.gov.au/greenpaper/index.html
12. See the NSW GGAS website at http://www.greenhousegas.nsw.gov.au for further details.
13. See Standards Australia at http://www.standards.org.au. Information on "AS 4978.1(Int)-2002: Carbon accounting for greenhouse sinks - Afforestation and reforestation" can be found at
14. See the Australian Financial Markets Association at http://www.afma.com.au for further details. The AFMA Environmental Products Working Group has devised documentation for spot and forward trading of renewable energy certificates and Australian state-based greenhouse gas emission reductions. These contracts can be found at http://www.afma.com.au/scripts/runisa.dll?AFMA.852988:LISTRIGHT:1363470039:pc=ENVIROPRDS
15. See the Next Generation Energy Solutions at http://www.nges.com.au/ for further details.

New Zealand Permanent Forest Sink Initiative and ETS

New Zealand has ratified the Kyoto Protocol and can participate in the Kyoto Flexibility Mechanisms. Half of New Zealand's greenhouse gas emissions are attributed to the agriculture sector, particularly methane emissions from sheep and cattle. The country also has an extensive plantation forestry estate with over 1.8 million hectares of plantations, primarily Radiata pine. Much of the plantation estate was established prior to 1990 and therefore does not qualify for carbon accounting and crediting under the Kyoto Protocol rules, but does have a liability if deforested (e.g., for land conversion to dairy production). The Kyoto forestry rules have caused substantial consternation in the New Zealand forestry sector, as most major institutional investors own non-Kyoto forests, while small investors who entered the market after 1990 own most of the Kyoto compatible estate.

In May 2004 the government announced the Permanent Forest Sinks Initiative (PFSI). The PFSI will accredit reforestation projects compatible with Article 3.3 of the Kyoto Protocol, where the forests will not be commercially harvested for at least 35 years and any timber harvesting will be on a "continuous forest canopy" basis. The forestry areas accredited under this program will need to be protected under a land title covenant that is governed by an approved harvesting plan. This approach is well-suited to reforestation of native species but is also an attractive option for long-lived exotic species like Douglas-fir and Redwood.

The New Zealand Government has announced a national ETS to be implemented in stages with the Forestry Sector entering first in January 2008. Legislation relating to the design and function of the ETS has been drafted for comment but is not currently enacted. The scheme will provide owners of forests established since 1990 with the option of taking both the benefit and liability of the carbon sequestration in their forests. Owners of pre-1990 forests are to be given a once-off allocation of 39 New Zealand ETS units (NZUs) for each hectare. If the owners of these forests convert them to agriculture they will be liable for the full emissions account for the area deforested. Under both the ETS and PFSI in New Zealand there is an opportunity to create a private account in the NZ Kyoto registry and register Assigned Amount Units (AAUs, the units allocated to countries in respect to their emissions target under the Kyoto Protocol) for the PFSI or convert the NZUs to AAUs. The ETS credits however may be subject to a cap on conversion to AAUs while the PFSI credits will not.

California Climate Action Registry and Project Protocols

California has passed legislation to reduce the State's greenhouse emissions to 1990 levels by 2020 and to 80% below 1990 levels by 2050[16]. As part of the implementing regulations to achieve these reductions, the State has agreed to adopt protocols developed for the voluntary California Climate Action Registry (CCAR) program. Protocols exist for forestry, landfill and livestock. Forestry protocols include a wider range of project types than systems developed under the Kyoto processes and include provisions for reforestation, improved forest management/reduced harvesting and forest conservation. Livestock protocols were designed to encourage participation by the agricultural community. Eligible project types include capturing and destroying methane emissions from livestock operations through the installation of anaerobic digesters. This very specific use limits participation to cattle and swine farmers but is a market-leading example of a government-backed protocol for carbon credit creation within the agriculture sector.

16. See http://gov.ca.gov/index.php?/press-release/4111/

Mallee tree plantation.

Bioenergy Policies

There have been myriad renewable energy support schemes introduced around the world, including mandatory requirements to implement a proportion of renewable energy as part of energy mix (e.g. Renewable Portfolio Standards), government subsidy programs, feed-in tariffs, and regulatory and voluntary schemes for renewable energy certificates (REC) .

A significant Australian initiative for renewable energy is the Mandatory Renewable Energy Target (MRET), established via federal legislation in 2001. MRET in its initial form set a target of 9,500 GWh /year of new renewable energy to be generated in Australia by the year 2010. The additional renewable generation proposed was considered to represent some 2% the total electricity generation in Australia at 2010. Annual targets were set for renewable energy generation to allow the additional generation capacity to be brought on line in a gradual manner over the years preceding 2010.

A scheme for creating and submitting RECs was established under the general coordination of the Office of the Renewable Energy Regulator (ORER) based in Canberra.

MRET was reviewed in 2004 and many proponents of renewable energy called for an increased target, however the federal government maintained the initial target of 9,500 GWh/y. In response to this perceived lack of growth, several states implemented state-based Renewable Energy Targets. In late 2007 the Australian Government announced that it would expand the MRET program to achieve a 20% share for renewable energy in Australia's electricity supply by 2020. The target of a new MRET is 45,000 GWh/year in 2020, combining the 9,500 GWh of the existing scheme, the various state-based targets and an additional component to stimulate even more renewable generating capacity.

At the COAG meeting in December 2007 the Commonwealth and States agreed to work cooperatively to bring the existing MRET and the various state-based targets into a single, expanded national MRET scheme by early 2009[17].

The MRET is implemented through the creation of a tradable

17. See www.greenhouse.gov.au/renewabletarget/index.html

REC which effectively acts to define the marginal cost of a Megawatt hour of renewable electricity vs. electricity derived from fossil fuels such as coal and natural gas. Under MRET, creation and trade of a REC is an alternative to a penalty for not providing the required amount of new renewable energy in a given period. The penalty is set at $40/MWh and this penalty helps to establish the value of a REC.

The actual trading price for RECs varies according to supply and demand, and for the initial years of the MRET scheme, RECs traded at approximately $20 to $30 per MWh.

The current average cost of electricity in Australia at a wholesale level ranges from $35 to $55 (with occasional spikes). Renewable energy certificates currently trade for approximately $45 per MWh, suggesting that renewable energy developers need a wholesale pricing of around $80-$100 per MWh to meet commercial requirements.

RECs may only be created from eligible sources of renewable energy, as defined under the MRET legislation. Eligible biomass sources for the creation of renewable energy under MRET include energy crops, agricultural waste, bagasse and wood waste (with some restrictions on material sourced from native forests)[19]. The rule sets for the RETs in the State jurisdictions vary slightly, in particular relating to the use of wood from managed native forests.

Economics of Bioenergy

The drivers of bioenergy production are the relative price of fossil fuels, the cost of feedstock (50-80% of the variable cost), conversion technology efficiencies and regulations stimulating demand[19]. All of these are currently in a state of flux, and clear market signals for investment are neither consistent nor well defined. The three main variables in project economics are the capital cost of the plant, the cost of the feedstock, and the other operating costs of the plant.

Indicative capital and operating costs for two hypothetical examples of biomass power plants (10 MW and 30 MW) are given in Table 2. This indicates that the cost of production (excluding feedstock) per MWh is considerably lower for a larger scale plant. However, a larger scale plant will require access to a feedstock resource sourced over a larger geographic area which is likely to result in increased transport costs. Indicative costs for feedstock from a range of sources is given in Table 3.

Based on this analysis the total cost of production for biomass energy would be lowest for a large-scale plant using bagasse as a feedstock, with costs of approximately $60 per MWh. In contrast, the total cost of production for a plant using feedstock from dedicated biomass crops may range from $110 to $180 per MWh depending on the haulage distance for the feedstock and operating scale of the plant. Clearly the most cost effective biomass feeds are based on by-products of higher valued crops – e.g., concentrated agricultural

Table 2 – Indicative cost comparisons for biomass energy plants of different scale

Description	10 MW plant Total	10 MW plant per MWh	30 MW plant Total	30 MW plant per MWh
Plant size	10 MW		30 MW	
Annual production	75,000 MWh		225,000 MWh	
Capital cost				
Total	$50 million		$90 million	
Annualised (@10% p.a.)	$5 million	$66	$9 million	$40
Operating cost (excl. feedstock)				
Per annum	$2.5 million	$35	$4.5 million	$20

Table 3 – Indicative cost of supply of biomass feedstock

Feedstock	Total	per MWh
Conversion	0.8 MWh/green tonne	
Bagasse		
- harvest & haul ($/t)	$0	
- crop value ($/t)	$0	
- total	$0	$0
Plantation residues		
- harvest & haul ($/t)	$20-$30	
- crop value ($/t)	$0	
- total	$20-$30	$25-$38
Dedicated plantation		
- harvest & haul ($/t)	$15-$25	
- crop value ($/t)	$30-$40	
- total	$45-$65	$56-$81

19. Roberts, D. (2008) "Bioenergy and the Convergence of Markets for Food, Fuel and Fiber" Presentation at Bio-Energy Policy and Forestry Resources: What lessons can BC and Canada learn from international experience?. Vancouver, BC, May

processes (such a sugar mills) and sawmill waste. This is exactly what we see in the market to date. An interesting question is the interaction of a carbon credit market and a REC market in spurring the development of energy crops.

If a typical coppicing eucalyptus crop is being grown and harvested for biomass, the system may generate carbon credits from the carbon stored in the standing crop, and RECs from the biomass energy. These are quite discrete and complementary opportunities, with sequestration in the standing biomass (including the below-ground biomass that is not removed from site) and fossil-fuel replacement via the bioenergy.

The sequestration benefits effectively create a subsidisation of fuel cost for the biomass energy system. With coppice, the up-front cost of establishment may be $1200 per hectare. If each hectare can contribute about 50 tonnes of CO_2-e per hectare to a carbon pool, this could largely offset the establishment costs at a carbon price of $25 per tonne.

More work is needed on the economics of these types of systems, and the interaction between carbon credits and RECs is discussed further below.

One additional point to note is that biomass energy can provide baseload generation (e.g. continuous energy systems). As a result bioenergy can complement the production of electricity by wind and solar as part of an overall renewable energy portfolio that provides for a more flexible and resilient energy system.

Interaction between Renewable Energy Credits and Carbon Credits

The generation of renewable energy is generally not included directly in the design of emissions trading schemes, except to the extent that renewable energy is considered to be emissions neutral. They both have an abatement effect, but RECs and carbon credits represent different approaches to carbon mitigation. One is related to one MWh of renewable energy and the other is related to a tonne of carbon dioxide equivalent. Conversions between these two metrics are straightforward only if the addition of renewable energy into the grid backs out other generation sources from the grid. For instance, a MWh of coal-fired electricity produces about 1 tonne of carbon dioxide emissions[20]. Assuming the use of renewable energy causes an equivlaent reduction in coal-fired generation, the REC price could be seen as a kind of shadow price of a carbon credit.

The Australian Government has indicated that the MRET scheme and the ETS will run in parallel, at least until the ETS market is sufficiently mature to drive investment in renewable energy in the absence of MRET[21]. Currently it is expected that this will occur sometime between 2020 and 2030. However, there is considerable debate about whether or not this is the most efficient way to achieve lowest cost abatement of greenhouse gas emissions. The ETS Discussion Paper (March 2008) prepared by the Garnaut Review[22] suggests that continuation of MRET in conjunction with the ETS will reduce investment in low emission, non-renewable energy sources, and this view is supported in a submission by the Productivity Commission[23]. In contrast proponents of bioenergy argue that both the MRET and the ETS are required in order to stimulate investment in biomass energy at least while the industry develops to a sufficient scale to achieve cost and production efficiencies[24].

Experience from emissions trading systems to date provides reasonable evidence for the source of emissions reductions as schemes develop. This is based on the marginal abatement cost curve, or the price at which the next cheapest unit of emission reductions can be provided. The market first purchases reductions in the emissions of a variety of non-CO_2 gases, such as methane, nitrous oxide, sulphur hexafluoride, etc., which are primarily produced from industrial processes and landfill. These gases have high multiples of CO_2 in their radiative forcing and therefore projects that reduce the production of these cases can generate carbon credits at substantially cheaper cost than projects that reduce carbon dioxide emissions. Experience shows that the reduction of these "industrial gases" is the low hanging fruit of the carbon market.

Once these offsets are "bought out," the market searches for the next lowest source of credits. In Australia we have seen evidence that energy efficiency programs such as those in the NSW GGAS could bring substantial volumes

20 National Greenhouse Accounts Factors. http://www.climatechange.gov.au/workbook/index.html
21 http://www.greenhouse.gov.au/renewabletarget/index.html
22 http://www.garnautreview.org.au/
23 http://www.pc.gov.au/__data/assets/pdf_file/0003/79716/garnaut.pdf
24 Kes McCormick (2008). Policy for Bioenergy – Experiences from Europe. Paper presented to the Bioenergy Australia workshop, Canberra, 26 June 2008

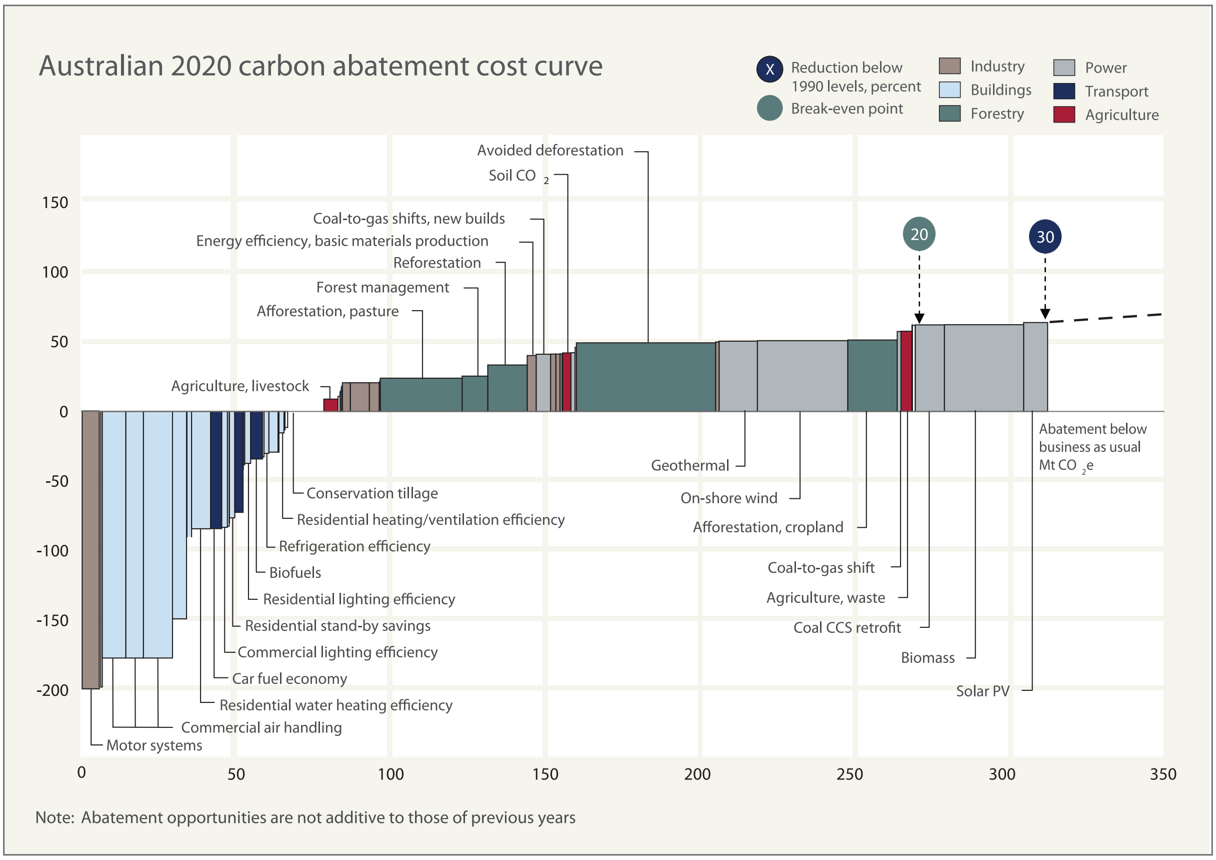

Figure 2 – Marginal abatement cost curve for emissions reduction projects[28]

of offsets into the market at a price above $10/tCO_2e$. Forestry generally enters the market as it approaches $15/tCO_2e$, but really only becomes an attractive investment in Australia once the price approaches $20/tCO_2e$, as demonstrated by the McKinsey marginal abatement cost curve (Figure 2). Renewable energy as we have seen under the MRET to date enters the market from a a price of approximately $25 per MWh for the more attractive wind-farm investments[25].

Figure 2 shows that a carbon price of at least $65 is generally required to spur investment in biomass energy projects. This is generally greater than the short- to medium-term projections of carbon price under emissions trading frameworks in Australia[26,] [27] indicating that complementary policies will be needed to support investment decisions in the medium term. This is consistent with the policy framework in Europe, which includes economic measures (e.g. taxes and subsidies), investment grants, and the installation of pilot projects as well as favourable treatment of bioenergy under the emissions trading framework (i.e. bioenergy is emissions neutral).

The fact that MRET and the ETS are likely to run in parallel (at least until 2020) provides the opportunity for projects to be developed whereby there is both a carbon sequestration benefit and a renewable energy benefit. For example, a plantation resource being managed for production of sawlogs could be accredited under a carbon sequestration program and managed as part of a larger estate (to meet long-term obligations for maintaining carbon stocks within the forest), with some of the lower grade material being used as feedstock to a bioenergy process. Alternatively, a tree-based energy crop could be developed specifically for the production of bioenergy, in which case the carbon sequestration benefit would be significantly reduced (due to a lower average standing biomass).

There is significant scope to manage planted forests in order to maximise the overall return from carbon, timber and bioenergy, rather than concentrating on one particular element. As well as having an impact on the project return, management strategy

[25] Note that this REC price represents the spot price at the time such wind farm projects have commenced. The actual long term REC price used in the projects are generally confidential and may differ from the spot price.
[26] Allen Consulting Group (2006). The Economic Impacts of a National Emissions Trading Scheme, Final Report. Report to the National Emissions Trading Taskforce, June 2006.
[27] New Carbon Finance (2008). Australian CPRS – Research Note August 2008. see http://www.newcarbonfinance.com
[28] McKinsey & Company (February 2008). An Australian Cost Curve for Greenhouse Gas Reduction.

can greatly influence the overall mitigation benefit that a planted forest provides. In particular, there are potentially large differences between stands that are harvested and replanted versus those that are not harvested. For example, a stand that is not harvested will sequester carbon as it grows but the rate of sequestration will reduce over time as the forest matures (Figure 3). In contrast, in stands managed for the production of bioenergy the carbon stock will oscillate up and down as stands grow and are harvested (Figure 4). However, assuming that the bioenergy produced from the stand is used to offset emissions from fossil fuels then there is a cumulative emission reduction benefit over successive harvests. An additional benefit for harvested stands is that the ongoing revenue from harvest events (timber, bioenergy etc) will provide revenue to ensure effective ongoing management over the long term.

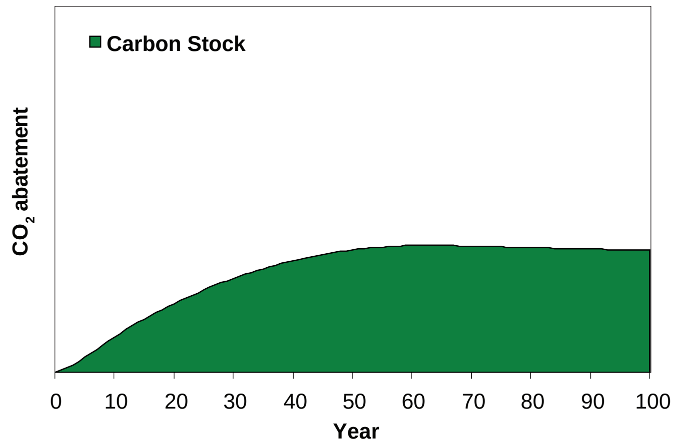

Figure 3 – Generalised carbon stock trend within a non-harvested forest (assuming no loss from fire)

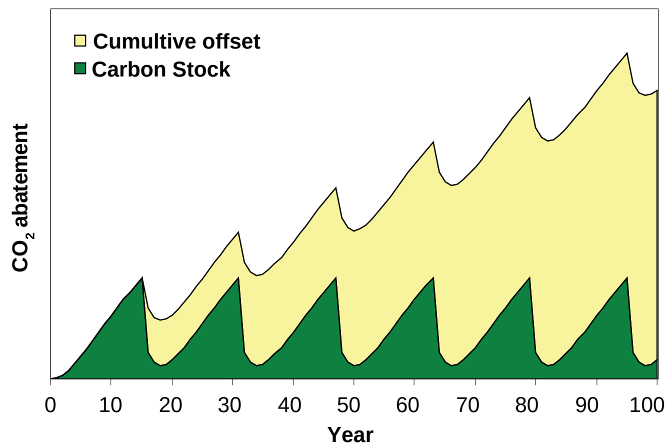

Figure 4 – Generalised carbon stock trend and cumulative offset of emissions from fossil fuels for a forest managed for bioenergy production

Examples of Bioenergy Systems

Australia has extremely low electricity prices by international standards and therefore renewable energy in general, and biomass energy specifically, have been economically marginal to a large degree, unless supported by the MRET or state-based renewable energy schemes.

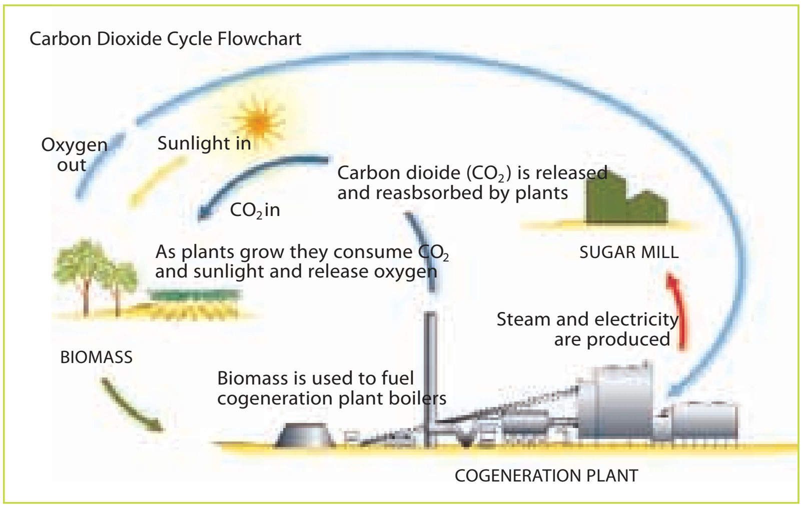

Figure 5 – Carbon Dioxide Cycle flowchart. Courtesy Rocky Point Sugar Mill

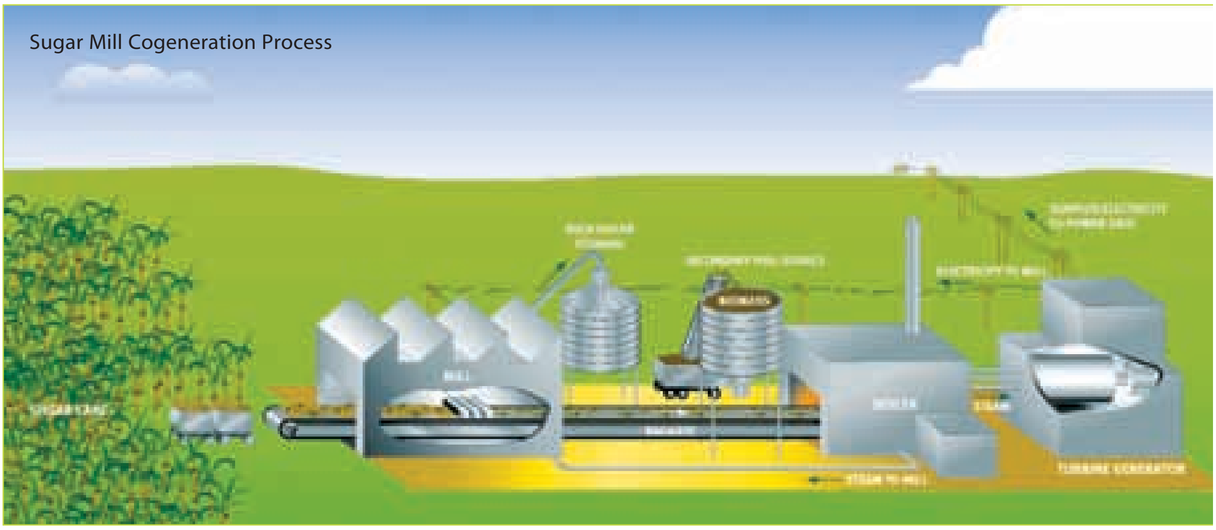

Figure 6 – Sugar Mill Cogeneration Process. Courtesy Rocky Point Sugar Mill

Overseas where energy prices are higher, or emissions reductions targets are more ambitious, other forms of biomass energy are being developed, including free standing biomass energy plants buying low grade timber or waste, energy cropping systems and pelletised biomass energy facilities.

Europe in particular has worked hard to expand biomass energy and we can see a range of the biomass energy systems in use over a number of years.

Examples of biomass energy systems in Australia and elsewhere are:

- Rocky Point Sugar Mill – bagasse and wood wastes (30MW)
- Delta Electricity/NSW Sugar Milling Cooperative co-generation plant in Condong, NSW (Sunshine Electricity), North Coast NSW
- Delta Electricity's biomass (sawmill residue, wood in landfill) co-firing with coal in NSW
- Visy's co-generation plant at Tumut (20 MW)

Alternative Systems

Co-firing of wood and other biomass in fossil fuel power stations is in wide use in Europe and the USA. Macquarie Generation has been a leader in developing biomass/coal co-firing facilities, pioneering the technology in Australia. In this system the proportion of electricity generated from the native forest wood waste is considered renewable. This is a very low cost renewable energy approach as it uses existing energy infrastructure (i.e. capital cost is already in place), has low incremental operating costs, and uses low cost fuel. The main additional cost is the transport of the material to the power plant. In practice, however, environmental groups criticised the accreditation of this system as renewable energy, and many retailers found the RECs from this system unattractive because of the controversy.

Creating markets for biomass energy as a by-product of plantation forestry could be attractive, particularly if the biomass energy plant is co-located with the processing facility. There are numerous examples of this in Europe and North America, and some examples have been successfully established in Australia. In general, forestry produces large logs suitable for sawmilling and small logs and treetops that are only suitable for pulp and paper and medium density fibre board. In some regions the lack of a pulp market or MDF facility means that the lower grade material is not utilised and is often left on site. This can actually add to the cost of reforestation as this residual material is generally windrowed or burned in situ. In some cases there can be 100 tonnes per hectare of this woody waste, and it would seem that this should be a high priority for removal and combustion in biomass energy plants co-located with sawmills or other wood processing facilities (e.g. The Lignor project[29] currently being developed in Western Australia).

Examples of freestanding biomass energy systems are available in Europe. Willow culture in Scandinavia has proven somewhat successful, but it can be considered the highest cost system of biomass energy fuel production. Without the higher value agricultural or forestry products to support the economics, the price of electricity must be quite high (well over $100 per MWh), or the REC price must be able to bridge the difference. In Australia Mallee eucalypts are being developed as a multiple purpose woody crop for the low rainfall (<600 mm) wheatbelt regions. Such crops could provide natural resource management benefits, but planting would be driven by commercial return from higher value products (eucalyptus, wood chip feedstocks) and residue for biomass energy. These systems have not yet achieved commercial application.

Another innovative system is known as integrated forest biorefinery (IFBR) in which biofuels and chemicals are produced on-site in addition to pulp and paper products. A pilot project in Maine, United States, is working to create transportation fuels, commodity chemicals and polymers as additional revenue streams to traditional pulp processing by extracting hemicellulose before pulping. While fuel and chemical production is relatively small compared to other plant-to-ethanol and chemical production processes, the additional revenue streams at processing can translate directly back to higher prices for biomass producers. The plant is expected to be operational by 2010.

The combination of different product lines with bioenergy (e.g. the biorefinery concept) allows the hurdle rate for investment to be met by combining returns from high value (but small production volume) products with those of commodity nature such as biofuels. In addition to returns from carbon credits and the tangible products discussed above there is also increasing opportunity for forest growers to commercialise the non-carbon related intangible products that forests can provide such as the enhancement of biodiversity and mitigation of salinity.

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29 http://www.lignor.com/index.html

Conclusion

It seems clear that the expansion of biomass energy in Australia will be a function of:

- the price of carbon in the CPRS
- whether both an MRET and the CPRS are allowed to operate in parallel, and
- the price of fossil-fuel based electricity over time.

Internationally, coal and gas prices have risen substantially, although most coal-fired power plants in Australia do not have to pay international fuel prices.

The final form and components of the greenhouse gas regulation system in Australia are not likely to be known until later in 2008.

The CPRS in Australia will provide a price signal for investors in regards to carbon pollution. However, at a modest carbon price the CPRS on its own will only stimulate investments in the lowest cost technologies, such as co-firing of biomass with coal, and will not provide the stimulus to generate significant investment in bioenergy projects.

Based on experience in the wind and solar energy sectors and from bioenergy development overseas, it is expected that considerable production efficiencies will be realised as the bioenergy industry expands in Australia. This will lead to a reduction in the cost of production of bioenergy and result in a more favourable competitive position against energy derived from fossil fuel sources.

Targeted policy for bioenergy development in parallel to the CPRS is crucial to see Australia achieve deeper cuts in carbon dioxide emissions and make a transition to a low carbon economy.

Carbon Trading and Renewable Energy

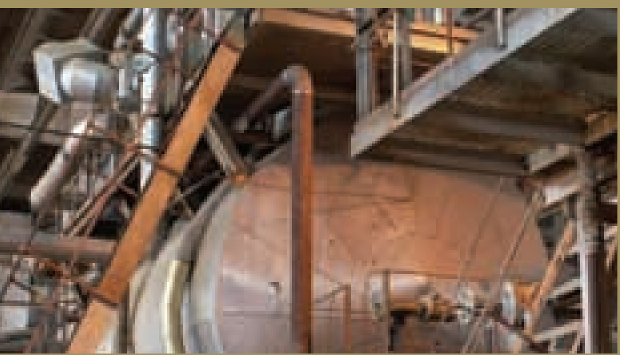
A discussion paper on carbon credits and bioenergy developments for forestry and agriculture

by N. O'Brien, M. Meizlish and A. Hawn
RIRDC Pub. No. 08/184

Global demand for alternative feedstocks for fuels, electricity, chemicals and a range of commercial products has grown dramatically in the early years of the 21st century. This demand is driven by the high price of petroleum, government policies to promote alternatives and reduced dependence on foreign oil, as well as growing efforts to reduce net emissions of carbon dioxide and other greenhouse gases. This paper provides a broad discussion on both carbon management and biomass energy as they relate to the forestry and agriculture sectors.

Analysis in this report indicates that the Carbon Pollution Reduction Scheme (CPRS) in Australia will provide a price signal for investors in regards to carbon pollution, but that at a modest carbon price the CPRS will not provide the stimulus to generate significant investment in bioenergy projects. In the authors view, targeted policy for bioenergy development in parallel to the CPRS is therefore crucial to see Australia achieve deeper cuts in carbon dioxide emissions and make a transition to a low carbon economy.

The importance of this report is that it provides information that will be useful in informing debate about the interactions between bioenergy production and emissions trading. This is highly relevant given the expanding emphasis on bioenergy production and the development of emissions trading schemes in Australia and internationally.



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