Australian carbon biosequestration and bioenergy policy co-evolution: mechanisms, mitigation and convergence

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Summary

The intricacies of international land-use change and forestry policy reflect the temporal, technical and political difficulty of integrating biological systems and climate change mitigation. The plethora of co-existing policies with varied technical rules, accreditation requirements, accounting methods, market registries, etc., disguise the unequal efficacies of each mechanism. This work explores the co-evolution and convergence of Australian voluntary and mandatory climate-related policies at the biosequestration–bioenergy interface. Currently, there are temporal differences between the fast-evolving and precise climate-change mechanisms, and the long-term 'permanence' sought from land use changes encouraged by biosequestration instruments. Policy convergence that favours the most efficient, appropriate and scientifically substantiated policy mechanisms is required. These policies must recognise the fundamental biological foundation of biosequestration, bioenergy, biomaterial industrial development and other areas such as food security and environmental concerns. Policy mechanisms that provide administrative simplicity, project longevity and market certainty are necessary for rural and regional Australians to cost-effectively harness the considerable climate change mitigation potential of biological systems.

Keywords: forestry; carbon; policy; climatic change; legislation; international agreements; Australia

Introduction

The recent historical diversity of climate-change-related policies and markets exemplify the extraordinary temporal and technical divides between climatic and policymaking timescales. This unique predicament can be symbolised through the interface of evolving climate-change policy with a biosequestration, bioenergy or biomaterial component. The aims of current carbon offsetting and biosequestration policies are to implement very long-term arrangements and management procedures for carbon biosequestration in the terrestrial landscape. However, the rate of evolution (and termination) of related Australian climate policies is sharply at odds with the 'permanence' required by these policies. This work explores the detailed complexity of current national and relevant international policy mechanisms and accounting methods for biosequestration and related bioenergy. In doing so the research demonstrates the significant ambiguity between economic value and quantifiable mitigation achieved to date. The objective of this research is to distil common policy lineages and complexities and their relative efficacy in carbon sequestration for climate-change mitigation; the longer-term aim of the work is to assist the evolution of appropriate mechanisms to facilitate a range of biomass-related industries to achieve climate-change mitigation and regional development objectives in Australia.

Where and how to place biosequestration and bioenergy in the national mitigation effort is challenging within competing (although related) spheres of conservation, primary industries, bioenergy and forestry. While fossil fuel combustion emissions can be estimated relatively quickly and accurately, emissions and biosequestration from land use and forestry activities are dependent on complex biological variables that may be manifest over very long timescales. This complexity is reflected in the provisions for land use, land-use change and forestry (LULUCF) for the first Kyoto Protocol commitment period (2008–2012), which has required a number of separate decisions, written in various documents over decades (Hohne *et al*. 2007). When the Kyoto Protocol was opened for signature in 1997, few would have imagined the complexity that would surround LULUCF policy (Fry 2007). Differential treatment of the LULUCF sector in climate policy is primarily due to the capability of biomass to sequester carbon into physical structures, and the associated issues regarding a quantification of net biological emissions and removals (Hohne *et al*. 2007). Inappropriate differentiation in land use policy can produce unintended consequences in the diversity of sectors dependent on limited terrestrial biological resource inputs. This indifference to distributive justice, and both inter- and intra-generational inequity, flies in the face of appropriate differentiation that may integrate the unprecedented complexity of global climate-change participants, technology and policy development (McDonald 2005).

From 2009 to 2011, both Australia's Carbon Pollution Reduction Scheme (CPRS) and the Carbon Farming Initiative (CFI) sought to streamline a number of domestic policies that aimed to achieve greenhouse gas (GHG) mitigation using biomass–biosequestration components (DCC 2008a; DCCEE 2011). In the lead-up to the proposed CPRS and CFI introduction, over-reliance on 'constructive ambiguity' between strong domestic interest groups arguably stalled the process and any further LULUCF mitigation developments. Similarly, the outlook for LULUCF mitigation policy internationally is also uncertain. Therefore, judicious innovation is required to develop agreeable solutions in future negotiations and successive policy mechanisms (Fry 2007; Hohne *et al*. 2007).

The Kyoto Protocol, Australia, LULUCF and major policy mechanisms[1]

Australia's initial Kyoto Protocol assigned amount units (AAUs) for the first 1-y commitment period is 2 957 579 143 AAUs. One AAU is equal to one tonne of carbon dioxide equivalent (tCO_2-e). For Australia to meet its Kyoto Protocol target of 108% above 1990 emission levels (multiplied by five for each year), the nation must not emit more than 2 957 579 143 tCO_2-e over the period. This target itself is currently under review by the Kyoto Protocol expert review team, a nominated international team of experts to assess its accuracy. Countries that fail to meet Kyoto Protocol targets during the first commitment period may be liable for a 30% additional penalty of the difference between their actual emissions and their target subtracted from their AAUs in a post-2012 commitment period (DCC 2008a).

In simple terms, for Australia to meet the national Kyoto Protocol target it must have equivalent Kyoto Protocol units in the national registry as the Kyoto Protocol emission target over the commitment period. The Australian National Greenhouse Gas Inventory (NGGI) accounts for national emissions over time. The NGGI accounts for LULUCF-sector changes in the calendar year, while all other sectors and the national Kyoto Protocol commitments are accounted against financial years. Thus, the Australian Kyoto Protocol commitment period is technically 2007–2008 to 2011–2012, except for LULUCF, which is accounted over the 2008–2012 period[2] (DCC 2009a). In the Australian LULUCF sector, only emissions from land-use change (LUC) activities (reforestation[3] and deforestation) are accounted towards the Kyoto Protocol target (DCC 2008b). Australia does have the option of accounting for Article 3.4 (revegetation, forest management, cropland management and grazing land management) as a part of the national Kyoto Protocol target. However, the natural variability of the continent, combined with high costs of monitoring, makes this undertaking expensive and impractical (UN and UNFCCC 2002; DCC 2008c; McHenry 2009). Therefore, Australia is likely to continue to exclude Article 3.4 emissions in the NGGI Report to the United Nations Framework Convention on Climate Change (UNFCCC) in relation to the Kyoto Protocol target.

Australia's forest definition for Kyoto Protocol purposes is a stand of trees with a potential height of at least 2 m and crown cover of at least 20% in areas greater than 0.2 ha (DCC 2008b). This definition allows the inclusion of Australia's sparse arid woodlands in the Kyoto Protocol net–net accounting system (Fry 2007; Hohne *et al*. 2007). In terms of Kyoto Protocol accounting, removal units (RMUs) are issued on the basis of LULUCF sink activities under Articles 3.3 and 3.4. Australia has one RMU issued as a result of a net removal of 1 tCO_2-e from Article 3.3 reforestation activities (DCC 2008b). Removals were 20.5 $MtCO_2$-e[4] in 2008, with a risk buffer of 1.8 $MtCO_2$-e, and are expected to remain constant over the 2008–2012 commitment period (DCC 2009a).

The vast area of arid land available for reforestation activities in Australia presents a potentially cost-effective removal option that most countries do not enjoy. Other Australian competitive advantages negotiated into the Kyoto Protocol include the now infamous 'Australia clause', contained in Article 3.7. This allows Australia to subtract emission removals by sinks from aggregate anthropogenic emissions in the base year from LUC (Hamilton and Vellen 1999; Fry 2007; Hohne *et al*. 2007). Australia originally signed the Kyoto Protocol because it was likely that carbon sinks would reduce the mitigation required to meet the Kyoto Protocol target as a concession to emission-intensive energy and export sectors (Howard 1997; Crowley 2007; Hohne *et al*. 2007). The 'Australia clause' resulted in the single largest mitigation activity for Australia, with legislative clearing restrictions significantly contributing to 83 million tCO_2-e of mitigation every year (132 – 49 million tCO_2-e p.a.) in the NGGI under Kyoto Protocol accounting rules (DCC 2009a).

The opportunities for Australia to issue RMUs, alongside the base-year concession, in addition to the negotiated target of an 8% increase in 1990 emissions, produces a lesser impetus for Australia to participate with other countries in carbon trading of emission reduction units (ERUs). ERUs are equivalent to RMUs and AAUs in meeting national Kyoto Protocol targets. However, ERUs are issued only by emission reduction at its source, or an emission removal with a carbon sink RMU from another Annex I (industrialised) country, through the Kyoto Protocol's 'joint implementation' (JI) mechanism (Dumanski 2004). Hosting JI projects essentially allows Annex I countries to export converted AAUs and RMUs as ERUs into the instigating Annex I country registry (DCC 2008a). JI participation allows ERUs issued for reductions in any of the six major GHGs, and the general rules for LULUCF for Annex I countries apply (Hepburn 2007; Hohne *et al*. 2007).

JI projects aimed at sequestration by sinks are allowed, but the credits are capped for forest management (Article 3.4), and cannot be banked[5] for use after the first commitment period (Hohne *et al*. 2007). Countries have a differentiated amount they are able to claim under forest management JI projects, and Australia has a zero capacity to claim under Article 3.4. However, in the first commitment period, Japan for example can claim up to 13 MtC per annum[6] in JI ERUs, under the accounting rules for net removals for forest management in the first Kyoto Protocol commitment

[1] The author apologises in advance for the extensive use of acronyms in this work. Unfortunately, this is a reflection of the (often unnecessary) complexity of the current policy and technical terminology.

[2] For simplicity, this work refers only to a Kyoto Protocol 2008–2012 commitment period for all sectors.

[3] The term reforestation is used generally in this research, and does not distinguish between afforestation and reforestation for practical purposes.

[4] Including the sub-rule in paragraph 4 of the Annex to Decision 16/CMP.1, relates to harvest losses following afforestation and reforestation since 1990. Such losses must be equal to or less than credits accounted for on that unit of land.

[5] Banking (or 'carry over') in climate change policy refers to the option of holding on to units into future commitment periods.

[6] Note: 1 tC is equivalent to 3.67 tCO_2-e, or 3.67 KP units.

period[7] (UN and UNFCCC 2002; Hohne *et al*. 2007). (See Table 1 for a list of schemes or policies, and their respective units).

In terms of national registry accounting, if Australia (as the host country) and Japan (the instigating country) were to use the JI mechanism for point-source reduction, then the abatement would result in Australia cancelling AAUs equal to the reduction from its national registry. If Australia hosted a Japanese JI reforestation activity, then any removal would result in Australia cancelling RMUs equal to the removal from its national registry[8]. Equivalent ERUs would be issued to Japan's national registry to assist meeting their Kyoto Protocol national emission target[9]. Japan could also harvest some of the reforested areas—up to the 13 MtC per annum. Notably, Australia has chosen not to host JI projects, and this long-held Commonwealth Government approach is expected to remain until details of domestic agricultural offsets are known and international mechanisms after the first Kyoto Protocol commitment period become clearer (DCC 2008b). The Rudd government, however, did seek to participate in JI, although only as an instigating country. The reasoning was to enable Australia to meet the nation's Kyoto Protocol target cost-effectively and to encourage comparable domestic carbon prices through trading (DCC 2008b, 2009b). As 'acting in the national interest' is often a guarded strategy, in this case it clearly does little to facilitate economic or technical spill-overs from JI activities on Australian soil or advance the national capacity to participate in international carbon markets. Possibly recognising these benefits, the Gillard government has indicated that Australian JI participation as a host country will be allowed under the CFI.

[7] The Japanese were early adopters of biosequestration research in Australia, and had the Commonwealth Government at the time allowed JI activity in Australia, hundreds of millions of dollars may have been invested in revegetation in regional and remote Australia.

[8] In the forestry project, the reduction would fall under Article 3.3 emissions.

[9] If the ERU was converted from an RMU, the ERU cannot be banked.

Globally significant mechanisms and LULUCF mitigation

The incentive for developing new climate-change-related markets and policy is to harness the global agricultural economic mitigation potential. The global agricultural mitigation potential is projected to be 12 000 $MtCO_2$-e per annum by 2030, which is comparable to energy supply, transport and industry sector potentials (Capoor and Ambrosi 2009; McKinsey and Company 2009). Globally, existing carbon markets remain strong despite the recent global recession and policy uncertainty. International carbon markets were valued at over US63 billion in 2007, US135 billion in 2008 and US144 billion in 2009, but stalled at 142 billion in 2010. The European Emissions Trading Scheme (EU ETS) has consistently represented between 70% and 80% by value (see Table 2). Only very small quantities of JI and CDM volumes and values are traded globally. Primary CER[10] (pCER) trading fell around 30% from 2007 to 2008, and an additional 50% from 2008 to 2009, while their corresponding value declined by just over 12% and 60%, respectively. Similarly, ERU trading also fell to around half over the period, while market value declined by 25% (Capoor and Ambrosi 2009; Kossoy and Ambrosi 2010; Linacre *et al*. 2011). Recent carbon trading preference is for guaranteed assets in the EU ETS, and away from pCERs.

On the supply side, CERs and ERUs created from CDM and JI projects continue to be constrained by delays in registration and issuance, high transaction costs and a post-2012 policy vacuum. Amidst such problems, the market share of LULUCF-based ERUs and CERs represents less than 1% of global trading. This is primarily due to concerns of permanence, accuracy of monitoring, reporting requirements and the ability of LULUCF ERUs and CERs to create an oversupply. As such, the EU ETS excludes LULUCF assets (Capoor and Ambrosi 2009). Australian policymakers should note that the mediocre attractiveness and or embargo of LULUCF assets internationally does not give

[10] pCERs are CERs that are purchased directly from entities in developing countries through the CDM. They contrast with secondary CERs (sCERs) that are financial products that do not represent or create emission reductions.

Table 1. Selected forestry-related schemes, associated units and abbreviations

Activity or scheme	Unit	Abbreviation
Deforestation (KP[A])	Assigned Amount Unit	AAU
Forestry (Reforestation) (KP)	Removal Unit	RMU
MRET/RET	Renewable Energy Certificate	REC
GGAS	NSW Greenhouse Abatement Certificate	NGAC
GreenPower	Renewable Energy Certificate	REC
GF	Verified Emission Reduction	VER
CPRS	Australian Emission Unit	AEU
CFI	Australian Carbon Credit Unit	ACCU
Joint Implementation (KP)	Emission Reduction Unit	ERU
Clean Development Mechanism (KP)	Certified Emission Reduction	CER
Clean Development Mechanism (KP)	Temporary CER	tCER
Clean Development Mechanism (KP)	Long-term CER	lCER
EU ETS	European Union Allowance	EUA
EU ETS	Primary Certified Emission Reduction	pCER
EU ETS	Secondary Certified Emission Reduction	sCER
CCX	Carbon Financial Instrument	CFI

[A] KP is an acronym for the Kyoto Protocol.

Table 2. Global carbon market value from 2007 to 2009[A]. Figures contributing to the totals are in italics.

Scheme	Value (million USD)		
	2007	2008	2009
Project based (total)	8195	7297	3370
Primary CDM	*7433*	*6511*	*2678*
Joint Implementation	*499*	*367*	*354*
Voluntary Markets	*54*	*419*	*338*
Allowance markets (total)	49361	101492	122822
EU Emissions Trading Scheme	*49065*	*100526*	*118474*
NSW GGAS	*224*	*183*	*117*
Chicago Climate Exchange	*72*	*309*	*50*
Others	—	*474*	*4182*
Non-project based (total)[B]	5451	26277	17543
Totals (rounded)	63007	135066	143735

[A]Sources: Capoor and Ambrosi (2009); Kossoy and Ambrosi (2010)
[B]Includes spot and secondary Kyoto offsets

the impression of a long-term policy future for biosequestration projects in such massive, and growing, carbon markets.

In a similar fashion to instigating JI projects, the Rudd government sought to increase national participation in CDM projects (DCC 2009c). The government at the time, however, was unwilling to partake in CDM forestry projects due to permanence issues. Under current Kyoto Protocol rules, CERs issued for afforestation or reforestation expire, and must be replaced[11] (Hohne *et al*. 2007; DCC 2008b). If forestry-related CERs are retired against a national target, and there is a reversal of sequestration, another Kyoto Protocol unit must replace it when it either losses certification or expires. Thus, the Rudd government's CPRS considered that retiring forestry-related CERs against Australia's Kyoto Protocol target would result in an unacceptable exposure to a replacement liability (DCC 2008b). As there is no mention of CDM participation in the CFI legislation, the perspective of LULUCF being a high risk seems to remain.

As the government also excluded tCERs and lCERs from the CPRS, those considering forestry biosequestration may pause to consider the risks of contingent obligations and administration costs that are unacceptably high for a government. It is clear that even when governments have the ability to capitalise on LULUCF activities, they have not often pursued them. In time, LULUCF assets may be more attractive, with alternative international market-based standards and methods similar to the California Climate Action Reserve (C-CAR), or the Voluntary Carbon Standard (VCS) (Capoor and Ambrosi 2009). Addressing permanence issues by 'discounting', 'deeming' or 'buffer' methods (akin to the C-CAR and VCS) may protect the holder of the asset against hazard events, and offer both a simple and credible alternative to Kyoto Protocol methods[12]. Such opportunities also make available several new land-based mitigation or conservation options for agriculture and LULUCF sectors, biodiversity and soil sequestration activities (Hohne *et al*. 2007; DCC 2008b; Capoor and Ambrosi 2009; McHenry 2009). Unfortunately, new approaches at this stage are likely to incur resistance, as existing climate-change policy (such as the Kyoto Protocol) has significant 'sunk costs' and would be likely to attract a similar suite of inadequate policies, both internationally and domestically (Prins and Rayner 2007). Australia's own sunk cost can be examined through an analysis of market-based policy co-evolution and convergence, the respective operational complexities, and overall efficacy with respect to mitigation from the LULUCF sector.

The evolution of Australian climate policy: strategies, markets and targets

The 1992 Keating Labor Commonwealth Government's National Greenhouse Response Strategy (NGRS) was the first national approach to include all sources and sinks of GHGs, across every economic sector (Parliament of the Commonwealth of Australia 2000). The NGRS was a Commonwealth, state and territory government commitment, formally endorsed by the Council of Australian Governments (COAG) in 1992. The NGRS included the 1990 adoption of the interim planning target (Toronto Agreement) of reducing GHG emissions by 20% from 1998 levels by the year 2005. Subsequent UNFCCC and Kyoto Protocol negotiations overturned the target (Taplin 1995; Parliament of the Commonwealth of Australia 2000). In 1995, 2 y prior to the Kyoto Protocol negotiations, the Keating government announced additional measures in what became known as the 'Greenhouse 21C' statement. Among several other initiatives, this announcement included the Greenhouse Challenge Program (GCP).

The GCP was a voluntary initiative between the Commonwealth and industry to provide a framework for undertaking and reporting GHG abatement activities, including forestry sequestration. In 1996, the newly elected Howard Liberal – National Coalition Commonwealth Government continued and extended the GCP under the name 'Greenhouse Challenge Plus Program' (GC+P). Out of this program came the first domestic policy that recognised carbon biosequestration, Greenhouse Friendly™. In 1997, immediately before the Kyoto Protocol conference, the

[11] tCERs expire after less than two commitment periods, and lCERs may expire after between 20 and 60 y, depending on the project.

[12] Provided that the sequestration 'discounting', 'deeming', or 'buffer' is conservative enough to not exceed the actual sequestered carbon remaining after a hazard event.

Howard government announced the package 'Safeguarding the Future: Australia's Response to Climate Change'. This package introduced the notion of mandatory targets for renewable energy in national electricity generation, and initiatives to treble carbon sinks in the form of domestic plantations and native revegetation by 2020 (Parliament of the Commonwealth of Australia 2000). Concurrently, the New South Wales State Government was designing a mechanism to increase renewable energy generation in electricity grids, based on a voluntary price-premium, supported by a rigorous accreditation process, which included bioenergy abatement (DCC 2009a) (see Fig. 1 for an Australian GHG mitigation policy timeline).

GreenPower

In NSW, the creation of the Sustainable Energy Development Authority (SEDA[13]) and its development of 'GreenPower' in 1997 aimed to build a domestic renewable energy industry (Parliament of the Commonwealth of Australia 2000; NSW Department of Water and Energy 2009). GreenPower remains as a national voluntary accreditation program, setting stringent environmental and reporting standards for renewable energy products offered by electricity retailers to households and businesses (GreenPower 2009a). SEDA's strict licensing requirements to accredit green energy sources, and guidelines, take into account the collateral environmental impacts of certain categories of renewable energy options (Parliament of the Commonwealth of Australia 2000). While GreenPower does not include biosequestration offsetting, it does accredit on a case-by-case basis bioenergy generators that consume biomass feedstock, such as cleared specified noxious weeds or wood waste from existing sustainably managed forest plantations and crops, grown on land cleared prior to 1990 (URS Australia Pty Ltd 2008; GreenPower 2009b).

The longevity and continued growth of GreenPower-accredited products demonstrate the importance of the voluntary program to Australia. GreenPower is recognised for promoting the assimilation of renewable energy and sustainably managed plantation policy into households, businesses and government utilities (Parliament of the Commonwealth of Australia 2000). The primary mechanism that GreenPower uses to ensure that its products are additional to concurrent renewable energy policies is to require the surrender of Renewable Energy Certificates (RECs), the tradable entity developed under the Mandatory Renewable Energy Target (MRET).

The Mandatory Renewable Energy Target (MRET)

The MRET is a 'baseline and credit' scheme that uses RECs to demonstrate compliance with annual interim renewable energy targets. RECs were developed to provide an economic incentive to construct new renewable energy generation capacity. Each REC has its own unique code, remains valid until surrendered against an MRET liability and represents 1 MWh of accredited renewable electricity. The penalty payment for non-compliance is a non-tax-deductable AUD40 per MWh (IEA 2006). All wholesale electricity purchases on electricity networks of more than 100 MW of installed capacity have had an increasing annual MRET liability since 1 April 2001. In order to meet their obligation, liable parties (wholesale purchasers) surrender RECs to the Office of the Renewable Energy Regulator (ORER).

[13] SEDA was incorporated in the NSW Department of Energy, Utilities and Sustainability in 2004, which was subsequently incorporated in the NSW Department of Water and Energy in 2007.

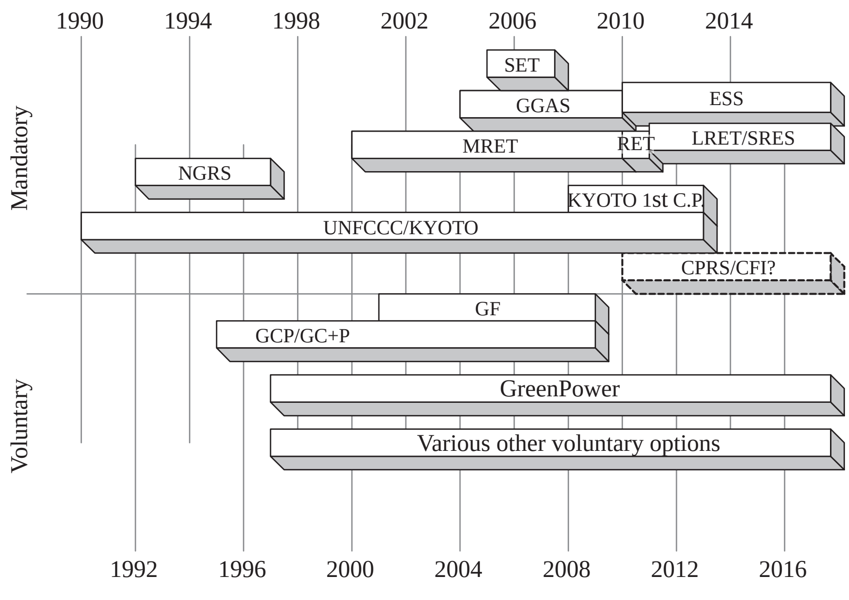

Figure 1. Major Australian climate change and energy market policy timeline (1990–2016)[A].

[A]SET represents some of the various Australian state electricity targets that were implemented or proposed in response to the perception of MRET becoming an inadequate policy around the year 2005. These were designed to be removed after the introduction of a successor to the MRET, known as the RET. In 2010 it was announced that the RET was amended to consist of two components as of 2011, the Large RET (LRET) for larger utility-scale electricity generators, and the Small-scale Renewable Energy Scheme (SRES), for smaller generation units (SGU) for domestic-sized electricity production (or displacement with solar hot water heaters).

The ORER, a statutory agency, administers *The Renewable Energy (Electricity) Act 2000*, the key legislative instrument of the MRET (MacGill *et al*. 2006). ORER-accredited renewable energy generators, including bioenergy generators, derive income from both the electricity they generate and the RECs they register. Every REC is created by a registered person, registered by the Renewable Energy Regulator, validated by the ORER, traded between registered persons and eventually surrendered to demonstrate compliance with the MRET. Once a REC is created it can be placed on a formal market or sold via bilateral deals (Kent and Mercer 2006). The MRET's small national additional renewable electricity target (9500 GWh by 2010) developed under the Howard government was widely criticised as merely maintaining renewable energy market share post-2010. State governments subsequently developed various schemes to address this shortcoming. At the COAG meeting in December 2007, the Rudd Labor Commonwealth Government and state governments agreed to work cooperatively to bring the MRET, and the various state-based targets, into a single expanded renewable energy target (RET). The RET aims to ensure that 20% of Australian electricity is generated from renewable sources by 2020. The Rudd government viewed the RET as an interim stimulus for deployment of renewable energy technology, to be phased out between 2020 and 2030 (DCC 2008a).

The MRET and its successors will continue to be a primary enabler of the Australian bioenergy sector. The MRETs REC price premium created a total of 1 137 530 MWh of certified renewable electricity generated from forestry and agricultural-related waste between 2001 and 2009. This mitigated an estimated 1 $MtCO_2$-e point-source net emissions from power stations (Table 3). A simple estimated carbon value from this small subsection of MRET-related agricultural and forestry mitigation can be calculated using the non-compliance penalty of AUD40, roughly representing the average REC price over the period. This abatement cost is about AUD45 per tCO_2-e[14] over the period. While this over-simplified calculation has severe limitations, it does demonstrate the creation of differential values of biomass and carbon in co-existing policies supporting either simple point-source bioenergy, or biosequestration mitigation.

[14] This rough estimate is an imprecise calculation due to the changing emission factors over time for each state, the assumption of a zero point-source emission from net accounting, and the omission of transport, harvesting and processing emissions, etc. The relatively simple 'back of the envelope' calculation was undertaken to demonstrate possible linkages between the costs and benefits of various policy mechanisms of competing mitigation policy choices.

Greenhouse Friendly™

In addition to the MRET, in 2001, the Howard Commonwealth Government launched the Greenhouse Friendly™ (GF) voluntary initiative. The initiative sanctioned various mitigation options, including certified renewable energy generation and biosequestration offsets (DCC 2009d). GF forestry projects required 'permanence' of at least 70 y and, if removed for any reason, obliged restoration to commence within 12 months (AGO 2006; NSW Government 2008a). Under the GF guidelines, projects that avoided forest clearing could have been approved if they met the same eligibility criteria as Kyoto Protocol forest sink projects, excluding human-induced requirements (AGO 2006).

By the end of 2008, there were five GF-forestry-approved abatement providers: Greening Australia, Landcare CarbonSMART, AusCarbon International, CO_2 Australia and Greenfleet. All forestry biosequestration activity was located in the eastern states (DCC 2009e). At the end of 2009 there were nine GF-forestry-approved abatement providers (NSW Government 2008a). Despite there being several approved abatement providers, very few offsets have been verified—primarily due to the small scale of initial sequestration and high costs of verification. The Rudd government stated that any future CPRS forestry-based carbon biosequestration would be similar to the GF scheme. Therefore, the relative attractiveness and deficiencies of the GF model may have implications for the level of biosequestration activity under any future CPRS. Even so, GF abatement credits (known as verified emission reductions, or VERs), will not be fungible with the CPRS Australian Emission Units (AEUs), and GF has now ceased as well as the GC+P. To make way for the CPRS, no new GF abatement project applications were considered after 4 February 2009. Transitional arrangements for GF participants included the continuation of current abatement projects until their deed conclusion before 2 July 2010 (DCC 2009e). Therefore, those who undertook carbon sequestration projects under GF are required by a policy that lasted only 8 y to maintain their offset for minimum of 70 y. Similar transitional measures were developed for the cessation of one of the largest global carbon trading markets for incorporation into the defunct CPRS, the pioneering NSW Greenhouse Gas Abatement Scheme.

Table 3. MRET certified bioenergy REC generation by source, and estimated point-source mitigation 2001–2009 (excluding bagasse generation and cogeneration)

Bioenergy resource[A]	RECs	Approximate emissions[B] tCO_2-e
Wood waste	1 016 165	904 885
Waste from processing agricultural products	61 930	41 016
Food and agricultural wet waste	46 048	555 400
Energy crops	9 705	8 637
Crop waste	2 282	2 077
Agricultural waste	1 400	1 708
Total	1 137 530	1 013 862[C]

[A] This table excludes the 1 551 935 and 1 751 866 valid RECs created from bagasse generation and co-generation activities, respectively.
[B] Using the annual emission factors (scope two) for each state electricity grid from the state of creation for each year
[C] Does not sum due to rounding

The Greenhouse Gas Abatement Scheme (GGAS)

The NSW GGAS was modelled on the MRET, although it was more comprehensive in its coverage. It allowed liable parties to achieve targets through renewable energy, decreased carbon intensities, energy efficiency or biosequestration options. In contrast to the MRET, the scheme units measured tCO_2-e abated, rather than MWh of renewable energy (ORER 2003). GGAS commenced in 2003, and has contributed significantly to Australian carbon market intellectual capital. It was renamed in 2007 by the new NSW Minister of Energy as the Greenhouse Gas Reduction Scheme, but continued to be known as GGAS. The objectives of GGAS were to reduce GHG emissions associated with electricity generation and to encourage offsetting activities (IPART 2008). The scheme required NSW and Australian Capital Territory (ACT) electricity retailers, large electricity consumers (> 100 GWh of annual demand) and some other minor parties who bought and sold electricity to meet mandatory benchmarks for reducing or offsetting GHG emissions, relative to their market share (DCC 2008a; IPART 2008). GGAS imposed a benchmark of 7.27 tCO_2-e per capita in 2007, from a benchmark of 8.65 tCO_2-e per capita in 2003 (IPART 2008) (Fig. 2).

Administered by the Independent Pricing and Regulatory Tribunal of NSW (IPART), GGAS was a 'baseline and credit' form of emissions trading. The GGAS registry did not provide a trading function. It did, however, manage the creation, transfer of ownership and ultimate surrender of tradable GGAS certificates, called the NGACs[15] (NSW Government 2005; IPART 2008). IPART was also the compliance regulator for benchmarking (IPART 2008). When participant's annual emissions exceeded their benchmark, they were required to offset emissions via surrendering NGACs annually. Any remaining emission liabilities incurred the GGAS penalty (IPART 2008; NSW Government 2008b). GGAS penalties were charged to participants failing to comply (beyond the acceptable 10% shortfall that they could carry forward) with their benchmark (NSW Government 2008b).

[15] LUACs (large user abatement credits) and RECs are also GGAS-tradable units. However, RECs are not exactly equivalent to NGACs. By using the GGAS pool coefficient for that year, one can convert RECs to NGACs. The value slowly increased from around 0.90 to 0.96 (tCO_2-e per MWh), from 2003 to 2009, respectively.

GGAS registry data indicate that over 20 million NGACs were created in 2008, and over 90 million between 2003 and 2008. Over 20 million NGACs were surrendered by participants to meet their 2008 benchmark obligations, and over 60 million over the life of GGAS. The 2008–2009 oversupply of NGACs saw a dramatic increase in the rate of voluntary surrenders of NGACs, which alongside the uncertainty of the scheme post-2009 led to a reduction in value (IPART 2009). (See Fig. 3 for the resulting change in NGAC value over time). Between 2007 and 2008 there was a ten-fold increase in voluntarily-surrendered NGACs, rising from around 50 000 to 488 000, totalling slightly over 545 000 between 2003 and 2008 (see Table 4).

GGAS and carbon sequestration requirements

GGAS-accredited demand-side abatement (DSA), low-emissions generation or forestry sequestration activities (IPART 2008). GGAS required that any carbon sequestration activities be undertaken in NSW. The *Greenhouse Gas Benchmark Rule (Carbon Sequestration)* amendment, known as the 'CS Rule', required that the applicant had the ownership or control of registered carbon sequestration rights on the title of the land, consistent with Article 3.3 of the Kyoto Protocol (NSW Government 2005; IPART 2008, 2009). The CS Rule accounted only for permitted sequestration once it had occurred and did not allow NGACs to be generated for expected sequestration, and documentary evidence was required to establish eligibility (IPART 2008). Eligibility required afforestation after 1 January 1990; a carbon pool manager controlling registered carbon rights on each title; relevant land use restrictions where the afforestation resides; documentation of maintenance or any harvesting procedure; and risk management strategies to ensure ongoing compliance (NSW Government 2005; IPART 2008).

Between 2003 and 30 June 2008, there were 3837 NGAC trades involving 75 645 926 certificates, of which around half involved only 1 442 382 CS Rule NGACs. There was a greater trading tendency for very small parcels of CS Rule NGACs than any other form of GGAS abatement, possibly reflecting relatively high perception of risk (IPART 2008, 2009). In addition, only 11% of created CS NGACs have been surrendered up to 2008, compared with more than two-thirds of all other GGAS certificates surrendered over the same period (IPART 2009). The number of NGACs created through the CS Rule represented less than 1% of total surrenders. Only seven of the 221 NGAC providers were

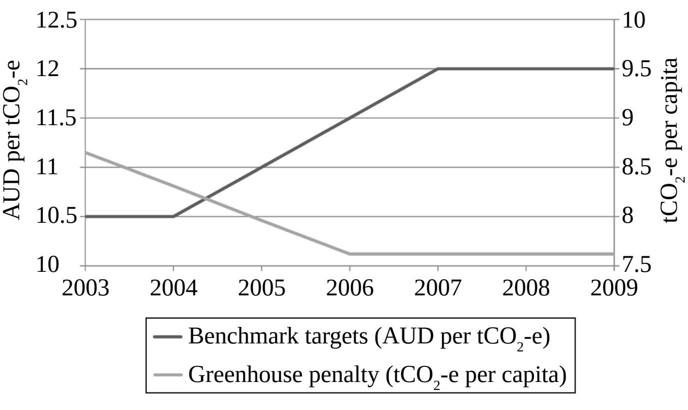

Figure 2. NSW GGAS benchmarks and penalties from 2003 to 2009

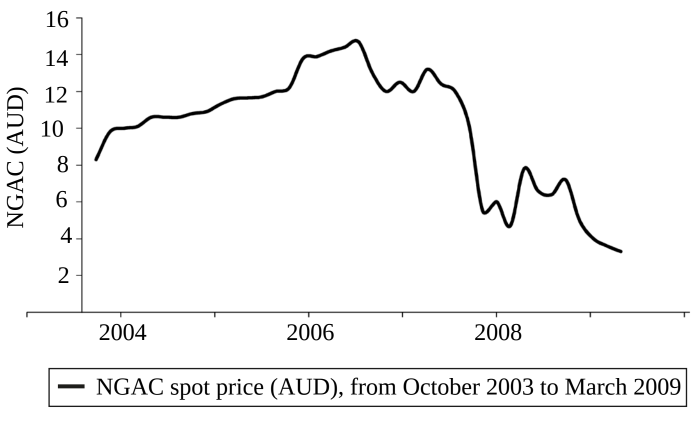

Figure 3. NSW NGAC values from 2003 to 2009

Table 4. NSW GGAS certificates (thousands) created, surrendered and voluntarily surrendered, by rule (2003–2008)[A,B]

Rule	Year						Totals[C]
	2003	2004	2005	2006	2007	2008	
Gen. (created)	6318	6744	7879	9548	12814	12340	55644
Gen. (surrendered)	1114	4432	7600	9291	9739	10866	43042
Gen. (voluntary)	—	—	5	—	11	383	399
DSA (created)	345	742	1509	8934	9928	8130	29589
DSA (surrendered)	53	606	382	2251	6158	9407	18857
DSA (voluntary)	—	—	0.1	1	33	73	107
CS (created)	—	166	538	588	699	675	2666
CS (surrendered)	—	—	—	50	25	183	258
CS (voluntary)	—	—	—	1	6	32	40
LUAC (created)	—	—	94	790	1286	1298	3468
LUAC (surrendered)	—	—	64	687	1040	1141	2932
LUAC (voluntary)	—	—	—	—	—	—	—
Total created	6333	7652	10021	19861	24726	22443	91367

[A]Source: IPART 2009
[B]Where 'LUAC' are 'large user abatement credits', 'CS' are 'carbon sequestration credits', 'DSA' are 'demand-side abatement credits', and 'Gen.' are 'generation credits'.
[C]Does not sum due to rounding

accredited under the CS Rule, and 99% of the CS NGACs were created by the Forestry Commission of NSW (IPART 2009). Therefore, for whatever reason, there is a comparably low level of attractiveness of carbon market forestry biosequestration projects and associated certified products.

In terms of project continuity, the Rudd government viewed GGAS forest biosequestration projects as 'likely' to be able to voluntarily opt into the CPRS, although the permanence of their obligations will be retained (DCC 2008a). Amidst the uncertainty, the Rudd government decided that some form of assistance was appropriate to compensate NGAC holders for the non-fungibility between NGACs and CPRSs AEUs for all categories (Capoor and Ambrosi 2009).

The CPRS, and CFI and biosequestration

The Rudd government committed to reduce Australian GHG emissions to a level 5% below 2000 levels by 2020 unconditionally, and by up to 15% in the context of a global agreement wherein other major economies strive for comparable reductions (DCC 2008b). The CPRS, a 'cap and trade' scheme, was expected to become the primary measure to achieve emission reductions domestically (DCC 2008a). The CPRS covered all six GHGs considered by the Kyoto Protocol and would capture around 75% of Australian emissions, involving mandatory obligations for around 1000 domestically operating entities (DCC 2008b). The Rudd government planned an AEU cap of AUD40 per tCO_2-e, rising at a real 5% per annum, and a fixed AUD10 price for the proposed first year (2011–2012) (DCC 2008a,b, 2009f). Such a low cap, relative to relatively recent high prices on international carbon markets, may have resulted in future difficulties in linking of the CPRS to international schemes (Capoor and Ambrosi 2009). The Rudd government expected the CPRS's AEU to be worth about AUD29 by 2012–2013—around three-quarters of the proposed cap (DCC 2009f). As the RET/LRET/SRES would have operated in parallel with the CPRS, the significantly smaller abatement cost is likely to have caused a depreciation of RECs relative to historical REC prices. The further inclusion of emission offsets from sectors outside the scheme (such as agriculture) may have resulted in an increase in emissions above the CPRS and Kyoto Protocol targets, due to a reduction in permit prices (DCC 2008b).

The Rudd government expected the market price of harvested wood products to exceed carbon value, suggesting the greatest benefits in relation to forestry activities were expected for owners of new, unharvested forests, established on less productive or marginal land. The CPRS included a retrospective reforestation establishment baseline (2008) to protect against perverse clearing prior to the introduction of the scheme. It was uncertain, however, if the CPRS would balance the potential for perverse protection of plantation timber monocultures at the expense of native forest exploitation for bioenergy. At the time, the CPRS documentation stated it would establish another forestry baseline to the 1990 Kyoto Protocol, creating additional exemption requirements for biosequestration covered by the then existing programs. This would penalise early-adopters of reforestation activities outside existing programs (DCC 2008b). Conversely, the proposed CPRS liability and associated administrative burden was not extended to biofuels and bioenergy emissions, including methane combustion from landfill facilities.

In 2008, the Rudd government aimed to commence the CPRS on 1 July 2010. It was, however, postponed 12 months supposedly due to the global recession (DCC 2008b, 2009f; Capoor and Ambrosi 2009). Finally the CPRS legislation was unable to pass through the senate due to lack of bipartisan support. The subsequent failure of both the third and final introduction of the CPRS legislation to the senate on the 2 February 2010, and the 15th Conference of the Parties resulting in the Copenhagen Accord[16] in late 2009, has left much uncertainty for LULUCF mitigation activities post 2012[17].

[16] Whether or not the Copenhagen Accord is really a failure will be determined in a review in 2015, despite many of the national targets citing a 2020 target date.

[17] The international mechanism known as 'reduce emissions from deforestation and forest degradation', or 'REDD-plus' remains as a single large international mechanism to mobilise funds specifically for the LULUCF sector for mitigation in developing countries.

The most recent proposed Australian LULUCF-related mitigation policy is the Gillard government's Carbon Farming Initiative. The CFI is a market-based scheme that uses a unit called an Australian Carbon Credit Unit (ACCU), equivalent to 1 tCO_2-e. If implemented, the Gillard government believes the CFI will be able to mitigate between 5 and 15 Mt tCO_2-e from Article 3.3 activities up to 2020 (DCCEE 2011). Based on historical policy efficacy, this is likely to be an overestimate. The CFI policy design relies heavily on 2008 and 2009 CPRS modelling and mechanistic assumptions, yet introduces a particularly complex methodology for the LULUCF sector. The available CFI literature suggests the Gillard government is well aware of the large number of assumptions, uncertainties, compliance obligations and the complexities of various proposed verification methodologies associated with the large range of LULUCF-related projects proposed to be incorporated in the CFI. The literature gives illustrative examples of a wide range of eligible activities; these are essentially environmental activities that aim to create a range of benefits often unrelated to mitigation. Examples of biosequestration and 'emission avoidance activities' include vegetative management, promotion of residual seed sources, coppicing, feral animal culling, enteric fermentation augmentation and seasonal burning of savannahs. Incorporating such a range of activities in a single scheme risks introducing unnecessary complexity in measurement, baselines and subsequent verification. In theory, the resultant uncertainty for the wide range of eligible activities will influence the value of ACCUs, which will in turn be influenced by Australia's naturally variable climate. As with other carbon markets, however, it is likely that market uncertainties and other fundamentals will be dominated by political influence. Furthermore, the CFI is proposed to operate with a small buffer (only 5% at present) of withheld ACCUs from each project as a small level of insurance against inadvertent loss considering the Australian climate. Sequestration projects are expected to remain as 'permanent' generally for 100 y, with a maximum reporting interval of 5 y. Yet CFI project proponents are likely to be able to terminate projects at any time, with the total number of ACCUs to be repaid to the CFI administrator upon termination (DCCEE 2011; Parliament of the Commonwealth of Australia 2011). Such terminations may become common, with biosequestration activities as small as 1 ha proposed to be allowed in the CFI increasing administrative requirements for the government. The inclusion of such micro-scale LULUCF activities indicates the CFI may become an inefficient mitigation policy with a high administrative burden to proponents and taxpayers.

In terms of market compatibility, the Gillard government states that ACCUs will be compatible with a variety of carbon markets (Parliament of the Commonwealth of Australia 2011). However, the ACCUs derived from Article 3.3 activities (akin to RMUs) will be small, and countries that will accept such ACCUs as banking of RMUs or ERUs—converted from either RMUs, tCERs or lCERs—are not allowed in most international markets. Nonetheless, ACCUs creation is expected to be consistent with the National Carbon Offset Standard, which is itself heavily based on Kyoto Protocol mitigation definitions and units. The standard itself does not delve into RMUs or LULUCF verification methods at a particularly detailed level. The CFI allows both voluntary cancellation and international sale of ACCUs (but which is likely to be limited in any case) which will not be used to meet Australia's international obligations (Parliament of the Commonwealth of Australia 2011). Finally, at risk of over-speculating about individual proposed policies and compatibility and convergence, this research presents aspects of the recent Australian policy convergence experience. The over-riding aim is to prevent policy problems recurring in future LULUCF-related policy developments.

The Australian experience of complementarity and convergence

State and territory governments were encouraged by the Rudd government to terminate GGAS and other non-complementary schemes. GGAS legislation was amended in 2006 to terminate at the commencement of the national CPRS (IPART 2008; NSW Government 2008b). At the cessation of GGAS, energy efficiency projects would have been unable to generate NGACs for avoided emissions. On 18 June 2008, however, the NSW Premier and Minister for Climate Change announced the NSW Energy Efficiency Trading (NEET) policy to maintain GGAS DSA Rule activities (NSW Government 2008b). NEET was renamed to the Energy Savings Scheme (ESS), and the initial start date changed from 1 January to 1 July 2009 (IPART 2008, 2009), and GGAS DSA Rule-accredited certificate providers and initiatives have transferred to the ESS (NSW Government 2008b; IPART 2009). The Rudd government stated that it would allow GGAS forestry CS projects to opt into the proposed CPRS, provided they met eligibility requirements (DCC 2008b). The CPRS forestry-based biosequestration was to be built on the GF scheme structure, which will affect around AUD14 million in abatement projects from the seven GGAS CS certificate-providers if the CPRS or a similar mechanism is eventually implemented. The differences between GF and GGAS biosequestration project standards include undiscounted GF carbon assets, when the relatively conservative GGAS '70 percent Rule' provided a carbon accounting buffer. Also, under GGAS the liability fell on the seller of the NGAC, whereas GF liabilities could be transferred to either party under contract. Moreover, the financial additionality test for GF forestry offsets was not existent in the GGAS scheme (NSW Government 2008a). These seemingly arbitrary differences between co-existing mechanisms have resulted in fundamental incompatibilities during subsequent policy integration. In order to prevent such issues arising and reduce the administrative burden and uncertainty for participants, a clear knowledge of existing mechanisms and outcomes nationally and internationally is required in the policy development process to improve trans-mechanism transferability.

While the GGAS scheme credits were traded internationally on the EU ETS, the transfer of the proposed CPRS's AEUs into international markets was not to be allowed in the early years. Kyoto Protocol units were deemed to be allowed for the proposed CPRS compliance domestically, except AAUs, a rule that was to be reviewed after 2012–2013. RMUs were to be eligible for CPRS compliance if they were issued and surrendered in the first commitment period of the Kyoto Protocol. As few countries are able to generate RMUs, however, the potential trade in RMUs would have been small within a CPRS. The CPRS was to allow AAUs to be banked without restriction, while banking of RMUs or ERUs, converted from either RMUs, tCERs, or lCERs, was not to be allowed. ERUs were to be recognised for compliance under the CPRS, although the Rudd government stated that Australia would not host JI projects in sectors covered by the CPRS (DCC

2008b). The Commonwealth Government's reasoning behind allowing unlimited numbers of eligible Kyoto Protocol units in the CPRS was to promote technology transfer, support Kyoto Protocol architecture, control domestic compliance costs and to facilitate Australian involvement in international carbon markets. The eligible units included those external to formal Kyoto Protocol flexibility mechanism markets (DCC 2008b). This reasoning seems to be at odds with the logic of disallowing JI activities to occur on Australian soil. The facilitation of technology and knowledge transfer from revegetation in remote Australia would be likely to increase Australian participation in international carbon markets.

On the 1 January 2008 the Chicago Climate Exchange (CCX), a voluntary carbon exchange, stated that mitigation projects already accounted for in national inventories for internationally agreed commitments and that have implemented domestic 'cap and trade' systems, will be ineligible to create CCX Carbon Financial Instruments (CFIs) (Chicago Climate Exchange 2008). Similarly, international non-Kyoto Protocol units such as CFIs were not acceptable for the proposed CPRS compliance in the pre-2013 period (DCC 2008b). If, however, Australia continues to exclude Article 3.4 emissions in Kyoto Protocol reporting and from any future 'cap and trade' system occurring after the potential carbon tax, Australian LULUCF mitigation activities may still be eligible to trade on markets such as the Chicago Climate Exchange. This assumes appropriate bilateral agreements and methods are developed[18] (McHenry 2009).

Any overlap between mitigation schemes will be likely to incur additional compliance costs, even when meeting one liability discharges another (AGO 2003). Such parallel compliance costs may exceed the expected abatement benefits, reduce participation or even markedly increase mitigation costs or energy prices (Wilkins 2008). While a diversity of climate-change or carbon markets offer choice, increase competition and develop accounting rigor, a convergence of markets and standards that retain the most advantageous qualities will be likely to increase participation (Illum and Meyer 2004; Capoor and Ambrosi 2009). In any case, the large number of new markets, the variability of their eligibility rules and the sequestration price volatility that has occurred in recent years demonstrate a high commercial risk to LULUCF biosequestration project proponents. Furthermore, the actual level of mitigation achieved by the LULUCF-related policies implemented in Australia to date does not bolster confidence.

Efficacy of Australian LULUCF mitigation policy

The primary aim of climate-change policy is to achieve emission reductions as efficiently as possible. Table 5 shows the historical efficacy of Australian mitigation policies over time, including market and non-market mitigation alternatives. Taking into account the calculation assumptions and intrinsic uncertainties, it effectively demonstrates the massive mitigation potential of simple clearing legislation[19], despite the nuances of the accounting method and policy implications. Conversely, both active and passive forestry sequestration attained small gains in mitigation[20]. The forestry-related activities that were captured in market mechanisms such as GGAS, GF and MRET are a very small component of total biologically-based mitigation in Australia. This is likely to be indicative of inefficient market accreditation procedures, high costs of compliance and long-term uncertainty of LULUCF options and policy, relative to point-source technical alternatives.

Whilst detailed assessments of the efficacy of each respective LULUCF mitigation policy mechanism is outside the scope of this work, the author notes that mitigation alone is not indicative of successful land use policy. For instance, highly productive food-producing regions may not be the most appropriate

[18] Article 3.4 emissions include those from all managed native forests, revegetation that does not meet forest criteria, and carbon stored in soil or vegetation on grazing or crop lands (DCC 2008c).

[19] The author means 'simple' from the perspective of policy mechanism development. Politically, land-clearing legislation is notoriously difficult to introduce, and is a particularly blunt instrument.

[20] While the deforestation mitigation calculation is based on the contentious KP 'Australia clause', it does demonstrate the utility of a relatively efficacious and simple regulatory mitigation measure. Land clearing in Australia still occurs, however, and remains as an emission liability.

Table 5. Australian LULUCF-related policy mitigation efficacy

Activity or scheme	Active data	Total no. of years	Approximate total mitigation ($MtCO_2$-e)	Average annual mitigation ($MtCO_2$-e)
Deforestation[A]	1990–2008	19	1 519.135[C]	79.954[C]
Forestry (reforestation)[A]	1990–2008	19	239.208	12.589
MRET[B]	2001–2009	8	1.014	0.126
GGAS	2003–2008	6	2.666	0.444
GreenPower[B]	1997–2007	9	3.869	0.430
GF	2001–2009	8	<1[D]	0.125[D]
CPRS/CFI	?	—	—	—

[A] Cumulative data derived from the Australian NGGI (KP accounting), and 2008 data from DCC (2009a)

[B] Using the annual emission factors (scope two) for each state electricity grid from the state of creation, for each year

[C] Uses 1990 NGGI deforestation (132.159 $MtCO_2$-e) as the baseline, and subtracts the annual deforestation emissions to obtain mitigation activity from deforestation reduction

[D] Of the 20 GF program-approved projects before 2008, there were only two forestry abatement providers. At that time the estimated annual program mitigation was 1.8 $MtCO_2$-e, and the author suggests that forestry mitigation projects would contribute less than 1 $MtCO_2$-e over the interval, based on similar forestry policy contributions (Capoor and Ambrosi 2008). At the end of 2009, there were nine GF-approved forestry abatement project providers; none had yet submitted claims for approval of abatement or independent verification.

locations in which to foster large-scale forestry carbon sinks. Predictable rates of LUC in rural areas should also be of concern to policymakers. Thus policy mechanisms designed to harness the agricultural–forestry mitigation potential must be stable over the long term, as any gains can be quickly reversed from LUC activities. Figure 4 demonstrates the relative volatility of existing and past policy carbon-related markets and the spread of mitigation value. Of interest are the two Australian 'baseline and credit' schemes, MRET/RET's RECs and GGAS's NGACs. While clearly exhibiting less volatility than the EU's ETS units (EUAs), the RECs and NGACs seemingly are unrelated, or may even be interpreted as showing inverse mitigation values over time. In contrast to fundamentals of LULUCF biosequestration costs, the value of mitigation in recent markets is highly sensitive to policy preferences and market designs. Thus policymakers must be careful when designing initial conditions and options to refine market performance over time, especially for reversible gains from the agricultural and LULUCF sectors.

Future climate-change policy should seek to avoid imposing unresponsive arrangements that are complex in nature and insensitive to economic differences between regions. Such outcomes create considerable differentiated compliance costs between adherents, and uncertainty between competing opportunities (Babiker *et al*. 2002). As Hamilton and Vellen (1999) documented, the 'Australia clause' divergence from the Kyoto Protocol additionality principals sets a discouraging precedent that exploits complexities to create exemptions. This precedent may prove problematic in future international climate negotiations, even for sectors outside LULUCF. As in past Kyoto Protocol negotiations, the same 'constructive ambiguity' that endorsed LULUCF activities is expected to broker deals in the future. However, as with the LULUCF sector, there are likely to be unforeseen burdens to manage in a complex policy environment (Hohne *et al*. 2007). Therefore, the best policy may be the simplest policy.

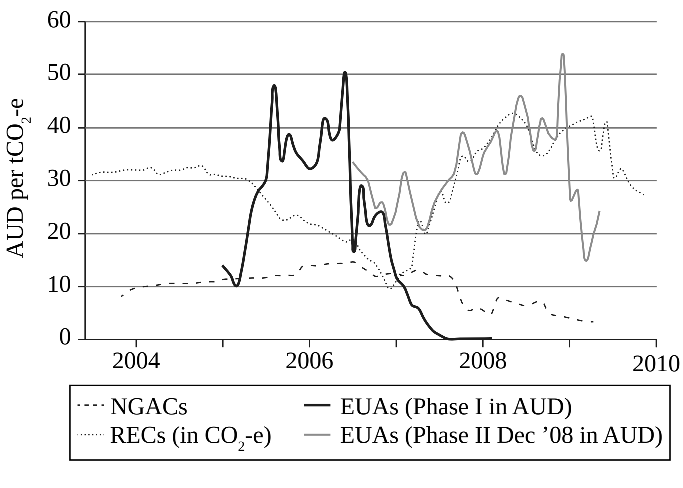

Figure 4. NGAC, RECs and EUA (Phase I and Phase II Dec. 2008) values from June 2003 to October 2009 (AUD). (MRET RECs are represented in terms of tCO_2-e, and were calculated in terms of an available annual average emission factors (scope 2) for each state's electricity network. EUA values were converted using an average monthly exchange rate.)

Fundamental criteria for prudent LULUCF mitigation policy

This research has distilled five relatively simple criteria to assist LULUCF biosequestration and bioenergy policymakers to avoid past policy oversights. These criteria are by no means detailed, yet collate findings from the Australian biosequestration and bioenergy experience to date.

1. As biosequestration and bioenergy are fundamentally a component of a biological system, they exhibit complex characteristics that will be more difficult and expensive to quantify than abiotic systems. Therefore, both additional rigour and flexibility must be introduced into region-specific mitigation verification methods that must also incorporate other local land use priorities (stable property values, salinity containment, food and water security, biodiversity protection, etc.). Such a regionally-appropriate perspective can be used to develop a simple deeming policy method (to avoid the duplication of detailed biosequestration verification) that balances certainty for project proponents, investors, emission liability holders and local communities.
2. Forestry biosequestration markets have largely failed to produce any meaningful mitigation in Australia in two decades since the Kyoto 1990 baseline. Whilst liquid or leveraged financial instruments may assist the function of biosequestration and bioenergy markets, such policy mechanisms introduce a problematic level of short-term volatility that is at odds with the long-term temporal realities of forestry assets, productive land values and climate change generally. Highly volatile markets risk long-term forestry asset 'gaming' in a temporally asymmetrical biosequestration process: long-term asset development and maintenance, in contrast to an essentially instantaneous harvest or loss.
3. Insular development of complex national biosequestration policies has unnecessarily increased administrative burdens and uncertainty for participants, and also generated fundamental incompatibilities during subsequent attempts to integrate policies. A clear understanding of the mechanics of co-existing mechanisms will improve fungibility of biosequestration activities nationally and internationally.
4. Baseline and credit-tradable quota schemes (such as the MRET/RET) are least-cost policies that can promote bioenergy industry development (or at least assist co-firing forestry wastes with coal) with targeted amendments. Such amendments may simply be the development of a subcategory of REC specifically providing an additional premium for verified suitable waste biomass utilisation in large-scale stationary thermal generators. This avoids much of the 'non-commodity' uncertainties of biosequestration quantification, and directly and verifiably displaces emissions from the single largest sectoral emitter in Australia.
5. Federalisation of region- or state-based LULUCF mitigation policy has resulted in stagnation of policy development and implementation in Australia (by all major parties or coalitions). Regionally efficient mitigation and adaptation within a diverse and geographically differentiated LULUCF landscape seems to be largely incompatible with a national Australian policy approach. Mechanistically similar state-

based mechanisms that are synergistic with regional land-use planning policy and infrastructure will be more likely to promote LULUCF mitigation activities that create external regional benefits.

Conclusions

Whilst a national approach streamlines the diverse array of mitigation initiatives to reduce administrative, monitoring and compliance burden (Wilkins 2008), this streamlining must be done judiciously as to not erase decades of regionally-appropriate mitigation policy development. Based on circumstantial data, successive Commonwealth Governments have been unable to achieve national LULUCF mitigation. The Commonwealth Government's approach to international negotiation and domestic climate change engagement is likely over the medium term to remain oscillating between political parties in power (McDonald 2005; Crowley 2007). Therefore, resigning LULUCF mitigation policy to the Commonwealth seems to be an unwise strategy in the medium term. In contrast, geographical differentiation has stimulated policy innovation from parallel state and territory engagement with the Commonwealth.

Notwithstanding resurfacing grievances regarding appropriateness of target-setting, government behaviour, interest groups, policy appropriateness and even Kyoto Protocol mechanisms themselves, Australian policymakers require complementary political, judicial and regulatory structures that can capture and harness firms and individuals to serve international obligations (Babiker *et al*. 2002; Prins and Rayner 2007). The inherent biological nature of the LULUCF sector is likely to require a diverse multi-jurisdictional, multi-disciplinary capability to balance factional preferences and enable regionally efficient mitigation and adaptation. The last two decades of policy development demonstrate that complex policies—even if they can be implemented in the first place—may generate only relatively inconsiderable LULUCF mitigation.

A sensible simplification of the proposed suite of LULUCF biosequestration and bioenergy mitigation policy mechanisms seems prudent. This is based squarely on the innate physical uncertainty of biological systems interacting with a market-based trading model overlayed with political influences. The substitution of overly complex LULUCF accounting methods for biomass and biosequestration activities towards discounting, deeming or buffer policies may be a necessary direction (Hamilton and Vellen 1999; Hohne *et al*. 2007). Based on past policy efficacy, these alternatives are more likely to provide a balance between responsiveness, simplicity, and sensitivity to economic and regional differences that harness the diverse Australian landscape's considerable biological mitigation potential. Ideally, global mitigation policy co-evolution involving biological systems could take an example from biological convergent evolution where dissimilar entities adapt to their unique environment using remarkably similar approaches that may not be perfect, but manage the common task.

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