Australian Government

Rural Industries Research and Development Corporation

Sustainable Production of Bioenergy

A review of global bioenergy sustainability frameworks and assessment systems

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by Deborah O'Connell, Andrew Braid, John Raison, Kristian Handberg, Annette Cowie, Luis Rodriguez and Brendan George

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Foreword from RIRDC

Bioenergy is the production of heat, power and liquid fuels (biofuels) from biomass. Sustainability is a critical issue for the bioenergy industry internationally. Many governments and market segments now consider that quantitative, robust and independently verified (or certified) sustainability credentials are vital in order for the bioenergy industry to expand globally. This is already translating to government policies in some countries. These policies will limit market access and government support to only those biofuels which meet specified sustainability criteria.

The bioenergy industry is relatively small in Australia. The need to reduce greenhouse gas emissions as well as future oil security issues will, however, provide drivers for the growth of the bioenergy industry.

This report reviews the sustainability issues that have arisen through rapid international expansion of the biofuels industry. It also reports on the international response to these issues in terms of both institutional systems, and sustainability assessment systems. It reviews institutional systems in place at the level of the Australian Government, and for one state (Victoria) as a case study. The theory and application of outcomes-based criteria and indicator assessment systems are discussed. The potential options and implementation pathways (should Australia choose to develop or apply these approaches) are also put forward.

A clear demonstration that the bioenergy sector can produce sustainable energy products, as well as make a significant contribution to the broader sustainability goals of Australia, would be a strong industry enabler. It would provide consumer confidence in bioenergy products, as well as the confidence for governments to invest in bioenergy as a plausible energy alternative. This report provides the underpinnings for the industry and government sectors to move towards these goals.

This project was co-funded by RIRDC (from RIRDC Core Funds which are provided by the Australian Government), CSIRO Energy Transformed Flagship, Industry & Investment NSW, University of New England and Victorian Department of Sustainability and Environment.
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This report is an addition to RIRDC's diverse range of over 1900 research publications. It is part of our Bioenergy, Bioproducts 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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Peter O'Brien
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Thank you Nick Abel (CSIRO), Michael Dunlop (CSIRO), Mark Glover (EcoWaste), Steve Schuck (Bioenergy Australia), Bruce Harrison (Biofuels Association of Australia), and officers from DEWHA, DAFF, DRET, DFAT, DCC AND DIISR for your reviews of this report at a couple of stages through its development. Your comments were detailed and incisive, and challenged us to dig more deeply to address your concerns and wide-ranging views on the topic. We have tried to address those which we could substantiate, and which fell within the remit of the report. We greatly appreciate the time, attention and expertise you have given to improving this report.

Thank you to our colleagues at CSIRO working in the 'Sustainable Biomass Production for Bioenergy in Australia' team. You have provided a stimulating depth of discussion and debate, shaping and challenging many of our ideas. This includes Michael Dunlop, Franzi Poldy, Barrie May, Damien Farine, Michael O'Connor, Joely Taylor, Alexander Herr, Mick Poole, Debbie Crawford, Tom Jovanovic, Peter Campbell, Dave Batten, Mick Poole and Tim Grant. Joely Taylor, Peter Campbell and Franzi Poldy have contributed a few paragraphs or data to this report. Jamie Allnutt (ENFAC) and Jamie Ackerman (EcoCreative) assisted with editing, references and diagrams.

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* In July 2009 the NSW Department of Primary Industries became part of Industry & Investment NSW

Glossary

Accreditation: third-party attestation of the demonstrated competence of a certification body to evaluate compliance with a standard.

Agricultural residues: biomass originating from crop production, harvesting, and processing in farm areas, including (among others) wood, straw, stalks, and husks.

Assurance scheme: an assurance scheme is a method to manage public concerns about bioenergy by demonstrating that the feedstocks are sourced sustainably.

Audit: an official examination and verification of accounts and records.

Biochar: carbon-rich solid product resulting from heating of biomass in oxygen-limited environment. The chemical and physical properties of biochar depend on feedstock (crop waste, energy crop, wood chip, municipal waste, manure, etc.) and process conditions (mainly temperature and time). These properties affect the interactions biochar has within the environment of its application (e.g. soil amendment benefits) as well as its longevity.

Biofuel: liquid fuel produced directly or indirectly from biomass.

Bioenergy: energy from biomass, including heat, electricity (or power) and liquid fuels.

Bioenergy sustainability framework: a framework is a basic structure underlying a system. This report uses the term bioenergy sustainability framework to refer to the collection of institutional and governance arrangements (international, national and local environmental, social and economic policies and actions) and scientific methods that assess the sustainability of bioenergy.

Biomass: material of biological origin (excluding material embedded in geological formations and transformed to fossil).

Biomass feedstocks: biological material used to feed conversion processes – for example bioenergy.

Book-and-claim system: also known as negotiable certificates system. Under this certification system the biomass is not traceable to the source but the end user submits certificates that guarantee the production of a certain quantity of sustainable biomass. Only the primary producer is certified.

Certification: third-party attestation related to products, processes, systems or persons that fulfilment of specified requirements (as laid down in a standard) has been demonstrated.

Chain-of-custody system: a system is used to link the volumes of biofuel with certain carbon and sustainability characteristics, to the volumes of biomass required for this which posses the same carbon and sustainability characteristics. Types of chain-of-custody systems include mass-balance, track-and-trace and book-and-claim.

Combined heat and power (CHP): the use of a heat engine or a power station to simultaneously generate both electricity and useful heat. Also known as cogeneration.

Cogeneration: Cogeneration or CHP (combined heat and power) is the simultaneous production of electricity and heat using a single fuel. The heat produced from the electricity generating process is captured as steam that can be used as a heat source for both industrial and domestic purposes and can be used in steam turbines to generate additional electricity.

Communities of consent: A “community of consent” refers to the people that provide the stakeholders in an enterprise with formal or informal consent to operate. The “community of consent” represents all levels of government, impacted communities, neighbours, NGOs, consumers and future generations.

Criteria: these describe the components of sustainability (e.g. biodiversity, social considerations) that are nominated for any particular assessment system. Sometimes criteria are described in terms of the desired condition (e.g. 'erosion is avoided', 'soil health is maintained or improved') and sometimes as a category for assessment (e.g. 'soil health'). See also **indicator**.

Cumulative impact: the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions.

Direct effect: effects that are caused by the action and occur at the same time and place. See also **indirect effect**.

Driver: a force that generates a change on a variable or parameter.

First-generation technology: currently deployed with a proven technology, existing commercial enterprises and mature markets. See also **second-generation technology** and **third-generation technology**.

Fischer-Tropsch: a catalysed chemical reaction in which synthesis gas (syngas), a mixture of carbon monoxide and hydrogen, is converted into liquid hydrocarbons of various forms.

Global warming intensity (GWI): a measure of the global warming impact of processes associated with the production of biofuels. The unit of measure for GWI is grams of carbon dioxide equivalent per megajoule of fuel delivered to a vehicle (gCO_2e/MJ). GWI encompasses the life cycle of production, transport, storage and use that affect global climate.

Identity-preserved system: An identity-preserved system is a tracking system that requires the physical separation and certification of each batch of product through the production and supply chain, thereby preserving the identity of each batch of certified product.

Incentive: a reward for a specific behaviour designed to encourage that behaviour, induce action or motivate effort.

Indicator: an indicator is a qualitative or quantitative parameter, by which a criterion can be measured and thus becomes testable. Indicators must be clear and verifiable. See also **criterion**.

Indirect effect: effects that have multiple steps in causality from an initial action, and have time lags or are distant from the original action. See also **direct effect**.

In-forest residue: wood, foliage and/or roots remaining in or next to the forest after timber harvesting.

Institutions (or institutional frameworks): the collection of international, national and local environmental, social and economic policies, rules, governance arrangements and social norms from different levels of government and industry through the value chain.

Label: used to demonstrate that a certain level of performance, related to the standard, is achieved. The performance level(s) that needs to be achieved to qualify for the label can be defined as part of the standard or as part of the certification and labelling process.

Marginal land: a term that is used (and mis-used) extensively in the literature on biomass and bioenergy. It has a specific economic context but in general is used to mean low-productivity or under-utilised land. This report uses the word 'marginal' only in direct citations, but generally uses the term low-productivity land. See also **low-productivity land**.

Mass-balance system: a system under which the biomass is partly traceable to the source; the certified biomass may be mixed with non-certified biomass during the production process; and all the companies in the 'sustainable biomass chain' are certified.

Meta-standard: an approach in which existing voluntary agri-environment and social accountability schemes are benchmarked against principles, criteria and indicators to assess the extent to which the feedstock produced in accordance with each scheme can be considered sustainable.

Monitoring: repetitive observations over time. Monitoring may focus on various aspects and may serve several purposes. Monitoring provides insight into the functioning of the system, and is a prerequisite for continuous improvement.

Norm: the reference value of an indicator. A norm is established for use as a rule or a basis for comparison. By comparing the norm with the actual measured value, the result demonstrates the degree of fulfilment of a criterion and of compliance with a principle.

Objective: the intended result to be achieved by a specific time. An objective is broader than a goal. One objective can be broken down into a number of specific goals.

P-series fuels: a set of renewable fuels that can substitute for gasoline, made up of a mixture of ethanol, methyltetrahydrofuran (MeTHF), pentanes plus, with butane. Approximately 35% of the blend is or can be created from waste products of other industrial processes.

Pyrolysis: the thermal decomposition of biomass at high temperatures (greater than 200° C) in the absence of air. The end product of pyrolysis is a mixture of solids (char), liquids (oxygenated oils), and gases (methane, carbon monoxide, and carbon dioxide) with proportions determined by operating temperature, pressure, oxygen content, and other conditions.

Second-generation technology: physically demonstrated at pilot scale, but not yet commercial due to scale-up issues or high costs. See also **first-generation technology** and **third-generation technology**.

Segregation method: The segregation method or a track-and–trace system is a tracking system that requires the separation of certified product from uncertified product, while allowing the mixing of batches of certified products. All certified product must go through the certified production and supply chain.

Sustainability assessment system: A sustainability assessment system monitors key system drivers and indicators over time, providing tools and data to judge the condition of and trends in the system, and whether sustainability goals and outcomes have been achieved.

Standard: a document that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods.

Targets: defined levels of performance required to be met for each criterion or indicator in order to achieve the goals set for achieving sustainability.

Third-generation technology: technology at the conceptual planning stage, ‘on drawing board’ or at benchtop demonstration stage, but that has a long way to go before it can be deployed. See also **first-generation technology** and **second-generation technology**.

Track-and-trace system: a system in which units are traceable back to their origin (e.g. an individual plantation). The essence of a track-and-trace system for sustainability purposes is the fact that it physically segregates products from certified plantations from other products (from non-certified plantations). See also **segregation method**.

Verifier: a fourth hierarchical level, below the level of indicators, to describe the data required to enable calculation of the indicator. A verifier refers to the source of information for the indicator and relates to the measurable element of the indicator.

Abbreviations

A3P	Australian Plantation Products and Paper Industry Council
ABARE	Australian Bureau of Agricultural and Resource Economics
ACCC	Australian Competition and Consumer Commission
AIAST	Australian Institute of Agricultural Science and Technology
ANZECC	Australian and New Zealand Environment Conservation Council
ARB	Californian Air Resources Board
ASF	Australian Forestry Standard
BMP	Best Management Practice
BSO	Biofuels Sales Obligation (New Zealand)
C&I	Criteria and Indicators
C&S	Carbon and Sustainability (C&S) reporting scheme
CITES	Convention on International Trade in Endangered Species
CNG	Compressed Natural Gas
COAG	Council of Australian Governments
CPRS	Carbon Pollution Reduction Scheme
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTE	Committee on Trade and Environment (WTO)
DME	Di-methyl ether
EBPC	Environmental Protection and Biodiversity Conservation Act 1999
EECA	Energy Efficiency and Conservation Authority (New Zealand)
EER	Energy Economy Ratio (California)
EIA	Environmental Impact Assessment
EISA	Energy Independence and Security Act 2007 (USA)
EJ	Exajoule (10^{18} joules)
EMS	Environmental Management System
EPA	US Environmental Protection Agency (USA)
EPFL	École Polytechnique Fédérale de Lausanne
EROI	Energy return on investment
ESD	Ecologically Sustainable Development
ETS	Emissions Trading Scheme
EU	European Union
FAO	Food and Agriculture Organisation
FSC	Forest Stewardship Council
FTA	Free Trade Agreement
GATT	General Agreement on Tariffs and Trade
GBEP	The Global Bioenergy Partnership
GHG	Greenhouse Gas
GMO	Genetically Modified Organism
GRDC	Grain Research and Development Organisation
GTAP	Global Trade Analysis Project model,
GWh	Gigawatt hours
GWI	Global Warming Intensity
IEA	International Energy Agency
IFPRI	International Food Policy Research Institute
ILO	International Labour Organisation
iLUC	Indirect Land Use Change
IRGC	International Risk Governance Council
IPCC	Intergovernmental Panel on Climate Change
ISEAL	International Social and Environmental Accreditation Labelling Alliance
ISO	International Organisation for Standards
LCA	Life cycle Assessment
LCFS	The Low-Carbon Fuel Standard (California)
LUC	Land Use Change

MERI	Monitoring, Evaluation, Reporting and Improvement
ML	Megalitres (10^6 litres)
NAFI	National Association of Forest Industries
NFF	National Farmers Federation
NGO	Non Government Organisation
NLWRA	National Land and Water Resource Audit
nrp PPMs	Non-product related process and production methods
NSEDS	National Strategy on Ecologically Sustainable Development
NSW DPI	New South Wales Department of Primary Industries
NTA	Netherlands Technical Agreement
OECD	Organisation for Economic Co-operative Development
OPEC	Organisation of Petroleum Exporting Countries
R&D	Research and development
RET	Renewable Energy Target (Australia)
RFS	Renewable Fuels Standard (USA)
RIN	Renewable Identification Numbers (USA)
RIRDC	Rural Industries Research and Development Corporation
RIS	Regulatory Impact Statement
RSB	Roundtable on Sustainable Biofuels
RSPO	Roundtable on Sustainable Palm Oil
RTA	Office of the Renewable Fuels Agency
RTFC	Renewable Transport Fuel Certificates
RTFO	Renewable Transport Fuel Obligation
RTRS	Roundtable on Responsible Soy
SA	Standards Australia
SCARM	Standing Committee on Agriculture and Resource Management
SFM	Sustainable Forest Management
SoE	State of the Environment Report
SUFAG	Sustainable Aviation Fuel Users Group
TBT	Technical Barriers to Trade (WTO)
TIM	Threat Identification Model
TWh	Terrawatt hours
UK	United Kingdom
UNCCD	United Nations Convention to Combat Desertification
UNCTAD	United Nations Conference on Trade and Development
UNEP	United Nations Environmental Programme
UN-Energy	United Nations Energy
UNFCCC	United Nations Framework Convention on Climate Change
UNICA	Brazilian Sugarcane Industry Association
USA	United States of America
Vic DSE	Victorian Department of Sustainability and Environment
WMAA	Waste Management Association of Australia
WTO	World Trade Organisation

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Executive summary

Please note: for simplicity of reading, the Executive Summary and Chapter Summaries do not contain all of the references contained in the main body of the text. If you wish to cite, please use full body of text.

What is the report about?

Sustainability is a critical issue for the bioenergy industry internationally and in Australia. Many governments and market segments now consider that quantitative, robust and independently verified (or certified) sustainability credentials are vital in order for the bioenergy industry to expand globally. This is already translating to government policies in some countries. These policies will limit market access and government support to only those biofuels which meet specified sustainability criteria.

The bioenergy industry – the use of biomass for heat, power (bioelectricity) and liquid fuels (biofuels) is relatively small in Australia. The need to reduce greenhouse gas emissions as well as future oil security issues will provide drivers for the growth of the bioenergy industry.

This report uses the term "bioenergy sustainability framework" (Figure 1-1) to refer to the combination of:

- institutional systems (including environmental, social and economic policies, laws and regulations); intergovernmental agreements; national, state or regional governments; transnational organisations and industry groups. Institutional systems are the means by which sustainability goals can be achieved (or not, if the policy settings drive the system in an unsustainable manner).
- sustainability assessment systems to monitor key system drivers and indicators over time, and to assess the state of system variables and trends.

In a well-functioning approach, there would be feedback between the institutional systems and the sustainability assessment systems across different scales. For example, sustainability assessment systems can be used to judge the success of sustainability policy goals. They can also be used to help to design sustainable solutions by feeding back into policy settings in an adaptive management framework. In turn, institutional systems can specify the details of a sustainability assessment system to be deployed.

In this report we discuss the theory behind sustainability assessment and the design of sustainable solutions; and discuss how a bioenergy sustainability framework might be applied. We review the sustainability issues that have arisen through rapid international expansion of the biofuels industry and report on the international response to these issues in terms of both institutional systems, and sustainability assessment systems. We review institutional systems in place at the level of the Australian Government, and for one state (Victoria) as a case study. We delve further into the theory and application of outcomes-based criteria and indicator assessment systems, and discuss the potential options and implementation pathways should Australia choose to develop or apply these approaches.

Who is the report targeted at?

The target audiences for this report are those who may have an interest, investment, share, concern or other involvement in the development of a bioenergy industry. This includes industry and policy readers from the agriculture, forestry, waste management, biofuel, investment, transport, energy and large fuel use sectors.

A detailed review is provided in each chapter in order to support our conclusions. These will be of interest to policy makers and decision makers, and to some in the industry. Plain English summaries referencing relevant figures can be found at the head of each chapter, and key messages at the end of each chapter. These will be of more interest to a general audience.

For those who wish to gain a quick overview, it is recommended to:

- read the executive summary
- the chapter summaries and key messages in Chapters 2–6
- the first and last chapters in their entirety.

Background

Global increases in population; associated resource development; increasing impacts of climate change; and threats to food, water and energy security have placed a renewed focus on the definition and implementation of sustainability concepts.

There has been an explosion in activity in the international arena in the application of sustainability concepts to biofuels since 2005, particularly as the production and/or use of biofuels in USA, Brazil and the EU has ramped up rapidly.

The European Commission in their January 2008 proposal on the promotion of the use of energy from renewable sources stated:

> The Community has long recognised the need to further promote renewable energy given that its exploitation contributes to climate change mitigation through the reduction of greenhouse gas emissions, sustainable development, security of supply and the development of a knowledge based industry creating jobs, economic growth, competitiveness and regional and rural development (European Communities Commission, 2008).

This statement highlights the drivers for the rapid industry expansion in countries developing bioenergy and biofuels industries.

There has been a series of steps in the international development of bioenergy and biofuels sustainability. Initially, mandated targets – especially for biofuels – were set at international and national levels to provide certainty and some economic sustainability for investors. Together with various financial incentives, these stimulated a rapid rise in biofuel production. The unintended consequences of the industry expansion (for example competition for food and land) have, however led to serious questions over the true sustainability credentials of these new and rapidly growing industries. Consequently, sustainability assessment systems are being developed, and institutional systems are now being used to set sustainability targets rather than just for industry stimulation.

This report reviews the international activities, and provides context for governments and industries to consider relevant approaches for Australia.

Aims and objectives

The terms of reference for this report were to:

- Review literature on recent international developments in sustainability criteria for bioenergy and biofuels
- Review the methods for assessment of sustainable biomass production for biofuels and bioenergy industries
- Collate the range of Australian biofuel and bioenergy production pathways (now and into the foreseeable future), including an assessment of key points in the supply-chain where sustainability criteria may be potentially applied and a qualitative assessment of the practicability of this
- List the areas of Australian policy (Australian and NSW* governments) which are relevant to the sustainability of bioenergy and biofuel.
- Identify possible pathways for adoption of Australian guidelines into policy or industry development (national and NSW*).

* Note, Victoria was substituted for NSW in the state case study

Methods Used

This report is based on reviews of the international literature by a team of authors from CSIRO, NSW Department of Primary Industry, University of New England, and the Victorian Department of Sustainability and Environment. We reviewed literature on:

- sustainability theory and practice
- the sustainability issues arising from biofuel and bioelectricity production
- the international activities being developed to address this issue
- the current Australian processes and approaches relevant to sustainability.

Through discussion between the authors and a broader range of industry and government officers, we developed a bioenergy sustainability framework and organised our review material around that. We have developed a broad set of conclusions via our review of the literature and discussions.

A Steering Committee comprised of industry and Australian Government representatives has provided comment on early and penultimate drafts of the report. In addition, some members of the authorship team are actively involved at an international level in meetings and discussions about these issues. This has provided very recent information contained in the report on the rapidly evolving international activities to address the sustainability of bioenergy and biofuels.

Results/Key findings

Introduction

1. ‘Sustainability’ is a complex and evolving concept that has a major human values component. The principles of balance between human, natural and manufactured capital; intergenerational equity; maintenance of the ‘triple bottom line’ (consideration of environmental, social, and economic concerns) are enshrined in legislation in Australia and many other countries. However most jurisdictions are struggling to deal with the challenges posed by expectations of sustainability – ‘Sustaining what, for whom, for how long?’ – taking into account the needs of future generations is extremely challenging.
2. In discussing sustainability for bioenergy we:
    a. give a very high priority to scientifically-based requirements for maintaining agreed ecosystem function and value delivery to future generations in systems that are commonly prone to unexpected, non-linear and often irreversible changes of state
    b. acknowledge the need to balance this with the human priorities for which values should be delivered – consultation and dialogue about sustainability and the necessary trade-offs among values, and in the levels of degradation risks incurred.
3. We use the term “bioenergy sustainability framework” to refer to the combination of:
    a. institutional systems (including environmental, social and economic policies, laws and regulations); intergovernmental agreements; national, state or regional governments; transnational organisations and industry groups
    b. sustainability assessment systems that can be used to monitor key system drivers and indicators over time, and to assess the state of system variables and trends
    c. in a well-functioning approach, there would be feedback between the institutional systems and the sustainability assessment systems across different scales. For example, sustainability assessment systems can be used to judge the success of sustainability policy goals. They can also be used to help to design sustainable solutions by feeding back into policy settings in an adaptive management framework. In turn, institutional systems can specify the details of a sustainability assessment system to be deployed.
4. We recognise that achievement of ‘sustainability’ ultimately takes place at a whole-of-system level, and is beyond the bioenergy sector alone. Devising sustainability assessment systems, and using them to design ‘sustainable solutions’ for bioenergy is only part of what will need to be done to achieve global sustainability. We take the pragmatic view that each component of a system can demonstrate sustainability in relation to local goals, and contribute to sustainability at larger scales (e.g. regionally, nationally, globally).

Bioenergy value chains and sustainability issues

1. Biofuels and bioelectricity are operating at very small scales in Australia to 2009. Biofuels supply 0.45% of total transport fuels while biomass contributes 0.7 % of total electricity. There are drivers to expand renewable energy for climate mitigation, and to increase the security of supply for transport fuels. These could lead to a rapid expansion of the bioenergy industry.
2. Sustainability issues arise at each stage of the value chain, as well as across the whole value chain. Issues arise and must be addressed at different scales and within different social and environmental contexts. For example, the concerns of neighbours with respect to a new conversion facility can often be addressed by a transparent and genuinely local consultation process. Objections from a state or national agricultural or conservation lobby group require a different analysis and response.
3. Sustainability issues arising directly from the bioenergy (and biofuel) value chain are reasonably well-defined and understood.
4. Significant expansion of the industry can create important sustainability issues such as competition with food production, indirect land use change, and landscape scale impacts on water, biodiversity and social values. Non-linear changes in biological impacts and ecosystem function may occur when scale thresholds are crossed. In addition, the social, economic and biophysical impacts are cumulative, and in many cases, also non-linear.
5. Indirect effects are difficult to address by the bioenergy industry or local jurisdiction alone, because the impacts can be manifest elsewhere, and frequently have multiple exacerbating causal factors (for example, the food v fuel issues). They are complex, difficult to analyse and the subject of ongoing debate.
6. There are many direct stakeholders, and broader communities of consent, with legitimate interests in the development of individual bioenergy projects, and in the non-additive effects of major expansion of the industry. Effective ways are needed to engage them in transparent and robust processes for achieving sustainability. This is a necessary condition for a community 'license to operate'. An effective social process will provide a critical enabler to industry expansion, or alternatively may show that this is not an acceptable outcome for the community.

International developments in bioenergy sustainability frameworks

1. Many countries have promoted bioenergy (with a particular focus on biofuels) in response to the drivers of climate change mitigation, sustainable development, security of energy supply, creation of knowledge-based industries creating jobs, economic growth, competitiveness and regional and rural development.
2. The unintended consequences of the industry expansion have, however, led to questions about the sustainability credentials of biofuels. Consequently, many countries, transnational organisations and industry bodies are developing various parts of a bioenergy sustainability framework as defined in this report. These efforts are currently scattered along a development pathway. Only the United Kingdom (under the Renewable Transport Fuel Obligation (RTFO) reporting scheme) and the Roundtable on Sustainable Palm Oil (RSPO) (under its audit and certification scheme) have actually implemented all or part of the schemes and reported on progress.
3. Those countries or organisations that are in the process of developing a sustainability assessment system are using criteria and indicator approaches that reflect economic, environmental and social sustainability principles.
4. Many sustainability frameworks under development identify the indirect effect of land use change on Greenhouse Gas (GHG) emissions, biodiversity and food as a very significant risk to sustainability. This is mainly because of the high degree of uncertainty in the assessment and global control of these effects. Some strongly recommend a slowing in the development of bioenergy until methods of dealing with the indirect effects have been established. Others assign default values based on life cycle assessments factoring in a GHG emissions burden assuming some level of indirect land use change.
5. All countries are struggling with how to implement schemes on the ground, including the scale at which they are applied (national-level targets, rules or guidelines versus project-scale implementation). It is still too early to be able to evaluate the practicality and effectiveness of any scheme.

6. There appears to have been insufficient attention given to how to evaluate differing sustainability outcomes, and how to address trade-offs in the components of sustainability that will inevitably need to be addressed.
7. There is general agreement that it is important to base new systems for assessing sustainability on existing processes and relevant certification systems (such as the Forest Stewardship Council (FSC)) wherever possible; that compliance costs should be minimised; and that schemes should be designed that lend themselves to mutual recognition to facilitate international trade in biomass, bioenergy and biofuels.
8. Many sustainability schemes will probably retain a significant voluntary element until important issues relating the effects of discrimination based on the sustainability of production of biomass and biofuels for international trade have been tested and agreed upon under WTO rules.
9. Sustainability standards should apply to agricultural practices for both food and fuel production, for example Article 17 (6) of the European Parliament's Directive (European Parliament, 2009). This is a significant issue for Australia where future expansion in supply of feedstocks for bioenergy may come from existing agricultural land, for which formal and systematic approaches to sustainability assessment are not currently implemented. Revegetation of agricultural land can often improve sustainability outcomes.
10. Whilst much can be learned from international experiences, it is clear that Australia has a unique set of sustainability issues relating to bioenergy. These relate in particular to our complex and biodiverse native forests, maintenance of fertility of our generally poor soils, protection of scarce water resources, management of fire in our highly fire-prone environments, and social issues associated with major change in management of agricultural landscapes. Australia is also very heterogeneous, meaning the sustainability issues and ways of managing them vary markedly from place to place. As a consequence there is a strong need for processes, and criteria and indicators that can deal with *local* sustainability issues.

Australian policies, regulations, legislation and other processes relevant to sustainable production of bioenergy

1. The Australian Government and various State Governments have a range of policy mechanisms in the form of regulations, targets, mandates, incentives, tax rules and standards with respect to bioenergy and biofuels. There are initiatives for clean and renewable energy and an expanded national Mandated Renewable Energy Target in place, as well as an emissions trading scheme (Carbon Pollution Reduction Scheme) before Parliament at the time of writing.
2. The bioenergy value chain crosses from biomass production through conversion to distribution (potentially including export and import markets) and therefore a broad range of other policies are relevant along the value chain. These include policies for water, biodiversity, climate change, agriculture, forestry, waste management, transport and regional development.
3. Emerging bioelectricity and biofuel value chains require reference to and compliance with this array of policies, legislation and regulations from Australia's three levels of government, often with additional industry specific codes of practice, agreements and requirements. This makes for a complex policy environment. However, the large number of policies, regulations etc. through the value chain indicates that there are many building blocks in place for a bioenergy sustainability framework, if they could be systematically aligned and synthesised. There will be gaps, and these could be addressed in a targeted manner.
4. Continual changes in biofuels policy, regulation, and funding arrangements over the last ten years has created considerable uncertainty for biofuel producers and investors. There are a number of reviews currently being undertaken by the Australian Government which could substantially change the investment and financial viability of enterprises and the overall industry.
5. The biomass production segments of the value chain are very heterogeneous and often very contentious. The biomass can come from native forests, plantation forests, agricultural systems (food or residues), changed land uses (which may be complementary or competitive with agriculture), and waste streams. There are important differences in the complexity and restrictiveness of the policy and regulatory environments from these different production systems:

   a. Native forests have relatively comprehensive, robust and mature policy frameworks which aim to achieve sustainable forest management in both public and private native forests. Plantations establishment and management is also relatively well regulated. In addition, there are robust sustainability assessment systems which seek to evaluate whether the policy mechanisms achieve their sustainability goals. There are two internationally accepted certification schemes for forestry operating in Australia.
   b. Agriculture does not have a comparable policy and regulatory framework with respect to setting and achieving sustainability goals. There are many 'best practice guidelines' encouraged through catchment management plans, Environmental Management System (EMS) and other initiatives which are voluntary, and as such are not systematically and comprehensively implemented. There are no widely-adopted sustainability assessment systems or internationally-recognised certification schemes for agricultural products (apart from organic produce).
   c. All Australian States have legislation which would not allow the broadscale clearing of native vegetation for bioenergy plantings.
   d. Waste is not considered a scarce resource – indeed a sustainable outcome for the waste domain would be less generation of waste, which may run contrary to the needs of energy-from-waste value chains. There is an implemented and effective set of policies at Australian and State Government levels for management of wastes, and to safeguard against combustion of inappropriate materials.

   This continuum of policy and regulation is possibly related to the perceived scarcity and value of the resource – native forests are considered scarce and deliver a wide range of non-market values; whereas waste is perceived as having no or little value. Agriculture has not been perceived as providing strong market or non-market values – although recent debates about future food security may mean that the perception is changing and that agriculture may in future be accorded more value by society in general.
6. There are robust national and state policies and regulations pertaining to the development of a processing facility for bioelectricity or biofuels. Environmental Impact Assessment – which requires regulatory consent and therefore references all of the relevant state and national legislation – is a well established approach but it is focused on assessing impact risks and mitigations. It provides for community consultation. It generally does not deal with the source of the biomass feedstock in established biomass production systems, or with whole of chain direct effects, or indirect effects.
7. There is no specific implementable sustainability assessment system in place in Australia for bioenergy (although NSW has legislated the use of Roundtable for Sustainable Biofuels Version Zero, which is not currently operational). The State of the Environment reports, Montreal or other criteria and indicators currently used (Chapter 5) are not sufficient for bioenergy, because they do not have adequate capacity to deal with:
   a. direct life cycle impacts through a value chain
   b. indirect land use change and the effects thereof, product substitution or other issues which are raised as key sustainability issues in the biofuels arena.
8. The potential implications for Australia of the lack of a cohesive and comprehensive bioenergy sustainability framework in Australia include:
   a. Australian biomass, bioelectricity and biofuel producers might not have access to international markets if they not able to certify product according to an internationally recognised scheme based on a detailed life cycle analysis.
   b. Australia risks being the recipient of biomass or biofuel products that do not meet the sustainability requirements of other nations.
   c. Biomass exporters may have different sustainability reporting requirements for exporting the same product depending on the market into which they are selling – for example, wood produced in Australia would technically be able to access a European market (e.g. packaging or paper) if they had Forest Stewardship Council (FSC) or Australian Forestry Standard (ASF) certification, but with exactly the same certification (and the same sustainability outcomes in the forest in Australia), may in the future not be able to access the energy market in Europe without complying with several extra sustainability assessment and reporting criteria.
   d. Bioelectricity and biofuel producers may struggle to obtain sustainability certification of biomass coming from heterogeneous sources (i.e. they can obtain FSC or ASF certification for biomass from forests, whereas they currently will not able to certify biomass from agriculture).

e. Australian and State Governments may encounter issues with the FTA and GATT. Biomass and biofuel imports and exports which may be subject to 'sustainable production' descriptions will have either no definitions, disparity of definitions, or lack of clarity in definitions of what qualifies as 'sustainably produced'. Australian industry and government may address this in part by engaging with international activities.
f. Loss of opportunity to build confidence in communities of consent (including government, NGOs and consumers) that bioelectricity and biofuels are being sustainably produced.
g. Loss of opportunity to differentiate those bioelectricity and biofuel products with poor sustainability credentials from those with sound credentials, thereby limiting an opportunity for the whole industry to develop in a sustainable fashion. The proposed CPRS accords all biofuels a zero carbon burden and does not encourage low emission biofuels.

9. An adequate institutional system should ensure that stimulation of the industry via policy and other financial incentives at the demand end of the value chain would not drive unsustainable use of resources in the upstream end of the value chain – i.e. other policy mechanisms operating at a broader scale across multiple sectors such as the National Water Initiative should prevent unsustainable use of water *per se*, including water use of bioenergy production. It is beyond the remit of this report to provide definitive conclusions. Based on the points raised above, however, there do appear to be gaps and vulnerabilities arising from existing arrangements.

Bioenergy sustainability assessment systems

1. There are many different approaches to sustainability assessment, most of which have their own epistemologies, cultures, languages and methodologies.
2. There are two basic approaches that are used to assess sustainability:
    a. input-based which assume that certain inputs or activities provide desired outcomes
    b. outcome-based in which monitoring is used to enable comparison of the condition of key system variables and trends with agreed sustainability objectives and targets.
3. Input-based systems (such as setting targets, specifying processes without monitoring the outcomes) may be appropriate where the risk (i.e. likelihood and consequence) is low, or where the systems are predictable and well-defined. In situations where the risk is high (or uncertain), these approaches do not have a high likelihood of ensuring sustainable outcomes.
4. In natural systems where relatively little is known about system response over the long term, and widespread loss of ecosystem function would have major consequences, an outcomes-based approach is critical. Any such assessment system must be embedded in effective process with feedback mechanisms to allow improvement of the assessment system itself, as well as the resources being managed.
5. If a due consideration showed that the sustainability risks of bioenergy were high and that existing input-based measures were insufficient to ensure agreed sustainability outcomes, then outcome-based sustainability assessment systems would be the most effective approach. If Australia is to participate in international trade of biomass or bioenergy, then implementation of a sustainability assessment system which is compatible with, and mutually recognised by international trading partners will be necessary.
6. A sustainability assessment system includes a process for governance of the assessment system itself; effective ways of engaging a wide range of stakeholders, including communities of consent, in defining sustainability objectives; methods for defining, measuring and reporting criteria and indicators (C&I); evaluation methods and processes; and mechanism for feedback, review and improvement.
7. Criteria (to describe the components of sustainability) and indicators (to track change in the criteria over time) approaches are being widely used to underpin 'outcome-based' assessments of sustainability.
8. The criteria and indicators (C&I) approach can be effectively embedded within an adaptive management approach to provide a structured process for assessing sustainability, for system improvement, for reporting to a range of stakeholders, and for independent third-party accreditation against requirements for product certification. When used in this way, C&I can underpin an effective sustainability assessment system. However, the application of the C&I approach to bioenergy is in its infancy, and many challenges remain.

9. The major challenges for the scientific assessment of the sustainability of bioenergy and biofuels value chains are:
    a. defining indicators relevant to the local context, but compatible with international approaches
    b. quantifying irreversible thresholds in natural systems, so that targets can be set to avoid these
    c. scale issues, especially moving from assessing the effects of single projects to assessing the often non-linear effects of scaling-up on landscapes (e.g. on water values) and beyond (e.g. the indirect effect on land use change in other regions or countries)
    d. quantifying trade-offs between different dimensions of sustainability – which are sometimes positive, and sometimes negative
    e. using C&I in designing sustainable solutions across sectors, where the data are sparse and several driving variables (climate, population) are outside of previous known ranges.
10. Sustainability assessment systems should build on existing activities and processes wherever possible, and require well defined governance and responsibilities. It is important that new systems are, as far as possible, compatible with other systems to assist mutual recognition, and thus facilitate international trade in biofuels or renewable energy certificates.
11. The extent to which a rigorous sustainability assessment can or should be implemented for bioenergy in Australia as an individual sector requires further discussion amongst stakeholders and communities of consent. There are clear expectations in the international arena that formal sustainability assessment is a requirement for biomass or bioenergy to be traded in many markets such as the EU. A system by which sustainability could be demonstrated or certified would be an enabler to industry expansion and international trade in Australia. However, there are outstanding issues to be resolved around the burden of proof of sustainability being placed on bioenergy especially in situations where land and water resources are shared between many production systems; the drivers for land use change are many-fold and the causal linkages to indirect effects are not clear.

Options for Australian industry to develop and implement a sustainability assessment system

1. There are many options that could be explored in response to assessing and achieving sustainability in the bioenergy domain, and some of these have been presented in this chapter. There is a need for further discourse amongst stakeholders and communities of consent in order to identify the most attractive, likely or necessary options. Further analysis of the risks to sustainability from the bioenergy industry, the opportunity costs of developing (or not) or adopting a sustainability assessment system, and the costs and benefits to public and private interests will be required in order to support industry and government decisions.
2. Once options are identified and an approach is developed, there are a number of mechanisms which could be used to implement the system. These include:
    a. Industry self-regulation
        i. Codes of conduct, applied by industry;
        ii. Consumer information mechanisms (labelling, trademarks, websites), applied by industry.
    b. Purchase specifications, applied by purchasers of biomass or biofuel
    c. Third-party compliance schemes
        i. Codes of conduct, as applied by industry/third-party partnership, or independent third parties
        ii. Consumer information mechanisms, including certification schemes, applied by independent third party or industry/third-party partnership
        iii. Government regulation, applied by government/s. The regulations may include compliance with items under 3 a) and 3 b).
3. However, useful observations from the discussion presented in this chapter are readily apparent:
    a. Codes of conduct and consumer information mechanisms are likely to be feasible policy options, thereby negating the need for regulation until it can be demonstrated otherwise.

   b. An Australian Standard would be suited to formalisation of the *means* by which the sustainability of bioenergy and biofuels can be assessed (i.e. not for evaluating whether sustainability goals are achieved, but for the assessment methods by which such determinations are made).
4. If there is a community expectation that the sustainability of bioenergy must be ensured, then a regulatory approach is warranted (subject to the demonstration of net benefit for the community).
5. The development of a standard is likely to be required in parallel to regulations.
6. Australia's World Trade Organisation (WTO) obligations are likely to require consideration in the design of a regulation relating to the bioenergy sustainability assessment system, as was described in the section relating to Australian standards above.

Conclusions and implications for stakeholders

How do we ensure that the significant potential offered by the use of biomass for electricity, heat and liquid fuels is tapped in a way which significantly improves sustainability outcomes? How can emerging industries which provide more sustainable solutions have an opportunity to expand by developing new value chains linking the incumbent agricultural, forestry and fossil fuel industries? There are some building blocks in place in terms of the scientific approaches to assess sustainability, and current institutional systems (including international, national and local environmental, social and economic policies, laws, regulations and social norms) to achieve improved sustainable outcomes for bioelectricity and biofuel industries. We have in this report proposed a few of the ways in which they might be built on to develop a sustainability assessment system. There are, however, many gaps and challenges outstanding.

For industry

Economic viability is an immediate imperative for the biofuel industry. Currently the very small first-generation biofuel industry in Australia is struggling for survival, and a second-generation industry does not yet exist. Transitioning from first- to second-generation technologies; gaining investment given the uncertain policy environment; and gaining the significant research and development investment required in order to provide the underpinnings for a financially viable and demonstrably sustainable industry are all enormous challenges for the biofuels industry.

Internationally, sustainability targets are sometimes expressed in terms of improvements relative to reference systems, especially for transport fuels. However, there has been less pressure brought to bear on the incumbent industries of agriculture or energy (against which biofuels must achieve significant improvements) to have robust sustainability targets themselves. Placing the burden of a) meeting significant sustainability targets over incumbent industries used as a reference and b) bearing the cost of demonstrating that they have indeed done so is a significant challenge for any new or emerging industry.

There will be extra effort required to design and/or adapt and implement a sustainability assessment system in Australia that complies with international standards, despite the existence of some relevant policy mechanisms as building blocks. For biomass producers, there may be additional requirements to meet sustainability requirements across a value chain, which do not apply if selling the biomass into traditional markets. It will be easier to demonstrate sustainability from forestry or waste feedstocks where there is a sustainability assessment system in place. If sourcing biomass from agriculture, there are no comprehensive and systematically implemented assessment systems or certification schemes currently in place.

There are implications and challenges for related industries. The vehicle industry has only very recently, in Australia and in the US, had pressure to meet sustainability targets and there has not been a major impetus for fuel efficiency or alternative low-emission fuels. Major fuel-use industries (especially those which are more dependent on liquid fuels, such as aviation, agriculture, mining and freight) are investigating ways of meeting sustainability targets using 'green' fuels. There is significant activity in the aviation sector in this regard, however they require a scheme to establish the credentials for a 'green' fuel. These challenges for the fuel-use industries represent major opportunities for second-generation biomass and biofuel producers.

For science

Sustainability is a complex and evolving concept that has a major human values component. There are many interpretations of how sustainability could be implemented, measured, monitored and demonstrated. The multitude of approaches have their own epistemologies, cultures, languages and methodologies – and yet the overarching challenge is to integrate across disciplines, sectors, time horizons and policy interfaces in order to address sustainability.

There are science challenges specific to the scientific assessment of the sustainability of bioenergy and biofuels value chains, even within the construct of outcomes based criteria and indicator methods, listed in Chapter 5 – Bioenergy sustainability assessment systems, conclusions 9 a – e.

The current quantum of R&D funding for development of bioenergy is orders of magnitude lower than, for example, the annual oil and gas exploration expenditure in Australia – which in 2006/7 was 2,225.5 million dollars (Australian Bureau of Statistics, 2008). The low levels and largely sectoral nature of research funding delivery in Australia is insufficient to deal with the issues described in this report. In particular, greater resourcing is needed for developing both the science content, and the social process for moving beyond the analysis of a particular industry (as is the focus of this report) to an integrated view of sustainability at whole-of-system level.

For policy

The overarching policy challenge is how to deal in a systematic and rigorous manner with the rapidly emerging sustainability issues around climate, water, energy, transport, biodiversity, land use and regional development – while simultaneously dealing with the inertia of incumbent industries and the broader community. Designing and implementing policy to achieve multiple objectives across this range of scales is a challenging, especially given the underlying scientific challenges described above.

The biomass production part of the value chain is very heterogeneous and most likely to be contentious. In Australia, sustainability assessment systems (and certification) are well developed for most forests. Native forests have relatively comprehensive, robust and mature policy, but plantations are not as well covered. There is an internationally accepted certification scheme for forestry.

Any major expansion of bioenergy in Australia is likely to be on agricultural land. There are opportunities to develop biomass production systems that are complementary to existing systems. There is as-yet untested potential to develop the low-productivity and under-utilised agricultural landscapes by establishing perennial energy crops that are adapted to an increasing climatic variability and climate change. There is also potential, however, under certain policy and economic settings for bioenergy (or plantings for carbon sequestration) to displace food production in medium- to high-productivity agricultural landscapes. The potential weediness of bioenergy crops may also present biosecurity issues.

For society

Food is a fundamental and irreplaceable human need, and the 'food v fuels' debate has vociferously and uncritically regarded food production as a higher order priority for use of land and water resources. Food security can be framed in four dimensions:

- availability (related to food production) – the amount of food produced and where
- access – who are the hungry, barriers to food access, including the cost of the food
- stability – variability across time of food production
- utilisation – the nutritional value of the food.

Society accords food production a very high priority – and with the global population increases converging with climate change impacts, the land and water resources required to provide food for the world are going to be under more pressure than they are currently. The use of good quality land and water for increasing food production would not, however, on its own redress global food security issues across these four dimensions. There must be broader consideration of multiple objectives for landscapes AND simultaneously tackling the other dimensions of food security – and this is a global policy and political challenge. For example, legumes provide the nutritional requirement for protein with a significantly lower greenhouse gas and water requirements than meat, but would require a shift in the values currently held by many parts of society.

There is a substantial effort required in science, economics and policy to guide the most efficient allocation and use of resources. A shift away from fossil energy to bioenergy represents an increase in efficiency if it results in a decrease in the external costs (or externalities), such as GHG emissions. However, an increase in the efficiency with which a fuel (or any other resource) is used does not equate to less use. Consumption may increase. For example, a survey in Sweden showed that if Swedes ate less meat in their diet, they would spend the money saved on travel – which would, in turn, increase the GHG emissions rather than reduce them.

It will take some major revisions of the world economy and resource use across countries and sectors, as well as major change in societal attitudes and behaviours to achieve a sustainable future. To the extent that sustainability assessment systems can be designed and implemented in the bioenergy industry, they will be able to claim a contribution from this sector in moving towards a sustainable future.

Sustainable bioenergy for Australia – where to next?

Australia lacks a cohesive and comprehensive bioenergy sustainability framework – in terms of institutional systems or sustainability assessment systems. What would be required to support the sustainability of biomass, bioelectricity or biofuels either produced in or imported into Australia?

We contend that the lack of robust evaluation of:

- potential for the growth of the bioenergy industry and contribution to the future energy mix
- different pathways for industry growth and the sustainability impacts that might occur
- the efficacy of existing policy settings at Australian and State Government levels to ensure sustainable outcomes in the case of rapid industry growth
- a formal scheme to assess and demonstrate sustainability.

are all barriers to consumer and broader government confidence, and therefore to industry expansion. A clear demonstration of the ability of the bioenergy sector to produce sustainable energy products, as well as make a significant contribution to the broader sustainability goals of Australia, would be a strong industry enabler. It would provide consumer confidence in bioenergy products, as well as the confidence for governments to invest in bioenergy as a plausible energy alternative.

A dialogue about the implications and prospects for bioenergy sustainability in Australia – involving industry stakeholders along the value chain, government, stakeholders and representatives of communities of concern – would be a useful first step. Exploration of scenarios for bioenergy development as part of a transition to a future energy mix would help to underpin a clear understanding of the sustainability implications of industry development along different pathways. For example, a future industry based on algae compared to complementary food/energy farming in lower productivity landscapes, or short rotation forestry provide different benefits and risks. An assessment of the risks, costs and benefits, and the distribution of these across public and private interests would also be useful to support decisions on the options and development and implementation pathways for bioenergy sustainability assessment. Engagement with international developments by Australian and State Governments, non-government organisations and industry is critical in moving forward.

1 Introduction

Chapter Summary

Rationale for the report

Sustainability is a critical issue for the bioenergy industry internationally and in Australia. Many governments and market segments now consider that quantitative, robust and independently verified (or certified) sustainability credentials are vital in order for the bioenergy industry to expand globally. This is already translating to government policies in some countries which will limit market access and government support to only those biofuels which meet specified sustainability criteria.

The bioenergy industry is relatively small in Australia. The need to reduce greenhouse gas emissions as well as future oil security issues will provide drivers for the growth of the bioenergy industry.

In this report we discuss the theory and application of sustainability assessment; review the sustainability issues that have arisen through rapid international industry expansion; and report on the international response to these. We review the broad policy framework at the national level and for one state (Victoria) as a case study. We provide description of systems to assess and certify sustainability, and discuss the potential options and implementation pathways should Australia choose to develop or apply these approaches.

Sustainability context

Global increases in population; associated resource development; increasing impacts of climate change; and threats to food, water and energy security have placed a renewed focus on the definition and implementation of sustainability concepts.

Sustainability is a complex and evolving concept that has a major human values component. Although the principles are enshrined in legislation in Australia and many other countries, most jurisdictions are struggling to deal with the challenges posed by expectations of sustainability – 'Sustaining what, for whom, and for how long?' Taking into account the needs of future generations – is not a simple task.

The principles of balance between human, natural and manufactured capital; intergenerational equity; maintenance of the 'triple bottom line' (consideration of environmental, social, and economic concerns) have been enshrined in legislation in many countries, including Australia. However, the practical implementation and market acceptance of these principles remains challenging.

Conclusions and key messages

The conclusions and key messages from this chapter are summarised at the end of the chapter, as well as in the Executive Summary.

1.1 Rationale for the report

Sustainability is a critical issue for the bioenergy industry internationally and in Australia. The public perception of bioenergy (heat, power and liquid fuel derived from biomass) is equivocal. The perception of biofuels in particular has changed from biofuels being regarded as an ‘environmental saviour’ to a ‘global villain’. The change in perception has largely come about through rapid increase in global biofuel production. This has in turn been associated with many actual (or perceived) negative consequences such as the use of food as feedstocks for biofuels and rise in food prices. However, the public view is slowly moderating because new technologies for biofuels – which do not compete with human food or animal feed for feedstocks – are now becoming a credible option.

Many governments and market segments now consider that quantitative, robust and independently verified (or certified) sustainability credentials are vital in order for the bioenergy industry to expand globally. In the international arena, there is active progress towards developing frameworks for the testing and verification of the sustainability of bioenergy products. This is already translating to government policies in some countries which will limit market access and government support to only those biofuels which meet specified sustainability criteria.

In contrast to the international experience, the bioenergy industry is very small in Australia. It currently supplies less than 0.5 per cent of transport fuels, and a similar proportion of electricity in Australia. Partly due to the small scale of the industry to date, there has been limited concern about sustainability impacts of the Australian industry (although the financial sustainability of the industry itself has been in question). For these reasons, there has been little need to progress towards a system for verifying or certifying sustainability credentials.

There are now many drivers in place in Australia which may provide the opportunity for increasing the production and use of bioelectricity and biofuels in Australia. The imperatives to reduce greenhouse gas emissions (which will increasingly be supported by policy) as well as future oil security issues will provide drivers for the growth of the bioenergy industry:

- Emission reduction – bioelectricity production provides substantial greenhouse gas emission reductions in comparison to coal, and is complementary to solar and wind generation (as it does not have intermittency issues). New technologies for biofuel production based on the fibrous, non-food portion of biomass also provide substantial reductions in greenhouse gas emissions.
- Oil security – although Australia is a net energy exporter, there is a growing dependence on imports of petroleum and petroleum products, used mostly for transport fuels. In 2003/04 Australia was 64% self sufficient in oil, LPG and other petroleum products, but this is projected to decrease to 41% in 2029/30 (Akmal and Riwoe, 2005). Australia’s dependence on imported oil comes at a time when many are concerned that peak global oil production is close, while global demand continues to increase. In addition, remaining oil reserves are becoming increasingly concentrated in regions of geo-political instability.

Therefore, bioenergy will have the opportunity to expand in Australia under certain policy and economic settings which may well come into play in the near future.

In this report we discuss the theory and application of sustainability assessment; review the sustainability issues that have arisen through rapid international industry expansion; and report on the international response to these. We review the broad policy framework at the national level and for one state (Victoria) as a case study. We provide description of systems to assess and certify sustainability, and discuss the potential options and implementation pathways should Australia choose to develop or apply these approaches.

1.2 Terms of reference and target audiences

This work was co-funded by RIRDC, CSIRO, NSW DPI and Vic DSE. The project had a Steering Committee which included experts from industry and the Australian Government. This Steering Committee reviewed early and penultimate drafts of the report and provided extensive commentary. The project terms of reference, and the section of the report in which they are addressed, is shown in Table 1-1.

Table 1-1 Project terms of reference and the section of the report in which they are addressed

Term of reference	Section of report
Review literature on recent international developments in sustainability criteria for bioenergy and biofuels	Chapters 3 and 5
Review the methods for assessment of sustainable biomass production for biofuels and bioenergy industries	Chapter 5
Collate the range of Australian biofuel and bioenergy production pathways (now and into the foreseeable future), including an assessment of key points in the supply-chain where sustainability criteria may be potentially applied and a qualitative assessment of the practicability of this	Chapters 2, 4, 5
List the areas of Australian policy (Australian and NSW* governments) which are relevant to the sustainability of bioenergy and biofuel.	Chapter 4
Identify possible pathways for adoption of Australian guidelines into policy or industry development (national and NSW*)	Chapter 6

* Note, Victoria was substituted for NSW in the state case study in Chapters 5 and 6

The target audiences for this report are those who may have an interest, investment, share, concern or other involvement in the development of a bioenergy industry. This includes industry and policy readers from the agriculture, forestry, waste management, biofuel, investment, transport, energy and large fuel use sectors.

A detailed review is provided in each chapter in order to support our conclusions. Summaries referencing relevant figures can be found at the head of each chapter, and key messages at the end of each chapter. For those who wish to gain a quick overview, it is recommended to read the executive summary, the chapter summaries and key messages in Chapters 2–6, and the first and last chapters in their entirety. The report structure is provided in the pullout box.

Pullout Box Report Structure
The report provides the depth and detail necessary to fulfil the terms of reference, and substantiate our conclusions. Following is an overview of the report's contents.

Chapter 1
- The rationale and background for the report is presented.
- The concepts behind sustainability are introduced, as are some of the issues implicit in considering the sustainability of a single sector such as bioenergy.
- The terminology considered under the banner of a bioenergy sustainability framework is described.

Chapter 2
- A contextual background to bioenergy and biofuels is provided, including a brief overview of types feedstocks and conversion technologies.
- Snapshots of the international and Australian biofuels and bioelectricity sectors are given.
- The sustainability issues and key stakeholders are mapped along a simplified generic bioenergy value chain.

Chapter 3
- The international activities in developing bioenergy sustainability frameworks are reviewed.
- Key developments with transnational organisations and intergovernmental agreements, as well as the national government activities are summarised.
- The key learnings and implications for Australia are distilled.

Chapter 4
- The existing policy and regulatory systems at the level of the Australian Government are described.
- A case study of Victoria is used to illustrate some of the policy and regulatory implications for the sustainability of bioelectricity and biofuels.

Chapter 5
- The theory and application of the 'sustainability assessment systems' component of the framework is discussed in detail.
- The different approaches to sustainability assessment are briefly introduced, and a case is made to use a criteria and indicators approach for a sustainability assessment system for bioenergy.
- The ideal characteristics of such a system are proposed.

Chapter 6
- A range of options for developing a sustainability assessment system in Australia are proposed, and the potential mechanisms by which it could be implemented are outlined.
- The various adoption pathways for these mechanisms, the key agents in the value chain who would undertake the activities, and the effort and likelihood of success of the different adoption pathways are discussed.

Chapter 7
- The overarching conclusions and insights from the report as a whole are provided, and some suggestions as to the pathways forward are given.

The remainder of this chapter provides context to the authors' collective understanding of sustainability, as well as an introduction to a bioenergy sustainability framework which guides and frames this review.

1.3 Sustainability concepts and their application

Sustainability lies at the interface between science and society and it is difficult to separate issues of human values from the scientific issues. Debates can become complex or emotive, while arguments are often driven by unstated sets of values and are poorly supported by either science content or adequate social processes for making decisions. Many cultures have historically survived in a sustainable manner, in harmony with their environment, over many centuries. There is also evidence that societies and cultures have collapsed due to unsustainable use of resources (Diamond, 2005). Today, the unprecedented global increases in population; associated resource development;

increasing impacts of climate change; and threats to food, water and energy security have placed a renewed focus on the definition and implementation of sustainability concepts. This section explains the approach of this authorship team to sustainability in general, before focussing in later sections on bioenergy.

The Brundtland Report, a significant and influential document on the subject of sustainability, clearly defined the concept of sustainable development as, 'Development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987). This report led to the United Nations Conference on Environment and Development, known as the Rio Earth Summit, in 1989. This summit proposed a program of sustainable development at a global level.

There has been a vast body of literature written on sustainability (discussed in more detail in section 5.2). While sustainability does mean different things to different people, there are defined sustainability principles that are internationally accepted. They generally encompass the concepts of:

- balance between human, natural and manufactured capital
- intergenerational equity
- maintenance of the 'triple bottom line' (consideration of environmental, social, and economic concerns).

The three principles above have been enshrined in legislation in many countries, including Australia. This report has been based on implementing the definitions in the legislation discussed below.

The National Strategy on Ecologically Sustainable Development defines economically sustainable development (ESD) as, 'Using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased' (Ecological Sustainable Development Steering Committee, 1992).

Section 3A of the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) sets out five principles of ESD, stating that:

> a) decision-making processes should effectively integrate both long-term and short-term economic, environmental, social and equitable considerations;
> b) if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation;
> c) the principle of inter-generational equity—that the present generation should ensure the health, diversity and productivity of the environment is maintained or enhanced for the benefit of future generations;
> d) the conservation of biological diversity and ecological integrity should be a fundamental consideration in decision-making; and
> e) improved valuation, pricing and incentive mechanisms should be promoted.

From these definitions, the general principles of ESD are clear. However, the practical implementation and market acceptance of these principles remains extremely challenging.

Many societal debates on sustainability (especially those which accord equal status to all three elements of the triple bottom line) do not sufficiently address the long-term maintenance of ecosystems from which all of the other values flow. For example, in Australia most of the debate about use of water in the Murray River in the late half of the 1900's was concerned with the importance and relative priority of delivering certain values to humans (e.g. agricultural irrigation, fisheries, grazing and pastoral cultural values). The non-market values of water (e.g. tourism and recreation, indigenous cultural values) have only been recently been recognised. They have had to compete for acknowledgement (and associated water allocations) against incumbent market values (and water allocations) (Abel et al., 2006; Dyack et al., 2007). In the meantime, the ecosystems have been badly degraded, thus threatening the delivery of many values to future generations. Thus, the stance taken in this report is that maintenance of the ecological processes from which quality of life values flow must necessarily take precedence in terms of maintaining the flow of those values into the future.

The use of non-renewable (energy and other) resources at the current rate is clearly not sustainable over the very long term – although renewable resources such as biomass offer better prospects.

Change from original, undisturbed ecosystem conditions may not in itself be 'unsustainable'. Ecosystem processes can be maintained at an agreed level (with an associated increased risk of unpredicted degradation) under human use of the land. However, land managers in Australia (and the world over) in the last two centuries have often assumed a level of ecological resilience that was not present, which has resulted in significant system degradation and decline. The degradation of ecosystem resources can take decades and be linear and incremental in some cases, with the ecosystem still able to maintain key functions- albeit at a lower level. For example, energy services may be provided by biomass which has lower greenhouse gas emissions than fossil fuels, but may use more water. The benefits to one resource (air) at the detriment to the other (water) can be traded off – as long as critical ecosystem process and functions are not irreversibly damaged.

However, the science of resilience in ecological and social systems has shown across a very broad range of systems that they are prone to reaching thresholds or 'tipping points' which can show rapid, non-linear changes of state or condition, which may be irreversible (Gunderson and Holling, 2001; Walker and Salt, 2006). We are now at a point where we face such thresholds in climate change, and probably also in water, oil availability and economic systems.

Therefore, in discussing sustainability for bioenergy through this report, we:

- provide precedence to scientifically-based requirements for maintaining agreed ecosystem function and value delivery to future generations in systems that are commonly prone to unexpected, non-linear and often irreversible changes of state
- balance this with the human elements around the priority of which values should be delivered – consultation and dialogue about sustainability and the necessary trade-offs among values, and in the levels of degradation risks incurred.

1.4 Introducing a bioenergy sustainability framework

A framework is a basic structure underlying a system. This report uses the term bioenergy sustainability framework (Figure 1-1) to refer to the combination of:

- institutional systems (including environmental, social and economic policies, laws and regulations) of intergovernmental agreements; national, state or regional governments; transnational organisations and industry groups. Institutional systems are the means by which sustainability goals can be achieved (or not, if the policy settings drive the system in an unsustainable manner)
- sustainability assessment systems monitor key system drivers and indicators over time, to assess the state of system variables and trends.

Institutional systems and sustainability assessment systems can be developed and applied across a range of scales. In a well-functioning approach, there would be feedback between the institutional systems and the sustainability assessment systems across different scales. For example, sustainability assessment systems can be used to judge the success of sustainability policy goals. They can also be used to help to design sustainable solutions by feeding back into policy settings in an adaptive management framework. Likewise, institutional systems can specify the details of a sustainability assessment system to be deployed. This is illustrated on many occasions in this report – for example for various governments in Chapter 3, as well as for the forestry sector in section 5.4.

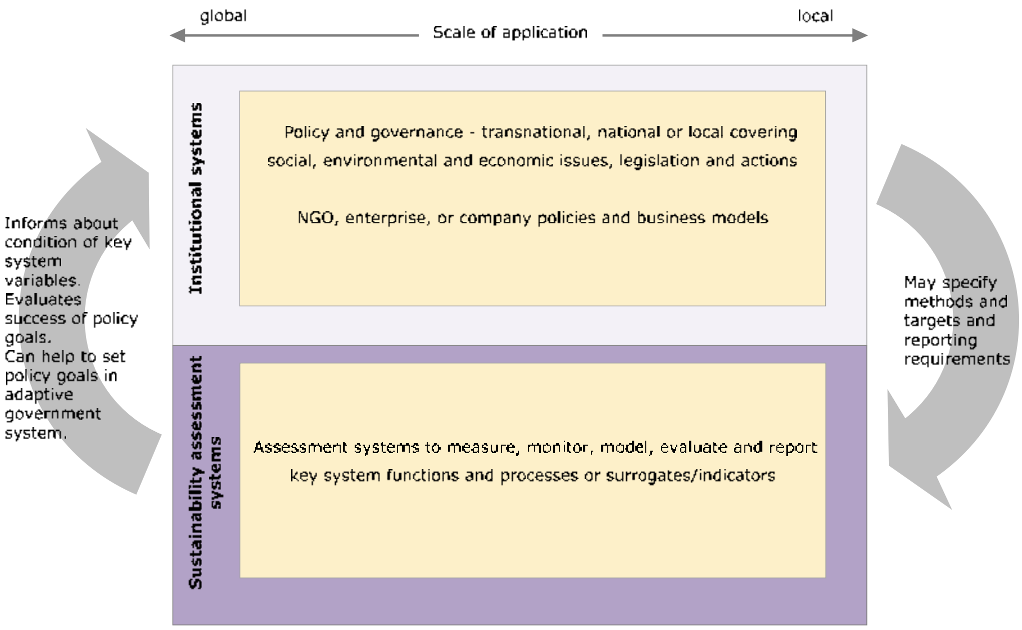

Figure 1-1 The bioenergy sustainability framework

In this report, we review and assess both elements of the bioenergy sustainability framework – i.e. both the institutional systems, as well as the sustainability assessment systems. Institutional systems such as targets, mandates and financial incentives have been used to drive the rapid increase in bioenergy (in particular biofuel) production and this has caused sustainability issues (further described in Chapter 2). Institutional systems are now being used to put in place some sustainability constraints (described in Chapter 3). They may be in the form of targets (e.g. a minimum greenhouse gas emission reduction) that must be met in order for the bioenergy product to qualify for market access or financial support. These institutional measures may be applied on their own, or in combination with sustainability assessment systems which will provide tools and data to judge whether sustainability outcomes have been achieved. The rationale for sustainability assessment systems to complement institutional systems is discussed in Chapter 4, along with examples of those which have already been implemented for forestry, or under development for bioenergy.

Achievement of 'sustainability' ultimately takes place at a whole-of-system level, and is beyond the bioenergy sector alone. Devising sustainability assessment systems, and using them to design 'sustainable solutions' for bioenergy is one very small part of what will need to be done to achieve global sustainability. Ideally, any sustainability framework for bioenergy would be nested within a more holistic and cohesive approach in the energy and land use sectors, and across all other sectors. In practise, this is a challenging task and there are some who disagree that addressing the issue on a sectoral basis is possible. However, in this report we take the pragmatic view that each component of a system can demonstrate at sustainability local scales, and contribute to overall sustainability.

In the next chapter, we provide some of the technical context for bioenergy technologies, and the sustainability benefits, detriments and trade-offs that have arisen (or may arise) from a rapid and large increase in the global production of bioenergy.

1.5 Key messages

1. 'Sustainability' is a complex and evolving concept that has a major human values component. The principles of balance between human, natural and manufactured capital; intergenerational equity; maintenance of the 'triple bottom line' (consideration of environmental, social, and economic concerns) are enshrined in legislation in Australia and many other countries. However most jurisdictions are struggling to deal with the challenges posed by expectations of sustainability – 'Sustaining what, for whom, for how long?' – taking into account the needs of future generations is extremely challenging.
2. In discussing sustainability for bioenergy we:
    a. give a very high priority to scientifically-based requirements for maintaining agreed ecosystem function and value delivery to future generations in systems that are commonly prone to unexpected, non-linear and often irreversible changes of state
    b. acknowledge the need to balance this with the human priorities for which values should be delivered – consultation and dialogue about sustainability and the necessary trade-offs among values, and in the levels of degradation risks incurred.
3. We use the term bioenergy sustainability framework to refer to the combination of:
    a. institutional systems (including environmental, social and economic policies, laws and regulations) of intergovernmental agreements; national, state or regional governments; transnational organisations and industry groups
    b. sustainability assessment systems that can be used to monitor key system drivers and indicators over time, and assess the state of system variables and trends.
    c. in a well-functioning approach, there would be feedback between the institutional systems and the sustainability assessment systems across different scales. For example, sustainability assessment systems can be used to judge the success of sustainability policy goals. They can also be used to help to design sustainable solutions by feeding back into policy settings in an adaptive management framework. In turn, institutional systems can specify the details of a sustainability assessment system to be deployed.
4. We recognise that achievement of 'sustainability' ultimately takes place at a whole-of-system level, and is beyond the bioenergy sector alone. Devising sustainability assessment systems, and using them to design 'sustainable solutions' for bioenergy is only part of what will need to be done to achieve global sustainability. We take the pragmatic view that each component of a system can demonstrate sustainability in relation to local goals, and contribute to sustainability at larger scales (e.g. regionally, nationally, globally).

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2 Bioenergy, biofuels and associated sustainability issues

Chapter Summary

Different technologies use different types of biomass to feed different types of conversion processes. Biomass feedstocks for use in an emerging industry can be considered in terms of the current production base (i.e. what is already being produced) as well as future production base (which may include new and novel plant species such as Pongamia or algae, or changes in land use to produce energy crops or forests). Biomass feedstocks from current and future production bases are shown in
Table 2-1.

Different fractions of any given biomass source can be used as feedstock for different conversion technologies and products. Grain is primarily used for human food and animal feed. Ethanol is now produced from the grain using first-generation fermentation and distillation technologies. In Australia, the stalks or stubble from crops are retained in a minimum tillage system, burnt in the field, or used for animal feed. The stubble may be used as feedstock for electricity or, with the advent of second-generation technologies, it could be converted into a range of energy products as shown in Figure 2-1.

Snapshot of bioenergy and biofuel industries

The scale or magnitude of any new and emerging value chain or industry is critical in underpinning any approach to sustainability.

Since 2005, the world supply of liquid biofuels has doubled (see Table 2-2). In 2008 this represented less than 2% of the world's requirement of liquid transport fuel. The current institutional framework in terms of mandates, targets and other incentives for biofuels provide an economic base for the development of biofuel industries. These targets are due to be met while new and second-generation conversion technologies are still under development, which means that they will rely on first-generation feedstocks and production technology.

Biofuels and bioelectricity are operating at very small scales in Australia to 2009. Biofuels supply 0.45% of total transport fuels (Table 2-3); while biomass contributes 0.7 % of the total electricity (Table 2-4). The production of biofuels in Australia since 2004 has been based on non-food feedstocks for this production, and thus there was virtually no impact on existing food chains. The supply of these feedstocks is, however, is reaching limits.

The introduction of biofuels mandates in New South Wales and Queensland may drive the increased production of first-generation biofuels based on local grains. Expansion of the industry based on first-generation technologies, without an expansion in the feedstock production base, will start to divert grain or sugar away from human food and animal feed value chains.

Bioenergy value chains and sustainability issues

A simplified generic bioenergy value chain is shown in Figure 2-2. New and emerging bioenergy value chains are complex, especially when they interact with a number of other incumbent industry value chains (for food, fibre and fossil fuels). Sustainability issues arising along the value chain (Figure 2-3) are described.

Biomass feedstock production and harvest

- Maintenance of critical ecosystem functions, as well as value delivery differs vastly between feedstock types, production systems and geographic regions of the world.
- Land and water resources will be increasingly contested and pressured for production of food, fibre, water, biodiversity, carbon storage and urbanisation. Bioenergy value chains which rely on diversion of material from production systems which are already stressed will inherit many of the sustainability issues associated with the incumbent production system.
- Natural systems may undergo incremental degradation while still maintaining ecosystem function and value delivery, but are prone to unexpected non-linear and irreversible 'threshold' or 'tipping point' changes.
- Producing lignocellulosic biomass can be cost-effective with low-input production systems, on low-productivity or under-utilised land. Oil mallee systems in Australia have been developed in Western Australia. There are many other systems on lower productivity or under-utilised land that may be possible but as yet are untested.
- The use of land to feed local and global populations, as well as more local issues of regional and rural livelihoods and landscape amenity are important. Interpretations and value judgements of developed nations with respect to some of these issues – for example the issues of child labour and gender equity in developing nations – can be problematic.
- Production of algal biomass may circumvent many of these sustainability issues, but requires basic research into the production systems.

Pre-processing and transport

- Infrastructure is required for transport and pre-processing (e.g. pelletising, drying) in order to transport the biomass to the conversion facility.
- There are trade-off between scale and distance (increased efficiency through increased scale means greater transport distance) and in processing (in-field chipping can increase efficiency of transport, but uses smaller, less-efficient chippers).

Processing

- Existing infrastructure can be used (e.g. coal-fired power stations) or could be used with minor modifications (e.g. adding an ethanol distillery to a sugar or flour mill).
- Small-scale bioelectricity facilities (e.g. small-scale gasifier) or medium- to large-scale enzymatic or thermochemical plants could be used for off-grid or supplementary generation. Issues include noise, dust, emissions, water use and other standard industrial issues.
- Community concerns about the location and operation of large new facilities must be balanced with jobs, regional diversification, livelihoods and stimulus to the local economy during the establishment and ongoing operation.

Product streams

- There are few sustainability issues associated with the products of heat and power *per se*, unless additional infrastructure is required.
- The rise in aggregate demand for heat and power is, however, a key sustainability concern at national and global scales.
- New technology products may (e.g. bio-plastics, paint additives and adhesives) may have specific sustainability issues depending on type of combustion and emissions, as well as consequential impacts (positive or negative) through replacing particular existing product markets.

Transport and distribution for retail

- As before

Domestic and international markets

- Depending on the particular product or suite of products, there may be new markets or existing markets (e.g. petrol, diesel, electricity, plastics and adhesives) for which the new products provide functional equivalents.
- For electricity, there are debates and tradeoffs between centralised electricity generation and distributed generation with electricity produced close to demand centres, requiring less distribution infrastructure and losses, as well as spreading of risk.

Consumption

- Biofuels must be compatible with the engine technologies for which they are intended to be used. There are economic issues of transition times and strategies given the residence time of vehicle, machinery and aircraft fleets.
- These issues are less important with bioelectricity since it is a standardised product.
- There is a societal view that new biofuel value chains should be demonstrably 'more sustainable' than incumbent energy, agriculture or forestry value chains.

Sustainability issues indirectly arising from bioenergy value chains

- A rapid international expansion in biofuels led to an increased demand for sugar and corn (for ethanol), and rapeseed (canola) and palm oil (for biodiesel). This in turn led to many unintended consequences in terms of contributing to price rises for some commodities, and to undesirable land use changes.
- The negative impacts of the production of biofuels include displacement of food producers and generating higher food prices on net consumers (mostly affecting poor, vulnerable and food-insecure households).
- Biofuels were not the sole reason for food price hikes – other drivers included poor harvest in major grain producer countries; high cost of fertilizers, transport and energy; regulatory policies; increase in demand for food; change in diet in emerging economies; increase in demand for biofuels; US dollar exchange rate changes; and speculation.
- Biofuels could also have some possible benefits for developing regions by opening new market opportunities for biofuel feedstock crops, increasing farmers' incomes due to higher products prices, and potential reduction of emissions.
- The capacity to expand supply of feedstocks varies in different regions of the world. Expansion of supply may be achievable in many areas of the world (e.g. where land is not producing profitable goods, known as 'set-aside' land). There are resource constraints on arable land and water in many areas of the world, however. Expanding supply may lead to other land uses becoming displaced – often in locations distant to the actual industry driving the demand. This is referred to as 'land use substitution', 'indirect land use change', or 'leakage'.
- The indirect causes and impacts of bioenergy on land use change are complex to determine, difficult to manage, and contested. This is because the science methods are immature, the data sparse, and because the benefits and costs are distributed differently among different social groups.
- The same issues still have the potential to arise in production of lignocellulose for second-generation biofuels or electricity. Replacing high-productivity land currently used for agriculture, with dedicated energy crops could occur, whereas other combinations of policy and economic settings could provide new profitable energy production from lower-productivity land.

Stakeholders and communities of consent

A license to operate from communities of consent is a major industry enabler. There is multitude of people and organisations involved in establishing and operating bioenergy value chains. This report makes the distinction between:

- stakeholders, who have a direct investment, share, concern in the value chain
- communities of consent, which provide the stakeholders with a license to operate. This license to operate may constitute formal licensing and regulatory processes, but also refers to impacted communities who may protest vigorously and stop the formal consent processes, or consumers who provide ultimate consent by buying the product. It also includes the future generations who are not here to represent their needs.

Ideally, a community license to operate is gained at an enterprise and industry level through structured dialogue and consultation with stakeholders as well as the communities of consent (Figure 2-5).

Conclusions and key messages

The conclusions and key messages from this chapter are summarised at the end of the chapter, as well as in the Executive Summary.

There are many different technological pathways to produce bioenergy (liquid fuels, heat and power). In this chapter we provide a brief overview of the technologies and the Australian bioenergy industry in order to provide context for the discussion of sustainability of bioenergy. We introduce the bioenergy value chains, and discuss sustainability issues arising directly from these value chains. We then introduce the sustainability issues arising indirectly from these value chains, and map the key stakeholders and communities of consent against a simplified generic value chain.

2.1 Biofuels feedstocks, conversion technologies and products

The various bioenergy technologies fall into three categories according to the maturity of deployment, as follows:

- First-generation technologies are currently deployed with a proven technology, existing commercial enterprises and mature markets. There are many different combustion technologies, as well as use of biogas for generation of heat and/or power. These technologies are widely deployed in other parts of the world (e.g. Scandinavia). For liquid fuels, first-generation technologies are fermentation of sugar and starch crops to ethanol, or transesterification of plant and animal oils to biodiesel.
- Second-generation technologies have been physically demonstrated at pilot scale, but are not yet commercial due to scale-up issues, or due to high costs. Second-generation technologies include several different types of biochemical or thermochemical transformation processes that can convert non-edible fibrous or woody portions of plants (called lignocellulose) to liquid fuel. There are also opportunities being investigated to use algae to produce biodiesel. Small scale gasification units for electricity generation are becoming available at reasonable cost.
- Third-generation technologies are at the conceptual planning stage, 'on drawing board' or at benchtop demonstration stage, but have a long way to go before they can be deployed. Third-generation technologies include modern biorefineries which could use lignocellulose to feed integrated processes producing energy and a range of new bioproducts (Kamm and Kamm, 2004; Haritos, 2007).

This review focuses only on bioenergy pathways, although it is probable that the sustainability issues and approaches which are dealt with in this report will be of direct relevance to other bioproducts.

Different technologies use different types of biomass to feed the conversion process. These are referred to as biomass feedstocks. Biomass feedstocks for use in an emerging industry can be considered in terms of the current production base (i.e. what is already being produced) as well as future production base (which may include new and novel plant species, or changes in land use to produce energy crops or forests). Biomass feedstocks from current and future production bases are shown in Table 2-1.

Table 2-1 Biomass feedstocks from current and future production bases, and the technologies that may be used to transform them to bioenergy and bioproducts (adapted from O'Connell et al., 2007)

Technology	Current production base	Future production base
First-generation biofuels • Ethanol from sugar and starch • Biodiesel from oil **First-generation electricity from anaerobic digestion**	• Sugar • Starch crops (e.g. grains) • Oilseed crops • Used vegetable oil • Tallow • Urban wet wastes	Current production base, as well as: • GM crops • new oilseed crops (e.g. Pongamia) • new sugar crops (e.g. agave)
Second-generation biofuels • Alcohols (including ethanol and butanol) • Synthetic diesels and gas **First- and second-generation heat and power from lignocellulose** • Wood fires for heating • Power from coal fired power station • Gasification	• Agricultural in-field residues (e.g. cereal stubble and sugar trash) • Agricultural processing residues (e.g. husks from rice or cereal, and bagasse from sugar) • Grasses – improved pasture and native • Plantation forestry – including different components such as in-field residues, harvest residues, thinnings, or diversion of low value products such as pulp logs • Native forest (as above) • Dedicated energy crops e.g. mallee rows in agricultural land • Forest processing residues (e.g. sawmill waste) • Organic waste in landfill • Woody weeds	Current production base, as well as: • expansion of plantation forestry • expansion of grasses by cultivating specifically for energy • expansion of dedicated energy woody crops (e.g. coppicing crops such as mallee, short-rotation forestry) • new/GM modified crops • algae in open ponds or bioreactors • possible contraction of organic waste in landfill
Third-generation biorefineries • Heat, power, liquid fuels • High-value bioproducts such as petrochemical replacements • No 'waste'	• All of the above	

Different fractions of any given biomass source can be used as a feedstock for different conversion technologies and products. For example, cereal grain is considered in Figure 2-1. The primary reason for growing grain has until recently, been for human food and animal feed. Ethanol is now produced from the grain using first-generation fermentation and distillation technologies. In Australia, the stalks or stubble from crops currently have one of the following fates:

- retained in a minimum tillage system to contribute to soil carbon
- burnt in the field
- harvested for animal feed or fed to animals *in situ.*

The stubble may alternatively be used as feedstock for first-generation electricity generation technologies, such as through co-firing in a coal fired power station to produce bioelectricity (most coal-fired power stations can use 10% biomass).

With the advent of second-generation technologies, a further range of possibilities opens up – the stubble could be harvested and:

- converted into ethanol via enzymatic technologies
- converted into syngas, and reformed into syndiesel using thermochemical processes
- converted by pyrolysis into biochar (which could be used to sequester carbon in soil and/or improve soil quality) and syngas (which could be used to produce syndiesel or run a turbine for bioelectricity)
- converted in a biorefinery into a range of novel chemicals, with energy as a coproduct.

This example provides a glimpse of the range of processes, products and new value chains which are possible using biomass to generate biofuels and bioenergy. The topic is dealt with in a great deal more detail in (Kamm and Kamm, 2004; Ragauskas et al., 2006; Haritos, 2007).

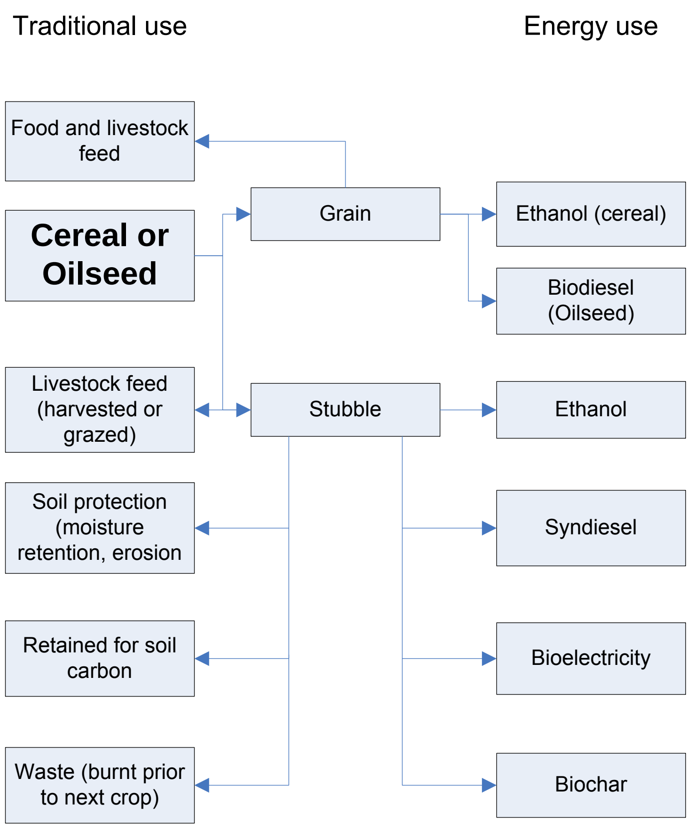

Figure 2-1 Alternative fates of oilseed or cereal grain and stubble

2.1.1 Snapshot of bioenergy and biofuel industries

The scale or magnitude of any new and emerging value chain or industry is critical in underpinning any approach to sustainability – not just in biofuels but in any resource use question. Biofuels and bioelectricity are operating at very small scales in Australia to 2009. However, there are many drivers in place such as the proposed Carbon Pollution Reduction Scheme (CPRS), the national Renewable Energy Target (RET) of 20% by 2020 (discussed further in section 4.3) which have the potential to drive expansion of the bioenergy industry.

2.1.1.1 International snapshot

Bioenergy has traditionally been used by humans for millennia and is still a primary energy source in some developing countries, mainly for heating and cooking. Worldwide, bioenergy provides about 10% of the world's total primary energy supply (47.2 EJ of bioenergy out of a total of 479 EJ in 2005)(GBEP Task Force on Sustainability, 2008).

Modern bioenergy is found in many forms – as pelleted wood or post-harvest straw for the production of heat and electricity from direct firing, or co-firing in coal-fired boilers. There has been rapid growth in the use of these types of biomass in Scandinavian countries for district heating and combined heat and power. Denmark obtained 6% of its energy requirements from biomass, Sweden almost 20% and Finland 24% (Lang, 2008). Biogas from the anaerobic fermentation of biomass produced in household or village biogas plants from human and animal waste is used in millions of households in China, India, Nepal, Vietnam and other Asian countries for cooking and lighting (Sims and Gigler, 2002).

Since 2005, the world supply of liquid biofuels has doubled (see Table 2-2) both in biodiesel and ethanol. However, in 2008 this still represented less than 2% of the world's requirement of liquid transport fuel.

Table 2-2 World supply of oil and biofuels from 2005 to 2008 (IEA Bioenergy, 2009)

Supply (million barrels/day – equivalent for biofuels)	**2005**	**2006**	**2007**	**2008**
Non-OPEC Oil Supply	49.8	50.3	50.7	50.6
OPEC Oil Supply	34.9	35.2	34.9	35.9
Biofuels Supply	0.7	0.9	1.1	1.4
Biofuels as % of oil supply	**0.83**	**1.05**	**1.29**	**1.64**

The current institutional framework in terms of mandates, targets and other incentives for biofuels (Worldwatch Institute, 2007; Petersen, 2008) provides an economic base for the development of biofuel industries. These targets are due to be met while new and second-generation conversion technologies are still under development, which means that they will rely on first-generation feedstocks and production technology (International Institute for Applied Systems Analysis, 2009). The implications of this are discussed in detail in section 2.3.

2.1.1.2 Biofuels in Australia to 2009

There has been growth in the production of biofuels in Australia since 2004 (as shown in Table 2-3), but it is still very small scale. In 2008, 100 ML of ethanol from C-Molasses or waste flour starch and 68 ML of biodiesel from used cooking oil and tallow, was produced. This represented only 0.45% of the total 37,500 ML of automotive gasoline and diesel consumed in Australia that year. Due to the use of non-food feedstocks for this production, there was virtually no impact on existing food chains. The supply of these feedstocks is, however, is reaching limits.

Table 2-3 Production of biofuels in Australia from 2004 to 2007 (IEA Bioenergy, 2009)

Production ML/yr	**2004**	**2005**	**2006**	**2007**	**2008**
Fuel ethanol	24	27	63	80	100
Biodiesel	10	57	91	59	68
Total Biofuels	**34**	**84**	**154**	**139**	**168**

The introduction of biofuels mandates in New South Wales and Queensland (discussed further in section 4.4), looks set to drive the increased production of first-generation biofuels based on local grains. While Queensland continue to will source ethanol from sugar (with CSR Ethanol's Sarina distillery producing up to 60 ML/yr), a sorghum-based refinery at Dalby in Queensland began operation in December 2008 and at full production, will use 220,000 t/yr of locally grown sorghum to produce approximately 90 ML/yr of ethanol. Industry expansion based on first-generation technologies, without an expansion in the feedstock production base, will necessarily start to divert grain or sugar away from human food and animal feed value chains.

2.1.1.3 Bioelectricity to 2009

Bioelectricity is a very small contributor to Australia's electricity production. In 2006/07, 227 TWh of electricity was generated in Australia, of which approximately 1.6 TWh was produced from biomass, or 0.7 % of the total (ABARE, 2009) (shown in Table 2-4).

The national RET (section 4.3) has already driven an increase in the generation of electricity from renewable sources, with this representing approximately 10% of total electricity generation in Australia in 2007. While most of this increase has been from wind sources, between 1997 and 2007 there was a doubling of the amount of renewable generation from biomass (mainly bagasse). The relative contributions of solar, wind, thermal and biomass to the 2020 target is not known – but clearly this will be a driver for increasing the contribution from biomass.

Table 2-4 Generation of renewable electricity from biomass in Australia from 2004 to 2007 (ABARE, 2009)

Biofuels	1991 (GWh)	2007 (GWh)
Bagasse*	513	1029
Black liquor**	154	267
Wood waste	63	213
Other***	4	83
Totals	**734**	**1572**

* Electricity and heat is produced from bagasse and used in the operation of sugar mills. In 2008 more than 415 MW was produced from bagasse in Queensland (Queensland Government, 2009)
** A by-product of the paper industry used in paper mills
*** Includes municipal solid waste combustion and food and agricultural waste

2.2 Bioenergy value chains and sustainability issues

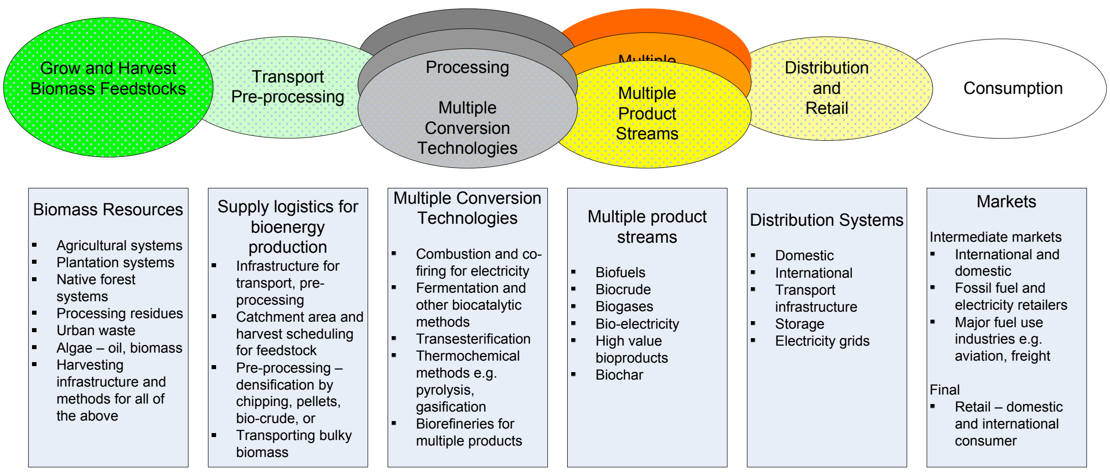

Figure 2-2 A generic value chain for bioenergy or biofuels, showing the main elements of biomass production and harvest, transport, biofuel manufacture into different product streams for domestic and international markets.

A value chain represents a connected set of activities. As products move through the linked activities they gain more added value than the sum of added values of individual segments (Porter, 1985). A simplified generic bioenergy value chain is shown in Figure 2-2. There are new and emerging bioenergy value chains that are complex in and of themselves. Additional complexity is introduced because they interact with a number of other incumbent industry value chains (for food, fibre and fossil fuels). In this section we use the generic value chain as a basis to discuss sustainability issues arising directly from each component of the value chain, as well as the operation of the value chain as a whole.

2.2.1 Biomass feedstock production and harvest

The first segment of the value chain is biomass feedstock production and harvest. There are critical sustainability issues around maintenance of critical ecosystem functions, as well as value delivery to biomass producers and the community at large. They will differ vastly between feedstock types, production systems and geographic regions of the world.

Land and water resources will be increasingly contested and pressured for production of food, fibre, water, biodiversity, carbon storage and urbanisation. Globally, there are many healthy agricultural landscapes which are highly productive. In Australia, however, many agricultural landscapes suffer from soil fertility decline, acidification, salinisation, erosion, fragmentation and loss of biodiversity. Our river systems suffer from over-allocation of water, salinisation and eutrophication. Many current production systems already are already showing signs of degradation – which vary in type and magnitude depending on the region and industry in question. Bioenergy value chains which rely on diversion of material from production systems which are already stressed will inherit many of the sustainability issues associated with the incumbent production system. Sustainability issues additional to those associated with the current production system may occur (e.g. using grain for fuel compared to human food or animal feed, or removing agricultural or forest residues which maintain soil carbon and nutrients).

There is scope for re-optimisation of some current production systems to cater for an energy market without diverting biomass from current uses (e.g. plantation forestry could introduce an extra thinning into the management regime if there were a market for the thinnings; or sugar could increase the fibre content for a small penalty in sugar content, thereby producing more fibre for energy). These may raise few sustainability issues over and above those which are already associated with the production system – but these systems are largely untested as yet.

There is evidence that producing lignocellulosic biomass for second-generation feedstocks can be cost-effective with low-input production systems, on low-productivity land or under-utilised (Tilman et al., 2006; Commission of the European Communities, 2007). Oil mallee systems in Australia have already been developed and tested in Western Australia (e.g. Bartle 2001, Bartle 2006, Bartle et al. 2007, Huxtable et al. 2007) and have relatively high energy return on energy invested (Wu et al. 2008). There are many other systems on lower productivity or under-utilised land that may be possible but as yet are untested. If these new systems are developed, there may indeed be a great deal of land that could potentially be used for energy crop production under specific economic circumstances (Hoogwijk et al., 2003).

The use of such land for bioenergy may improve or worsen sustainability outcomes. For example there may be great environmental and social benefits, including salinity control, improved biodiversity outcomes, opportunities for enterprise diversification for farmers, and developing an industry which contributes to rural livelihoods. It may also, however, in certain economic circumstances and geographic areas, compete indirectly for the land, water and labour currently used for food or fibre production or environmental services in higher-productivity landscapes. The biosecurity risks must also be carefully evaluated in Australia. The plant functional traits for an ideal bioenergy crops (fast growth, ability to thrive in poor-productivity landscapes, ability to tolerate droughts and fires) also typify a very effective noxious weed. Therefore serious consideration of biosecurity risks must have a high priority before new plantings are made.

Critical issues related to this segment of the value chain include the use of land to feed local and global populations, as well as more local issues of regional and rural livelihoods and landscape amenity. In many parts of the world, there are issues around the human rights of the biomass producers – for example, gender equity and use of child labour – to be considered. The interpretations and value judgements of developed nations with respect to some of these issues – for example the issues of child labour and gender equity – can problematic in the local context (Fehrenbach, 2008).

Production of algal biomass is far from economically viable currently, and requires basic research into the production systems such as open- or closed-pond systems, photobioreactors or natural waterways. The science behind selection or modification of appropriate algal strains, the structure and operation of ponds, fertilisation with nutrients and CO_2 in different environments at scales for large-scale production has not been well established. Sustainability issues related to natural waterways will be critically important – if nuisance algal blooms are harvested there could be positive outcomes. If natural waterways become economically viable in the future as growth mediums for algae, however, the impacts on ecology and rural livelihoods will need to be investigated.

Usually a different set of issues arises in post-consumer waste forms of biomass – for example, the potential toxic emissions from combustion of some materials. Paradoxically, the desirable sustainable outcome of minimal post-consumer waste would diminish this potential feedstock source for bioenergy.

2.2.2 Pre-processing and transport

The second segment of the value chain is pre-processing and transport to the processing facility. Infrastructure is required for transport and pre-processing (e.g. pelletising, drying) in order to transport the biomass to the conversion facility. Transport of bulky biomass is expensive, and the impacts will depend on the freight mode (road, rail, ship), distance travelled, the scale of the enterprise, and whether new transport infrastructure is required or existing systems can be used. There are many trade-offs to be considered between these factors, for example there is a trade-off between scale and distance (increased efficiency through increased scale means greater transport distance) and in processing (in-field chipping can increase efficiency of transport, but uses smaller, less-efficient chippers). There are also issues to consider with the form in which biomass is transported (e.g. raw biomass, densified biomass such as pellets, processed energy products such as bio-oil, or energy services such as electricity), and the trade-offs with each of these options (Schlamadinger, 2005). These tradeoffs are well illustrated under Australian conditions by Yu et al. (2009).

2.2.3 Processing

The third segment of the value chain is processing. There are a large range of conversion technologies that could be employed in processing to bioenergy and biofuels. In some cases, existing infrastructure could be used (e.g. coal-fired power stations) or could be used with minor modifications (e.g. adding an ethanol distillery to a sugar or flour mill). Small-scale bioelectricity facilities (e.g. small-scale gasifier) or medium- to large-scale enzymatic or thermochemical plants could be used for off-grid or supplementary generation. The physical ‘footprint’ of these facilities are generally very small in comparison to that required for the biomass production.

Sustainability considerations, in regards to processing, will include the technology employed, the feedstock types and transport used. Typically, issues include noise, dust, emissions, water use and other standard industrial issues. Frequently, there are also strong community concerns about the location and operation of large new facilities. The issues of jobs, regional diversification, livelihoods and stimulus to the local economy during the establishment and ongoing operation of the facility are key sustainability considerations.

2.2.4 Product streams

First-generation products are largely:

- heat and power
- ethanol (for blending with petrol)
- biodiesel (for neat use or blending with mineral diesel).

There are few sustainability issues associated with the products of heat and power per se, unless additional infrastructure is required. The rise in aggregate demand for heat and power is, however, a key sustainability concern at national and global scales.

The sustainability issues with first-generation liquid fuels products have centred on impacts of tailpipe emissions, health and safety, and energy efficiency and wear in engines.

As second- and third-generation technologies become commercial, the products may include a wide range of other fuels (butanol, P-series fuel, Dimethyl Ether DME) and bioproducts (e.g. bio-plastics, paint additives and adhesives) (Haritos, 2007). Each of these may have specific sustainability issues depending on type of combustion and emissions, as well as consequential impacts (positive or negative) through replacing particular existing product markets. The use of a material such as biomass to produce energy may ultimately be considered a less ‘sustainable’ or lower priority use of the carbonaceous material (especially if other forms of energy such as geothermal, solar, wind and tidal expand sufficiently). In the future, the biomass material may be considered more sustainably used in biorefineries to produce high value materials which can not be replaced by any other sources.

2.2.5 Transport and distribution for retail

Transport impacts for material products will have similar impacts to those listed in section 2.2.2, and will depend on the product and freight mode (road, rail, ship), distance travelled and the scale of the enterprise, and whether new or existing transport infrastructure is required. Power, heat, and liquid fuels have very different transport issues, efficiencies, and optimal distances across which they can be transported. It is important to understand the trade-offs in terms of bioenergy sustainability considerations.

2.2.6 Domestic and international markets

Total market demand for a product has two components (Batten and O'Connell, 2007):

- intermediate demand, which is purchasing patterns of intermediate consumers (such as oil companies and service stations for biofuels, electricity companies for bioelectricity) who may further process, blend and distribute products for eventual sale to consumers
- final demand, which is purchase by consumers.

Depending on the particular product or suite of products, there may be:

- new markets domestically or internationally for a new product with a new use
- existing markets (e.g. petrol, diesel, electricity, plastics and adhesives) for which the new product would substitute – known as functional equivalence. These markets may be difficult for the new product to penetrate (e.g. oil majors have in the past been resistant to uptake of ethanol, and consumer demand has been low), partially protected (e.g. mandated volume of ethanol blend with petrol) or conditional (market access only to sustainably certified products).

For electricity, there are debates and tradeoffs between:

- centralised electricity generation and ageing distribution networks, and the losses encountered with long distance transport of electricity
- distributed generation with electricity produced close to demand centres, requiring less distribution infrastructure and losses, as well as distribution of risk.

2.2.7 Consumption

The final segment of the value chain is consumption. Biofuels will need to remain compatible with the engine technologies for which they are intended to be used. There are economic issues of transition times and strategies given the residence time of vehicle, machinery and aircraft fleets. These issues are less important with bioelectricity since it is a standard product.

There is a societal view that new biofuel value chains should be demonstrably ‘more sustainable’ than incumbent energy, agriculture or forestry value chains. Both the intermediate and final markets increasingly expect that biofuel and bioenergy products demonstrate sustainability. There is increasing consumer awareness of (as well as a high degree of confusion about) not only impacts within a new biofuel value chain, but also the impacts on existing value chains (e.g. grain diverted away from existing food chains, contributing to high food prices and shortages in some regions) and indirect land use effects (e.g. expansion of corn production areas in response to increased demand leading to displacement of soy production, which has migrated to other locations and led to land clearing). These issues are discussed further in section 2.3.

2.3 Sustainability issues indirectly arising from bioenergy value chains

Internationally, there was a very rapid scale up from 2004 to 2008 in first-generation biofuel production. This led to an increased demand for sugar and corn (for ethanol), and rapeseed and palm oil (for biodiesel). This in turn led to many unintended consequences in terms of contributing to price rises for some commodities, and to undesirable land use changes.

There is a great deal of literature on the 'food v fuels' debate. Biofuels were not the sole reason for food price hikes. Other drivers included poor harvest in major grain producer countries; high cost of fertilizers, transport and energy; regulatory policies (e.g. production quotas); increase in demand for food; change in diet in emerging economies; increase in demand for biofuels; US dollar exchange rate changes; and speculation (Trostle, 2008). This is discussed further in the food v fuels pullout box.

The negative impacts of the production of biofuels include displacement of food producers and generating higher food prices on net consumers (mostly affecting poor, vulnerable and food-insecure households). Nevertheless, biofuels could also have some possible benefits for developing regions by opening new market opportunities for biofuel feedstock crops, increasing farmers' incomes due to higher products prices, and potential reduction of emissions (Msangi et al., 2007). As the 'food v fuels' debate has been the major point of debate about sustainability in relation to first-generation biofuels, we provide some commentary on the issue in the food v fuels pullout box.

Economic theory predicts that when demand outstrips supply, prices hit short-term highs. In the medium-term, however, supply will expand to fulfil the new demand levels, reaching a new equilibrium price. These mechanisms do not hold, however, when there are constraints on resources, or when the factors affecting the increase in demand change (e.g. the biofuel demand falls after the oil price falls).

The capacity to expand supply of feedstocks varies in different regions of the world. Expansion of supply may be achievable in many areas of the world (e.g. where land is not producing profitable goods, known as 'set-aside' land) (Hoogwijk et al., 2003; Smeets et al., 2006). There are serious resource constraints on arable land and water in many areas of the world, however. Within this economic framework, supply of biomass for bioenergy cannot continue to expand if other competing uses of the land (human food, animal feed, fibre, energy, water yield, biodiversity and C sequestration) are more profitable. Expanding supply may lead to other land uses becoming displaced – often in locations distant to the actual industry driving the demand. This is referred to variously in the literature as 'land use substitution', 'indirect land use change', or 'leakage'.

A mainstream economic view is that land that is not producing an economic surplus is 'idle'. However, the land is often providing unmarketed benefits to humans by providing clean water, fuelwood, communal grazing, fish, wildlife, bush foods and medicinal plants. These usually unmeasured benefits might be rated more highly by the local users than income from cropping. When such land is held under traditional tenure, local users are in danger of having it appropriated by the state or business interests, or some combination of these, to grow commodities (Pearce, 1993.)

The indirect causes and impacts of bioenergy on land use change are complex to determine, difficult to manage, and contested (Searchinger et al., 2008; Fargione et al., 2008; Mathews and Tan, 2009). This is because the science methods are immature, the data sparse, and because the benefits and costs are distributed differently among different social groups (see section 2.4). One example is the recent expansion of palm oil production in Asia. Established palm oil plantations supply markets for food and cosmetics. As the demand for palm oil increased (driven largely by biofuel markets in Europe but potentially also from an increase in demand from the food market), rainforest was cleared to expand palm oil production. The public outcry led to the formulation of the Roundtable on Sustainable Palm Oil (RSPO) guidelines (discussed in detail in Chapter 3 and 4). The result is that those palm oil plantations which were already existing to supply the food market can comply with the sustainability requirements of RSPO. They now supply the markets which require 'sustainably produced palm oil', while the newly cleared plantations now supply those markets which appear less discerning of the sustainability credentials and the loss of non-market values of the cleared rainforest This is essentially a displacement of the clearing effect from one market to another – the material consequence (rainforest clearing for new palm plantations) is therefore not tractably addressed if only one market segment (biodiesel) demands sustainability certification while another (food and cosmetics) does not.

It is proposed by many that the development of second-generation technologies will nullify the issues of direct impacts on human food and animal feed chains. However, the same issues still have the potential to arise – it depends on how and where the second-generation biofuel feedstocks are produced. Replacing high-productivity land currently used for agriculture, with dedicated energy crops could occur, whereas other combinations of policy and economic settings could provide new profitable energy production from lower-productivity land (bearing in mind the reservations noted earlier).

The issue of indirect effects on land use, stimulated by rapidly increasing demand for feedstocks for first-generation biofuel production, is now widely understood as an important issue to consider by consumers and governments. Solutions are, however, difficult to devise and there is major international research and policy effort currently directed towards this. Many of the sustainability approaches reviewed in Chapter 3 and 4 acknowledge the problem, and some of them are starting to propose ways in which the issue can be addressed.

Pullout Box Food v Fuels

Biofuels are not the only reason for the increase of food prices. In terms of the food v fuel debate, most of the criticism for biofuel production are associated with the idea that the higher food commodity prices in the last few years are a consequence of the use of food (mostly cereals, oils and sugar cane) as feedstock to produce fuels. This criticism has proliferated because it is intuitive, easily understood by the public, and has some empirical evidence to support it especially from the use of first-generation technologies for the production of ethanol from maize in the US. Nevertheless, the real reasons for the higher food prices are diverse, complex and in most cases biofuels plays only a minor role in the price increment. Some of the factors for food price increase have appeared in the last two to three years, while others reflect underlying trends in supply and demand for agricultural commodities that began more than a decade ago. These factors are summarised in Figure 2-3.

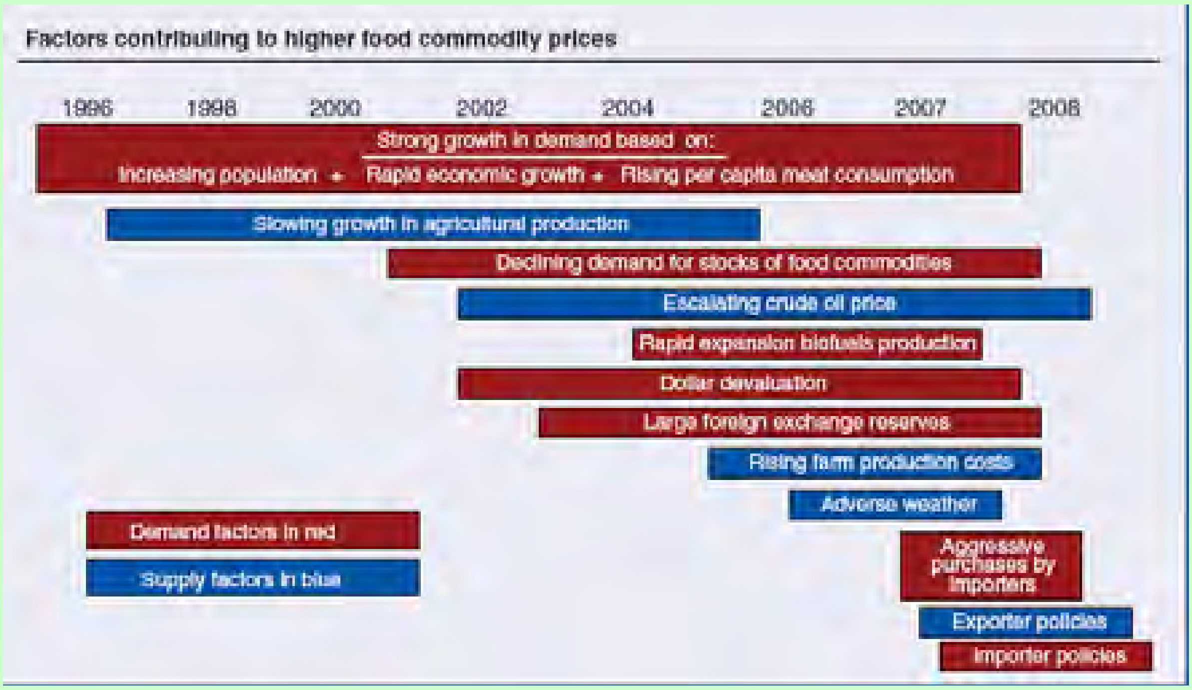

Figure 2-3 Factors contributing to increases in food prices 1996–2008 (Trostle, 2008)

Pullout Box Food v Fuels cont…

The impact of biofuel on food prices is region-specific. In some regions, for some feedstocks, there is direct competition between biofuels and food, and the rapid expansion in biofuel production contributed to increase the food prices (Batten and O'Connell, 2007; von Braun et al., 2008). Not all the countries are equally affected by the global increase in agricultural prices. The transmission of the increment into the local prices depends on the transparency of the markets, market power and accessibility. In response to rising food prices, some countries took protective policy measures (e.g. taxes, export bans) designed to reduce the impact of rising world food commodity prices on their own consumers. However, such measures typically force greater adjustments and higher prices onto global markets (Banse et al., 2008). In Australia, it is likely that there has been little impact of biofuels on food prices, because they have been based until 2008 on non-food sources.

The impact of biofuel on food prices is commodity-specific. Since many factors affecting food prices are non linear and operate at different scales of analysis, it is hard to quantify their separate impacts. There is no consensus about the contribution of biofuel demand to the increase of agricultural prices, but some models from International Food Policy Research Institute (IFPRI) – for example (Rosengrat, 2008) – suggest that increase in biofuels demand explains 30% of the average increase in cereal prices. Nevertheless, these estimates are usually criticized since many other studies (e.g. Banse, Nowicki & van Meijl, 2008) indicate that the impact of biofuels on world price levels is commodity-specific. For corn, the impact is high because most US ethanol is produced from it. However, for other cereals not used for biofuel production (e.g. wheat and rice), only indirect effects over the land use affects the world price level and the 30% increase estimated by IFPRI seems to be too high.

Another important issues in the food v fuel debate is the role of markets to set prices. It is expected that if the price of agricultural commodities increase, market forces will in time provide a certain degree of corrective action – but only if there are no policies or regulations that prevent markets from operating freely. However, the review of country policies suggest that the use of taxes or export bans create market distortions that contribute to increase in the prices of commodities.

The consumers from developing countries where the income level is low and there is deficit in food and energy are those suffering more from changes in the price of commodities. This is because they spend a larger proportion of their income on food and their staple food products are also potential feedstock for biofuel production. High prices of agricultural products might provide additional income opportunities for farmers, it is uncertain whether they could benefit from the periods of high prices since, in most cases, they do not have surplus to send to markets, and their local economies are not well linked to the global markets.

A common economic postulate from a neoclassical perspective is that technological changes might solve many of the current constraints and problems if there is room for innovation and adoption of technologies. However, improvement on biofuel technologies that uses food feedstocks will not solve the food v fuel debate, since increasing the competitiveness of biofuels related to food will exacerbate the trade-offs. Investments and improvements in second-generation technologies (use of cellulosic sources) might contribute to reduce the direct conflict for the use of feedstock for food consumption or fuel production, but the indirect competition between agricultural and forest systems for land and water resources requires further analysis.

The sustainability issues across the value chain are summarised in Figure 2-4.

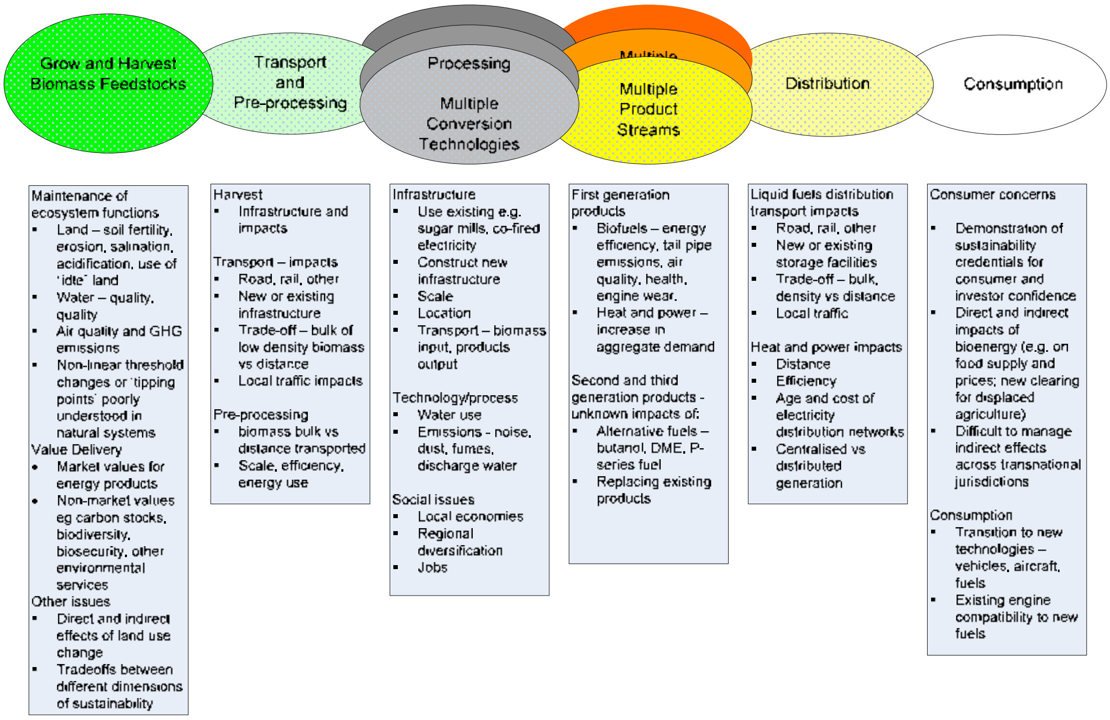

Figure 2-4 Summary of sustainability issues across a generic bioenergy value chain

2.4 Stakeholders and communities of consent

A license to operate from communities of consent is a major industry enabler. There is multitude of people and organisations involved in establishing and operating bioenergy value chains. This report makes the distinction between:

- stakeholders, who have a direct investment, share, concern in the value chain
- communities of consent, which provide the stakeholders with a license to operate. This license to operate may constitute formal licensing and regulatory processes, but also refers to impacted communities who may protest vigorously and stop the formal consent processes, or consumers who provide ultimate consent by buying the product.

Ideally, a community license to operate is gained at an enterprise and industry level through structured dialogue and consultation with stakeholders as well as the communities of consent. The communities of consent can be represented by any or all of the groups listed below (O'Connell et al., 2005) (Figure 2-5).

2.4.1 Local, state and national governments

Governments are responsible for formulating and implementing measures that facilitate sustainable development of a bioenergy (or biofuels) industry, in support of broader policy objectives. Multiple levels of government, working across the various stages in a bioenergy value chain, should be cognisant of the interactions of policies across broad domains covered by bioenergy. They have responsibility to assess and manage the economic, environmental and social impacts of individual projects, or the broader industry against a range of policy goals. In the case of national governments, these considerations may extend to international treaty commitments such as WTO. Local, state and national governments are responsible for the various formal project assessment processes enshrined in legislation and regulation and by-laws. Government departments may not only regulate, but also provide advice and extension services to assist broader policy implementation. This is dealt with in detail in Chapter 4.

2.4.2 Impacted communities

This group may include other industry groups which may be impacted by the development of a new industry (e.g. the animal feedlot industry would be affected by an alternative competing market for feed grain), as well those who may be subject to the social and economic impacts of either a facility or an industry. For example, they may be concerned with aesthetic or recreational values in addition to the amenity issues that might flow from a particular project development, or they may be excited at the prospects of new job opportunities.

2.4.3 Neighbours

Any potential bioenergy or biofuels activity will have neighbours of the biomass production or procurement system, conversion process and perhaps even in the energy reticulation and utilization phases. Neighbours may include adjoining land holders (paddock-scale) or regional at a catchment-scale. Neighbours are likely to be the part of the community most directly affected by such impacts as land, water and air considerations and noise.

2.4.4 NGOs

Environmental, human welfare, local business development groups etc. may all have specialist agendas that intersect with a proposed land use change to yield biomass and its subsequent conversion to energy for direct use or reticulation.

2.4.5 Consumers

Consumers and purchasers fall into the categories of intermediate and final consumers (Batten and O'Connell, 2007). Intermediate consumers are the oil companies or other large purchasers of bioelectricity or biofuel and then retail or use in large fleets, while the end consumers are the ultimate customers. Customers are increasingly discerning, but also increasingly confused by the plethora of claims and counterclaims on the sustainability (or lack thereof) of biofuels in particular, and the complexity of the arguments put forward on either side.

2.4.6 Future generations

The concept of sustainability requires that current resource use practices consider the interests of future generations. Future generations are not here to represent their own interests, which are upheld with debatable effectiveness by current policies and legislation, and which must be represented by other sectors of the community in making decisions in the current timeframe.

Each of these sectors of the community can be mapped onto the value chain (Figure 2-5). An industry which is able to address broader concerns – beyond the formal compliance steps – will have a far greater chance of gaining a broad community license to operate. The minerals industry has accumulated substantial experience and expertise in this.

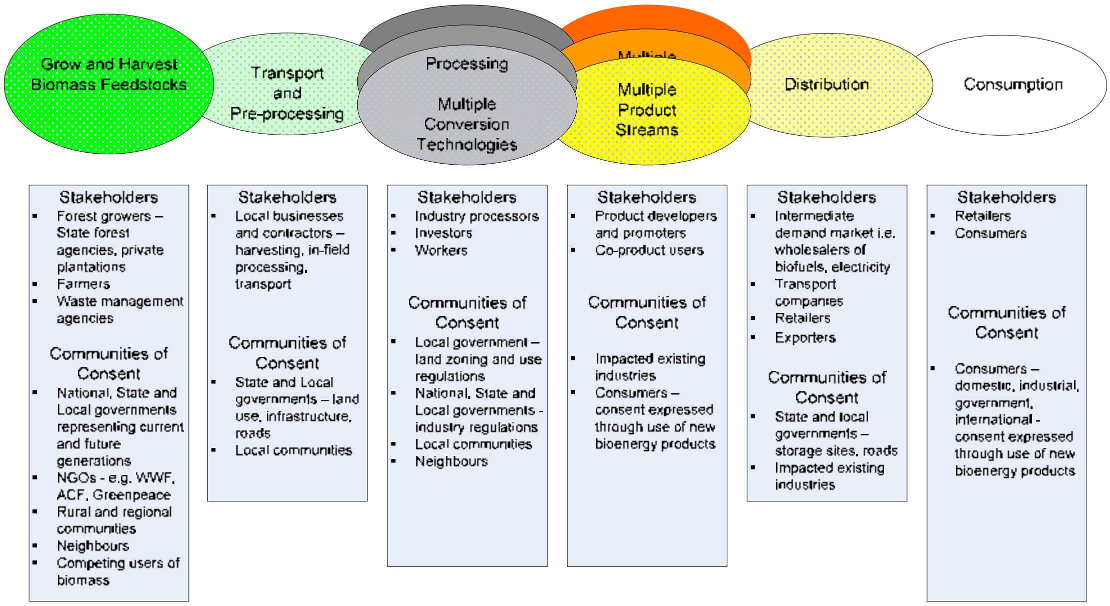

Figure 2-5 Stakeholders and communities of consent in bioenergy value chains

2.5 Key messages and conclusions from this chapter

1. Biofuels and bioelectricity are operating at very small scales in Australia to 2009. Biofuels supply 0.45% of total transport fuels while biomass contributes 0.7 % of total electricity. There are drivers to expand renewable energy for climate mitigation, and to increase the security of supply for transport fuels. These could lead to a rapid expansion of the bioenergy industry.
2. Sustainability issues arise at each stage of the value chain, as well as across the whole value chain. Issues arise and must be addressed at different scales and within different social and environmental contexts. For example, the concerns of neighbours with respect to a new conversion facility can often be addressed by a transparent and genuinely local consultation process. Objections from a state or national agricultural or conservation lobby group require a different analysis and response.
3. Sustainability issues arising directly from the bioenergy (and biofuel) value chain are reasonably well-defined and understood.
4. Significant expansion of the industry can create important sustainability issues such as competition with food production, indirect land use change, and landscape scale impacts on water, biodiversity and social values. Non-linear changes in biological impacts and ecosystem function may occur when scale thresholds are crossed. In addition, the social, economic and biophysical impacts are cumulative, and in many cases, non-linear.
5. Indirect effects are difficult to address by the bioenergy industry or local jurisdiction alone, because the impacts can be manifest elsewhere, and frequently have multiple exacerbating causal factors (for example, the food v fuel issues). They are complex, difficult to analyse and the subject of ongoing debate.
6. There are many direct stakeholders, and broader communities of consent, with legitimate interests in the development of individual bioenergy projects, and in the non-additive effects of major expansion of the industry. Effective ways are needed to engage them in transparent and robust processes for achieving sustainability. This is a necessary condition for a community license to operate. An effective social process will provide critical enabler to industry expansion, or alternatively may show that this is not an acceptable outcome for the community.

In the following chapter, we turn our attention to the international responses to the sustainability issues raised in this chapter.

3 International developments in bioenergy sustainability frameworks

Chapter Summary

Institutional systems including mandated targets and financial incentives – especially for biofuels – have driven rapid industry expansion globally. This has led to serious questions over the true sustainability credentials of biofuels. Sustainability assessment systems are now being developed, and institutional systems are now being used to set sustainability standards and targets.

Review of international approaches

Different approaches have been taken in terms of institutional systems in different regions, at different scales (transnational through to regional). The institutional systems reviewed in this chapter are illustrated in the top half of Figure 3-1, and include a range of transnational, national, regional and industry scale approaches. A few sustainability assessment systems are also under development. In this chapter, we review two industry based systems (for soy and palm oil), as well as those under development by transnational organisations (e.g. Roundtable for Sustainable Biofuels, Global Bioenergy Partnership) or at national levels (e.g. the Cramer approach in the Netherlands). These are shown in the bottom half of Figure 3-1. In many cases there are feedbacks and interactions between the different components of the system and these are also described.

The key literature reviewed in this chapter, and its relevance to Australia, is summarised in Table 3-1.

Conclusions and key messages

The conclusions and key messages from this chapter are summarised at the end of the chapter, as well as in the Executive Summary.

3.1 Introduction

In this chapter, we review the activities of a range of international organisations in the area of bioenergy (especially biofuel) sustainability frameworks. There has been an explosion in activity in the international arena since 2005, particularly as the production and/or use of biofuels in the USA, Brazil and the EU has ramped up rapidly.

The European Commission in their January 2008 proposal on the promotion of the use of energy from renewable sources stated:

> The Community has long recognised the need to further promote renewable energy given that its exploitation contributes to climate change mitigation through the reduction of greenhouse gas emissions, sustainable development, security of supply and the development of a knowledge based industry creating jobs, economic growth, competitiveness and regional and rural development (European Communities Commission, 2008).

This statement highlights the drivers for the rapid industry expansion in countries developing bioenergy and biofuels industries.

There has been a series of steps in the international development of bioenergy and biofuels sustainability. Initially, mandated targets – especially for biofuels – were set at international and national levels to provide certainty and some economic sustainability for investors. Together with various financial incentives, these stimulated a rapid rise in biofuel production. The unintended consequences of the industry expansion described in Chapter 2, however, have led to serious questions over the true sustainability credentials of these new and rapidly growing industries. Consequently, sustainability assessment systems are being developed, and institutional systems are now being used to set sustainability targets rather than just for industry stimulation.

Different approaches have been taken in terms of institutional systems in different regions, at different scales (transnational through to regional). The institutional systems reviewed in this chapter are illustrated in the top half of Figure 3-1, and include a range of transnational, national regional and industry scale approaches. A few sustainability assessment systems are also under development. In this chapter, we review two industry based systems (for soy and palm oil), as well as those under development by transnational organisations (e.g. Roundtable for Sustainable Biofuels, Global Bioenergy Partnership) or at national levels (e.g. the Cramer approach in the Netherlands). These are shown in the bottom half of Figure 3-1. In many cases there are feedbacks and interactions between the different components of the system and these are also described.

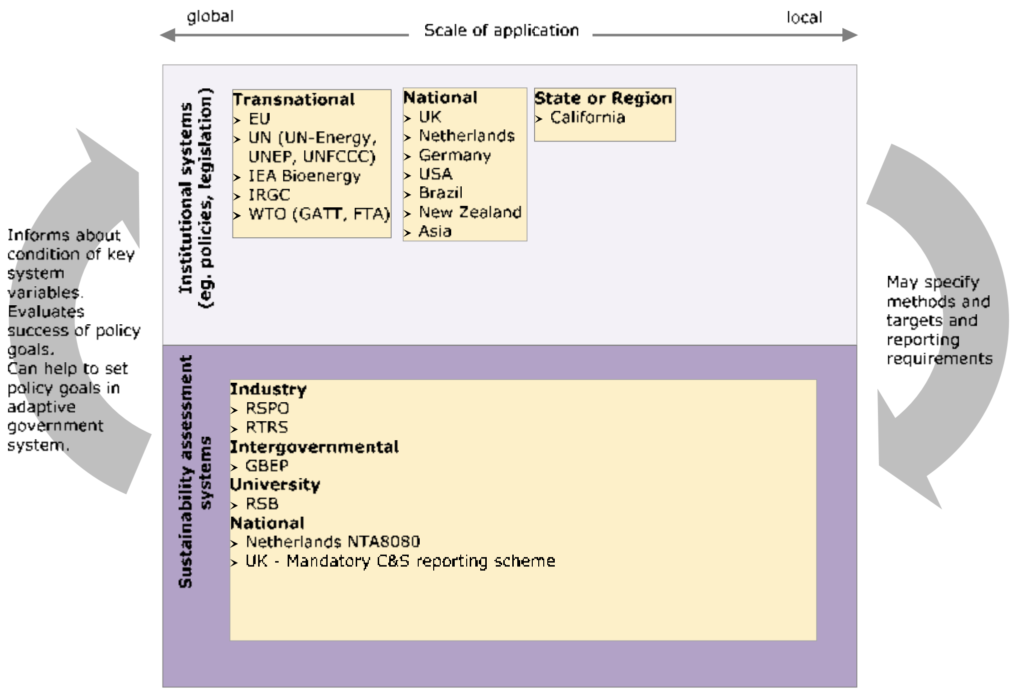

Figure 3-1 Components of the bioenergy sustainability framework reviewed in this chapter include institutional systems from transnational through to state or regional scale, as well as sustainability assessment systems.

3.2 Transnational organisations

The transnational organisations active in the consideration of sustainability in bioenergy and biofuels are divided into organisations that are global in their consultative processes – for example the United Nations (UN), the Global Bioenergy Partnership, the International Energy Agency's (IEA) Bioenergy, the Roundtable on Sustainable Biofuels (RSB) and the International Risk Governance Council (IRGC); the EU, a transnational organisation in that it provides an oversight for its Member States; and organisations such as the Round Table for Sustainable Palm Oil (RSPO) and the Roundtable for Responsible Soy (RTRS) that act and consult at a global scale on a product-specific basis.

3.2.1 The United Nations

Several UN agencies – UN-Energy, the United Nations Environmental Programme (UNEP) and the United Nations Conference on Trade and Development (UNCTAD) – are involved in working towards sustainability in bioenergy and biofuels. The output of their deliberations are available either directly through the publications of their own agency reports or indirectly through their input into organisations such as the École Polytechnique Fédérale de Lausanne (EPFL) Energy Centre's initiate, the RSB and the Global Bioenergy Partnership (GBEP).

3.2.1.1 UN-Energy

UN-Energy is a collaborative framework of all UN agencies working in the energy area. Their paper *Sustainable Bioenergy: A Framework for Decision Makers* (UN-E, 2007) is a document that identifies and addresses a wide range of issues, particularly those that will affect the poor in the developing countries that are moving towards new bioenergy industries. The paper identifies nine key sustainability issues in bioenergy development:

1. the ability of modern bioenergy to provide energy services to the poor
2. implications for agro-industrial development and job creation
3. health and gender implications
4. implications for the structure of agriculture
5. implications for food security
6. implications for government budget
7. implications for trade, foreign exchange balances, and energy security
8. implications for biodiversity and natural resource management
9. implications for climate change.

Each of the nine key sustainability issues is introduced in a broad or local context. Within that context, the issues that need to be addressed are identified and a course of action that needs to be taken is recommended with an outline as to how this should be implemented. For example, for the fifth issue (implications for food security), the issues of who are the hungry, and the impact of biofuels on food availability and access are addressed. In the section on implementation, the need to develop an analytical framework for both food security and bioenergy, the need to enhance agricultural productivity and need for food security to be given priority amongst the various policy domains are identified and discussed.

3.2.1.2 United Nations Environment Programme

The United Nations Environment Programme (UNEP) and DaimlerChrysler have been working together to set standards in biofuel blends and to develop sustainability criteria for the cultivation of biomass used for biofuels. For the second part of this endeavour, they formed a working group with the State of Baden-Wűrttemberg, Germany and have produced a working paper on developing sustainability criteria and standards for the cultivation of biomass used for biofuels (UNEP, 2007). The paper provides an oversight of how certification systems are set up and operate and a review of existing certification systems in forestry (4 systems reviewed), agriculture (5 reviewed), bioenergy for heat and electricity production (3 reviewed) and trade (1 reviewed). For each of the reviewed systems (e.g. the Forest Stewardship Council, or FSC), the structure of the organisation; its purpose; the criteria it covers (general, social, economic, ecological); how accreditation, certification and labelling is undertaken and audited; is set out. The value of this document is in its compilation of information on existing certification schemes.

These UN documents do not provide a specific structure for a sustainability framework but they do provides a global picture of the many issues that will affect the development of bioenergy industries in developing countries. Their relevance for the development of a sustainability framework for Australia is that they identify issues that should be considered when assessing the sustainability and certification of biofuels that may be imported into Australia.

3.2.1.3 The Global Bioenergy Partnership

The Global Bioenergy Partnership (GBEP) was launched in May 2006 to implement the G8 Gleneagles Plan of Action to support 'biomass and biofuels deployment, particularly in developing countries where biomass use is prevalent'. There are close links between the United Nations and the GBEP, with the GBEP Secretariat hosted at the Food and Agriculture Organisation of the United Nations (FAO) headquarters in Rome.

One of the GBEP's objectives is 'to suggest rules and tools to promote sustainable biomass and bioenergy development'. In light of this, the GBEP Task Force on Sustainability is currently working to develop a set of global science-based criteria and indicators for the sustainability of bioenergy. The Task Force describes the scope, purpose and use of the criteria and indicators as:

> This work is intended to provide relevant, practical, science-based, voluntary sustainability criteria and indicators to guide any analysis undertaken of bioenergy at the domestic level. The criteria and indicators themselves, when made part of such analysis, should be used with a view to informing decision-making and facilitating the sustainable development of bioenergy and, accordingly, shall not be applied so as to limit trade in bioenergy in a manner inconsistent with multilateral trade obligations.

This project is progressing with the intention of reporting to the G8 Summit in April 2010.
GBEP has produced two documents of interest to this review. The first, *A Review of Current State of Bioenergy Development in G8 + 5 Countries* (GBEP and FAO 2008; AO 2008) provides information on the development of bioenergy in the thirteen countries that it covers, including the drivers, policies, production, trade and consumption of bioenergy, although at the rate of global development of bioenergy much of this information would now be out of date. The second GBEP document is an inventory of current initiatives on sustainable biofuel development (GBEP and FAO 2008) which lists relevant initiatives by country.

3.2.1.4 United Nations Framework Convention on Climate Change (UN-FCCC) and Kyoto Protocol (KP)

The United Nations Framework Convention on Climate Change (UN-FCCC) is not a central player in bioenergy per se, because it is focussed more broadly on climate change. However the carbon accounting rules for bioenergy are clearly specified here, and it is therefore important to understand the role of this organisation in bioenergy sustainability. The Parties to the United Nations Framework Convention on Climate Change and Kyoto Protocol account for bioenergy greenhouse gas emissions in accordance with guidelines prepared by the Intergovernmental Panel on Climate Change (IPCC). Under these guidelines, Parties are liable for methane and nitrous oxide emissions from biomass combustion (IPCC, 1996), as well as for carbon-dioxide emissions from combustion of peat, which is treated as a fossil fuel (IPCC, 2006a).

Carbon-dioxide emissions from combustion of biomass other than peat are reported but not included in national totals. This approach is based on the assumption that net atmospheric carbon-dioxide flows from biomass are either zero or are accounted elsewhere in national greenhouse gas inventories (IPCC, 1996). These assumptions do not necessarily hold for imported bioenergy or where national accounts do not cover all lands from which bioenergy feedstocks are sourced.

In addition, IPCC guidelines recommend that capture and storage of biomass emissions in geological formations should be credited as 'negative emissions' (IPCC, 2006b).

Separate provisions apply to Clean Development Mechanism projects undertaken in developing countries. For these projects, the developer must demonstrate that biomass derives from a renewable source in order to be able to generate credits for sale in the international carbon market.

3.2.2 IEA Bioenergy

The International Energy Agency (IEA) Bioenergy was established in 1978 to foster cooperation between countries that have national programmes in bioenergy research, development and deployment. It provides a structure for collective effort to avoid duplication of research, standardise methods, disseminate information and build some common understanding in the field of bioenergy. Membership currently consists of 22 countries, including Australia plus the European Commission.

The work program for IEA Bioenergy is divided up into tasks, identified as Tasks 29 to 42. Although several of the Tasks make some reference to sustainability, Task 40, Sustainable International Bioenergy Trade – Securing Supply and Demand, is the task of most relevance to this review. One of the aims of this task is 'to evaluate the political, social, economic and ecological impact of biomass production and trade, and develop frameworks to secure the sustainability of biomass resources and utilisation'. Other Tasks, such as Task 38 (Greenhouse gas balances of biomass and bioenergy systems) provide technical and policy information for some of the basic processes to evaluate key sustainability issues such as GHG balance.

A significant output of Task 40 is the 2006 report by Jinke van Dam and others, *Overview of recent developments in sustainable biomass certification* (van Dam et al., 2008). This provides a very comprehensive coverage of the initiatives at the time of preparation of the report, listing all the key organisations – international and national governments, non-government organisations (NGOs), and energy companies, as well as their focus and activities. The report also addresses the limitations to biomass certification and strategies for implementation, finally providing a useful list of recommendations on the development of a certification system.

IEA Bioenergy will remain an active and important initiative in relation to addressing key opportunities for bioenergy industry expansion as well as linking policy development to address ongoing and new issues (e.g., response to indirect land use change).

The recently released 2010 – 2016 Strategic Plan for the IEA Bioenergy (IEA Bioenergy, 2009) specifically aims to meet the following objectives:

1. Promote the market deployment of technologies and systems for sustainable energy production from biomass
2. Understand the potential for bioenergy to reduce greenhouse gas (GHG) emissions, and to identify and promote best practice solutions which lead to significant GHG savings
3. Advise policy and decision makers by providing scientifically sound and politically and commercially independent data and information
4. Support policy development and deployment in Member Countries, and more widely, by communicating effectively with the relevant IEA bodies, industry, other key stakeholders in the IEA Technology Network, and other interested parties
5. Actively encourage the maintenance and development of networks of participants involved in research, development, demonstration, deployment, and education, and to provide for the effective dissemination of information on bioenergy
6. Increase the involvement of industry in IEA Bioenergy
7. Increase membership with emphasis on countries with a significant bioenergy RD&D infrastructure and appropriate policies
8. Increase interactions with other global, multilateral energy and environmental programmes.

IEA Bioenergy is striving to assist policy makers by increasing the connection between technical work and potential outcomes. And the organisation is specifically looking to engage more widely across the bioenergy value chain with other 'global, multilateral and environmental programmes'. From the current and newly proposed Tasks IEA Bioenergy, through the objectives outlined above, are aiming to meet their Vision of:

"*achiev[ing] a substantial bioenergy contribution to future global energy demands by accelerating the production and use of environmentally sound, socially accepted and cost competitive bioenergy on a sustainable basis, thus providing increased security of supply whilst reducing greenhouse gas emissions from energy use*".

Through its ongoing involvement Australia is a significant supporter of the IEA Bioenergy activities. Bioenergy Australia is the vehicle for Australia's participation in IEA Bioenergy.

3.2.3 Roundtable on Sustainable Biofuels

The Roundtable on Sustainable Biofuels (RSB) is an initiative of the Swiss university, EPFL, whose Energy Centre set up the RSB, 'bringing together farmers, companies, non-governmental organizations, experts, governments, and inter-governmental agencies concerned with ensuring the sustainability of biofuels production and processing'. The RSB's aim is to 'develop a standard for sustainable biofuels production through an international consultation process'. In August 2008, RSB released the first draft of its proposed principles and criteria in a paper *Global principles and criteria for sustainable biofuel production: Version Zero* (EPFL, 2008). This is the product of twelve months of global stakeholder discussion in working groups, expert groups and face-to-face meetings under the International Social and Environmental Accreditation Labelling Alliance (ISEAL) Code of Practice for Standard Setting to ensure equitable inclusion and transparency in the process. As with the UN agencies, the RSB is keen to utilise sustainability standards already in place and the draft standard has been based on previous work by the FSC, the RSPO, the Sustainable Agriculture network and other sustainable agriculture initiatives in order to align standards and reduce eventual reporting burdens as much as possible.

Version Zero is laid out in more detail in Appendix 1. It sets out twelve agreed principles, together with the criteria for each principle, and some key guidance comments. It does not include indicators. The principles, listed below with their associated criteria are:

1. Legality. Biofuel production shall follow all applicable laws of the country in which they occur, and shall endeavour to follow all international treaties relevant to biofuels' production to which the relevant country is a party.
2. Consultation planning and monitoring. Biofuels projects shall be designed and operated under appropriate, comprehensive, transparent, consultative, and participatory processes that involve all relevant stakeholders.
3. Greenhouse gas emissions. Biofuels shall contribute to climate change mitigation by significantly reducing greenhouse gas (GHG) emissions as compared to fossil fuels.
4. Human and labour rights. Biofuel production shall not violate human rights or labour rights, and shall ensure decent work and well being of workers.
5. Rural and social development. Biofuel production shall contribute to the social and economic development of local, rural and indigenous peoples and communities.
6. Food security. Biofuel production shall not impair food security.
7. Conservation. Biofuel production shall avoid negative impacts on biodiversity, ecosystems, and areas of high conservation value.
8. Soil. Biofuel production shall promote practices that seek to improve soil health and minimize degradation.
9. Water. Biofuel production shall optimize surface and groundwater resource use, including minimizing contamination or depletion of these resources, and shall not violate existing formal and customary water rights.
10. Air. Air pollution from biofuels production and processing shall be minimized along the supply chain.
11. Economic efficiency, technology, and continuous improvement. Biofuels shall be produced in the most cost-effective way. The use of technology must improve production efficiency and social and environmental performance in all stages of the biofuel value chain.
12. Land rights. Biofuel production shall not violate land rights.

The Roundtable on Sustainable Biofuels (RSB) acknowledges that the standard that they are developing only addresses the unintended consequences of the direct activities of the biofuels production chain. There is awareness amongst RSB global stakeholders of the indirect impacts of macro-economic policies, subsidies, trade barriers, market interactions in food, fodder and fuel, and land use change within a developing biofuels industry. RSB sees the minimization of indirect impacts as governments' responsibility and intends, through a consultative process with governments, international agencies and others over the next year, to establish an understanding of the indirect effects of biofuels production and how they can be measured and controlled.

RSB proposes that the standard that it develops be universally applicable to the production of all biofuels. It is acknowledged that it will be necessary to balance the aspirational parts of the standard with business realities and that 'small producers may have difficulty complying with some criteria'. There is also recognition that it may be difficult for governments to implement the standard within their own national sustainability framework for biofuels. Certainly, RSB's use of prescriptive language in the principles suggests that these are 'non-negotiable' which, combined with their aspirational nature, is likely to make it very difficult for industry either to accept or fully implement them.

RSB sought global stakeholder feedback on Version Zero which has been completed with input from individuals and organisations from over forty countries. RSB is currently using this input to develop Version One, with a view to having a certification system implemented in 2010.

3.2.4 International Risk Governance Council

The International Risk Governance Council (IRGC) is an independent organisation based in Switzerland that uses scientific knowledge and expertise from international sources to examine emerging global risks and to formulate recommendations for the governance of these risks. In 2008 the IRGC released a report titled *Policy Brief: Risk Governance Guidelines for Bioenergy Policies* (IRGC, 2008).

The IRGC report provides a precautionary perspective, warning policy makers of the issues, impacts and potential problems associated with the development of a bioenergy industry. Much of the report is devoted to identifying the risks and areas of potential failure in governance. These include:

- environmental risks to biodiversity, ecosystem services, water quality and quantity, soil health, and air pollution, as well as risks from GHG emissions and the development of genetically modified organism (GMO) energy crops
- social risks in food security, land rights, and employment, and the public concern regarding the sustainability and environmental impacts of bioenergy production
- economic risks including rising food prices and the inappropriate use of mandates, subsidies and other economic instruments that can create market distortions and other inequities
- opportunity costs, as the IRGC sees inadequate accounting for opportunity costs as a general risk and believes that bioenergy should only be developed where it is the best option for using the resources
- unrealistic expectations (by governments and others) in the potential of bioenergy which may lead to the setting of targets and development trajectories that are unsustainable
- inappropriate resolution of trade-offs with food and competition for land both locally and globally
- poor governance in ecosystem management, including use of water resources and deforestation
- underestimations of the direct and indirect effects of bioenergy production on GHG emissions and climate change
- short-term policies that can hinder future improvements in bioenergy technologies;
- inappropriate use of the precautionary approach. Although this is an approach favoured by the IRGC when managing risks which have high levels of uncertainty, the IRGC warns that it can be used inappropriately (e.g. application of a total ban on the use of food crops for bioenergy). Uncertainty should be reduced as much as possible through the use of life cycle assessments (LCAs) and environmental impact assessments (EIAs) with a subsequent reduction of risk. The precautionary approach is then only applied to the residual risk
- failure of governance to properly implement adaptive management to manage risks and foster improvement, or to design policies that can effectively be implemented across the full range of stakeholders and circumstances.

The value of the IRGC report for those proposing to develop a sustainability framework for bioenergy is in that it provides a checklist of the risks and potential areas of failure of governance and, the IRGC suggestions as to how these may be handled.

3.2.5 European Union

In September 2007 the European Parliament, in its Resolution on the Roadmap for Renewable Energy in Europe, requested that the Commission of European Communities prepare a proposal for a renewable energy legislative framework including targets for the shares of renewable energy sources for the EU and Member States. The eventual outcome of this was the adoption in April 2009 of the *Directive of the European Parliament and Council on the promotion of the use of energy from renewable sources* (European Parliament, 2009). Some information from the Directive is set out below:

- The Directive sets the objectives of increased use of energy from renewable sources as part of a package of measures to meet Kyoto and Community commitments to reduced GHG emissions with the additional benefits of security of (energy) supply, economic growth, employment and regional and rural development.

- The Directive sets binding targets for the whole community and individual Member States so as to provide certainty for investors of a ‘mandatory target of a 20% share of renewable energies in overall community energy consumption by 2020 and a mandatory 10% minimum target for to be achieved by all Member States for the share of energy from renewable resources in transport petrol and diesel consumption by 2020’ in the context of a target of 20% improvement in energy efficiency by 2020.
- The Directive gives strong emphasis to the requirement for biofuel production to be sustainable. Paragraphs 65 to 85, inclusive, all refer to sustainability principles, processes, guidelines, and needs for further action over the next 1-2 years to remedy existing deficiencies.
- The Directive (Paragraph 76) recommends the biofuels and bioliquids that meet sustainability criteria command a premium price, compared to those that do not, in order to encourage those in the market to implement change to meet the criteria. In addition, to promote the development of new technologies, Article 21 (2) states that the contribution made from biofuels produced from residues and non-food lignocellulose counts as twice that of other biofuels in meeting national targets.
- The Directive (Paragraph 85) states in part, ‘The Commission shall develop a concrete methodology to minimise greenhouse gas emissions caused by indirect land use changes’. A measure to reduce use of agricultural land that could potentially lead to indirect land use change has been initiated through an incentive to use degraded and contaminated land, unsuitable for agriculture. Annex V provides a calculation for the incentive bonus of 29 gCO_2eq/MJ to be subtracted in calculating the GHG emissions for biofuels produced from biomass obtained from (defined) degraded and contaminated land.
- Article 17 (Environmental sustainability criteria for biofuels and other bioliquids) outlines a set of ‘sustainability criteria’ [(17 (2) to 17 (6)]. The sustainability directives are a mixture of broad principles, hard targets, and rules/guidelines. Some components are mandatory and others voluntary initially, but with the intention to move toward more rigorous implementation. Member states are requested to find their own way of meeting some of the requirements. Some directives apply only to the national scale, but as discussed below many apply to the finer project scale. These are initially very loose arrangements, there being no agreed evaluation processes or agreed outcomes. Compliance issues are dealt with in Article 18, and Article 19 provides a methodology for calculating (including provision of defaults) GHG impacts.
    - 17 (1) states that the sustainability criteria set out in the Article must be met for biofuels and bioliquids derived from raw materials cultivated *inside* or *outside* the community to be eligible for inclusion in mandated national targets, compliance with renewable energy obligations or financial support schemes.
    - 17 (2) sets the GHG emission savings from the use of biofuels and other bioliquids at ‘at least 35%’, rising to 50% from 1 January 2017 and 60% for post 1 January 2017 installations. Whilst these targets are arbitrary (one could argue that lower targets should also be acceptable if other important objectives, such as fuel security or regional development, are also being met), they are clearly designed to encourage transition from first- to second-generation biofuels over time. A methodology is provided for calculating GHG emissions savings, including defaults for common biofuel production pathways. Importantly, the effects of land use change (that can lead to emissions from biomass and soil carbon over an extended period of time) are included.
    - 17 (3) directs that land with high biodiversity (including grasslands) should not be converted for biofuels production. This refers to some grasslands and shrublands, native forests where there is no clear evidence of human activity, and nature conservation areas. Assessment would be complex for some of these situations. In Australia, non-forested native vegetation (including grassland) on low productivity lands may not be protected under State Government regulations, and this criterion may be relevant for second-generation biofuels produced in Australia in the future.
    - 17 (4) directs that land with high carbon stocks (as defined in Article 17 (4)) should not be converted for biofuels production. This refers to wetlands, continuously forested areas, or woodland with low tree canopy cover. However, these areas are exempt provided that the GHG emissions reduction targets are still met after emissions from conversion are taken into account. The intent of this criterion is to minimise emissions from organic soils and from dense forests.

- 17 (5) directs that biofuels shall not be made from raw material obtained from land that was peatland in January 2008, unless the production of the raw material does not involve drainage of previously undrained land.
- 17 (6) directs that agricultural raw materials cultivated in the community and used for the production of biofuels must be obtained in accordance with specified EU regulations for good agriculture and environmental condition. Although currently applied only to cultivation in the EU, application of such a criterion to biomass from other countries would raise significant issues in Australia where there are very limited formalized sustainability requirements for agriculture (section 4.7.1.2). This is a very important issue for Australia in the future because much of the future production of feedstocks for biofuels are likely to be derived from new plantings (woody and non-woody) on existing agricultural land.
- 17 (7) puts the onus on the Commission, rather than on Member States, to report every two years on measures taken in respect to the sustainability criteria outlined above. Significantly, it should also report on protection of soil, water and air – these are not mandatory with their own specific criteria at the moment. The Commission should also report on the effects of increased demand for biofuels on a range of social sustainability measures (food prices, development issues, land use rights, labour issues, biosecurity, trade in endangered species etc.). The first report is due in 2012.
- 17 (8) makes it clear that biofuels eligible for inclusion in national targets through meeting the sustainability requirements of the Directive cannot be considered ineligible by Member States on *other* sustainability grounds.
- The sustainability criteria as set out in Article 17 can be considered as the minimum required by the European Union (EU) for the sustainable production of biofuels and bioliquids, However, in order to avoid the possibility of sustainability criteria inhibiting trade in biofuels and bioliquids between Member States, Article 17 (8) in effect makes these sustainability criteria the maximum that can be applied.

- Article 18 (Verification of compliance with the environmental sustainability criteria for biofuels and other bioliquids) provides further explanation for Member States on these criteria adding the requirement for Member States to record measures taken for soil, water and air protection, restoration of degraded lands and the avoidance of excessive water consumption. Feedstock suppliers are to use a mass balance approach to demonstrate that the sustainability criteria have been met. Member states are to devise a method to demonstrate adequate independent audit of the information supplied.
- Article 18 (4) suggests that the Community may accept voluntary schemes of third countries (i.e. not Member States) that 'demonstrate that consignments of biofuel comply with the sustainability standards set out in Article 17 (3) to (5)'.
- Article 18 (9) requires reporting by the Commission to the European Parliament by 31 December 2012 on the effectiveness of the system and whether mandatory requirements for air, soil and water protection should be added.
- Article 24 states that the Commission will establish an on-line transparency platform to make information on the sustainability of biofuels publicly available.

The annexes to the Directive set out the 2020 targets for the individual Member States with an indicative trajectory; agreed energy content of transport fuels; specifications for 7% and 10% biodiesel blends; the default values for GHG emission savings for biofuels; and the methodology to be used to calculate the GHG emissions from the production and use of transport fuels, biofuels and bioliquids.

Within the Directive, the Commission announced that it would undertake an analysis of a sustainability scheme for the sustainable management of biomass resources other than biofuels and other bioliquids by the 31st December 2009.

In response, the Biomass Technology Group (BTG) produced a report titled *Sustainability Criteria and Certification Systems for Biomass Production* (BTG, 2008), an in-depth analysis of existing biomass production sustainability criteria and certification systems with the objective of providing 'a basis upon which the Commission's services could decide which actions to undertake in view of proposing minimum sustainability criteria and certification systems for the production of biomass in the EU and imported biomass'. The methodology used in the analysis is set out in Annex B of the BTG report, providing a theoretical framework for the concept of sustainability criteria and certification systems.

The scope of the report was limited to an analysis of the minimum set of sustainability criteria of biomass production based on energy crops and forestry operations in the EU. By excluding the traditional agricultural activities on crops for food/fodder production, the EU's proposals for minimum sustainability criteria should not conflict with the EU's international agricultural trade commitments, especially the General Agreement on Tariffs and Trade (GATT) under the World Trade Organisation (WTO).

The report consists of a literature and policy review of the EU Member States, Non Government Organisations (NGOs) and international organisations; an overview of existing certification systems; an analysis of barriers, in particular those associated with WTO agreements, the Technical Barriers to Trade (TBT) agreement and the General Agreement on Tariffs and Trade (GATT) 1994; an examination of the wider issues – land availability for food/material/energy, EU energy security and Kyoto obligations etc.; and conclusions and recommendations for the EU.

The study reaches the following conclusions:

- Many of the policy makers – the European Parliament, national initiatives, international working groups and a number of NGOs – advocate certification of biomass to ensure GHG emissions reductions and production of biomass in a social and environmentally sustainable way, expressed in various concept sets of principles, criteria and indicators. However, some NGOs are sceptical of the effectiveness of certification systems.
- Although no forest certification systems were found to take into account GHG balances, forest certification systems such as the FSC and the Programme for the Endorsement for Forest Certification (PEFC) show how criteria development can take place and can act as examples when developing sustainability criteria.
- The forest certification systems show how the independence and procedures of third-party certification bodies can be secured by the use of ISO standards and can also provide a basis for estimating the costs for biomass certification.
- Obligatory sustainability criteria and certification systems are possible, but will not control the effect of biomass production on competition with food and indirect land use changes, for which additional measures will be required. They can at best effectively guarantee GHG savings and protection of biodiversity and the local environment.
- As voluntary biomass certification systems do not effect WTO agreements to the extent that an obligatory certification system would, stricter criteria can be formulated and the system extended to cover social issues such as the rights of indigenous people.
- EU wide obligatory sustainability criteria can be seen as a good starting point towards sustainable use of biomass, with potential to influence the agricultural sector.

The report concludes that the EU sustainability criteria should be regarded as *minimum* criteria to ensure that rational carbon savings are achieved and major environmental impacts avoided and recommends that the EU proceed with the development of its minimum biomass criteria and create the necessary conditions so that the market develops certification systems using the minimum sustainability criteria and eventually additional voluntary sustainability criteria.

3.3 National governments

3.3.1 The United Kingdom

In April 2008, the UK Government commenced the Renewable Transport Fuel Obligation Order 2007 (RTFO) which is intended to reduce the GHG emissions from road transport by encouraging the supply of renewable fuels. The initial target was that at least 2.5% of the total amount of road transport fuel in 2008/09 should biofuel. The UK Government proposed and has implemented a reporting framework that covers both the net GHG savings and the sustainability of biofuels. The government's stated aims are to reward biofuels under the RTFO in accordance with the carbon savings they offer from April 2010 and, from April 2011, only those produced from feedstocks that meet appropriate sustainability standards. Biofuel suppliers will be required to meet the reporting requirements in order to participate in the incentive scheme (i.e. to receive Renewable Transport Fuel Certificates, or RTFCs). The scheme is run by the Office of the Renewable Fuels Agency (RFA).

During the development of the scheme, advisory reports were prepared for the UK Department of Transport that cover both pillars of the reporting scheme – GHG savings (E4tech, 2007) and sustainability (ECOFYS, 2007).

The result of this development process is the Department of Transport's January 2008 document *Carbon and Sustainability Reporting Within the Renewable Transport Fuel Obligation: Requirements and Guidance. Government recommendations to the Office of the Renewable Fuels Agency* (Department of Transport, 2008). It contains all the information required for the RFA to implement the monthly and annual reporting scheme. Annexes A–J and Part Two: Carbon Reporting default values and fuel chains provide supporting information for the reporting process and the relevant data to be used in calculating the carbon intensity of a fuel chain.

In summary:

- The British Government sees this mandatory carbon and sustainability (C&S) reporting scheme with its element of voluntary information, as a stepping-stone towards a mandatory assurance scheme (i.e. a scheme in which only those biofuels meeting all the C&S criteria can be sold). Suppliers will be required to report monthly if they wish to claim RTFCs, but initially may report that they do not have information on the sustainability etc. of their biofuels.
- The RFA will require annual, independently verified reports from suppliers applying for RTFCs. Fuel suppliers that fail to meet their obligation under RTFO to supply renewable transport fuels or purchase RTFCs from suppliers with surplus RTFCs will be required to pay a buy-out penalty.
- Targets have been set for three key aspects of the reporting scheme. For 2008/09, these are: a) the percentage of feedstock meeting a Qualifying Environmental Standard to be 30%; b) the annual GHG saving of fuel supplied expressed as a percentage to be 40%; and c) the amount of data in the reporting of renewable fuel characteristics to be 50%. These targets are not mandatory, but are indicative of what the government expects from fuel suppliers. Currently, they are set to increase up to 2011.
- The British Government recommends that the RFA publish reports on the performance of individual suppliers and makes information available to consumers that can inform their purchasing decisions.
- The British Government sees the principal environmental and social risks arising where feedstocks are produced (i.e. at the plantation). The RFA should require suppliers to focus on this part of the supply chain.
- A 'meta-standard' approach is used under which existing voluntary agri-enviromental and social accountability schemes or standards, such as that developed by the FSC, are benchmarked against an RTFO Sustainable Biofuel Meta-Standard. Benchmarking is carried out against the criteria and indicators and the auditing quality of the standard being considered.
- The use of defined by-products and residues for the production of biofuels will not require sustainability reporting but will still require carbon reporting.
- Validation of the C&S reports will be verified using a chain-of-custody or mass-balance approach.

This Carbon and Sustainability Reporting scheme has several attributes to note:

- The scheme has been developed and implemented with the recognition that it is a stepping-stone. Initiating the implementation of the scheme as such should identify gaps where data is currently not available, where research may be required and where environmental and social sustainability will need to improve.
- Although a mandated reporting scheme, it allows biofuel suppliers some voluntary reporting and use of default figures when information is not yet available. This initial voluntary aspect of the scheme should allow it to operate without restricting trade or triggering WTO provisions as would likely happen with a fully mandated assurance scheme.
- The aim to reward biofuels according to carbon savings and meeting appropriate sustainability criteria should encourage biofuels suppliers to improve the carbon savings along the biofuels production chain, properly address sustainability criteria and provide better reporting data.

The RFA has released monthly and quarterly reports on fuel supplied under the RTFO. The most recent report, the twelfth, covers the year April 2008 to April 2009 (Renewable Fuels Agency, 2009) Over the 12 month period, 24% of biofuels met environmental standards (target 30%) and GHG savings of 47% were achieved (target 40%). This figure excludes emissions from indirect effects.

Even as the C&S reporting scheme under the RTFO was being implemented, new evidence was emerging on the displacement effect of biofuels on land use and the impact of this on GHG savings (Searchinger, 2008). In recognition of this, the UK Government requested that the independent RFA undertake a review 'to specifically examine emerging evidence of the indirect effect of biofuels'. The outcome of this is the July 2008 *Gallagher Review of the indirect effects of biofuels production* (Gallagher, 2008).

The main driver of the UK Government's support of biofuels through the RTFO is the desire to reduce net GHG emissions in the transport sector. Studies have shown that the use of biofuels from feedstocks produced without land use change, can reduce GHG emissions. For example, current European biodiesel technologies achieve 40–50% reductions compared to conventional diesel. However, where the production of biofuels leads directly to land use change (e.g. deforestation for biofuel feedstock plantings) or indirectly (e.g. biofuel feedstock plantings on existing agricultural land leading to deforestation for new agricultural land), then the GHG emissions associated with the land use change (release of soil carbon and the loss of above ground carbon in vegetation and litter) can negate any benefits in GHG reduction from the use of biofuels. Calculations undertaken by E4Tech as part of the Gallagher Review estimate that in the UK, bioethanol from wheat without land use change would give a GHG saving of 28%, but if its production led to cultivation of set-aside grassland it would take 20 to 34 years to pay back the carbon released due to land use change. The Review notes that 'GHG savings will be better where biofuels are grown on rotational rather than permanent set aside or fallow land'.

Direct land use change in the production of biofuels have been addressed in sustainability frameworks and policies, for example the EU's Directive which sets minimum sustainability criteria. Dealing with and quantifying indirect land use is more difficult.

As the Gallagher Review states:

> The boundary of life cycle GHG calculations for biofuels needs to be extended to include:
> - The well to wheel GHG emissions of the biofuel;
> - Emissions arising with direct land use change;
> - Emissions arising from indirect land use change (including effects arising from substitution of waste or residue feedstock used in other applications – such as tallow); and
> - Avoided indirect emissions from the use of co-products.
>
> This is a significantly more complex calculation than is currently used but is necessary to reflect a realistic view of the overall lifecycle GHG-emissions of biofuels.

Refer section 5.5.3 for more information.

Two methods of quantifying the effects of land use change, one using partial equilibrium modelling, the other a deterministic approach are reviewed with the comment that both contain uncertainties, rely on assumptions and are not suitable as regulatory tools. In the absence of quantitative assessments that can ensure biofuels with good GHG savings, the Review suggests that 'more prescriptive approaches constitute an appropriate risk management measure.'

In addition to the indirect effects of biofuel production on GHG emissions, the Review considered land availability, the drivers of land use change, reducing pressure for land use change, commodity prices and food security, new technologies and how the large areas of uncertainties on the overall impacts and benefits of biofuels should be addressed.

The conclusions and recommendations are a combination of general points to be applied at a global level and more specific points that address EU and UK biofuel policies. For example, 'a lower EU 2020 target is proposed in recognition of indirect land use change and absence of adequate control measures.' Following is a brief summary of the general conclusions of Gallagher Review:

- A slowdown in the growth of biofuels is needed. The introduction of biofuels should be significantly slowed until adequate controls to address displacement effects are implemented and are demonstrated to be effective.

- There is probably sufficient land for food, feed and biofuels on current estimates up to 2020. Feedstock production for biofuels must avoid agricultural land that would otherwise be used for food production.
- Biofuels production must target idle and marginal lands and the use of wastes and residues.
- Specific incentives must stimulate advanced technologies as they have the potential to produce biofuels with higher GHG savings and are able to use a wider range of feedstocks including residues. However, some new technology feedstocks (e.g. oil mallee plantings) may result in more indirect land use in the absence of coproducts. The use of coproducts from first-generation technologies as animal feed, will avoid some use of additional land to provide animal feed.
- Biofuels contribute to rising food prices of some commodities, notably corn products and oilseeds, that adversely affect the poorest. Lower targets and shifting production for biofuels away from food producing land should reduce price rises on affected food commodities.
- A genuinely sustainable industry is possible provided that robust, comprehensive and mandatory sustainability standards are developed and implemented.
- Lower targets, flatter trajectories (i.e. a slower build up in the amount of biofuels produced) and stronger controls are needed. The Review recommended that volume or energy based targets be replaced with comparable GHG saving targets to drive the production and supply of fuels with lower carbon intensities. However, it will require improved methodologies to allow the wider boundaries in GHG life cycle analysis as stated above, to support this recommended change in targets.
- Stronger, enforced global policies are needed to prevent deforestation particularly in South America, Africa and parts of South East Asia.
- Sustainability standards should be extended to all agricultural production.

Taken as a whole, the Review's conclusions and recommendations, although mainly aimed at EU and UK policies, form the beginnings of a framework to deal with the indirect effects of biofuel production – although significant uncertainties remain.

3.3.2 The Netherlands

The Netherlands, like the UK, is active in developing renewable energy policy including ways of ensuring the sustainability of both locally produced and imported biomass for energy production. A significant consultative process was conducted to produce a report to the Dutch Government titled *'Testing framework for sustainable biomass'* (Cramer, 2007). Appendix B lists 95 organisations that participated in consultative meetings. This report sets out and recommends a testing framework based on:

- the identification of six themes that determine the sustainability of biomass – GHG emissions, competition with food and local applications of biomass, biodiversity, environment, prosperity and social well-being
- the development of these themes into nine principles and twenty five criteria. Each criterion is matched with an indicator or, where it was not possible to develop a testable indicator, a reporting mechanism has been recommended.

This report is a significant document because – as well as setting out the agreed themes, principles, criteria, indicators and methodologies to be used – it also provides an explanation of all the decisions taken during the process of developing the recommended testing framework.

In order for the framework to cover indirect effects caused by indirect changes in land use, the group has recommended reporting at a macro level be undertaken by the Dutch Government. It is emphasised that this will require cooperation from national and regional authorities in the biomass producing countries.

The Dutch Technical Agreement (NTA 8080, *Sustainability criteria for biomass for energy purposes*), released in March 2009 by the Centre of Standardisation, formalises the application of the principles, criteria and indicators developed by Cramer into a sustainability standard for biomass (NEN Centre for Standardization, 2009). The NTA applies the sustainability requirements to those organisations which produce the primary biomass. For the provision for GHG balance, the NTA applies to all organisations that belong to the whole bioenergy chain, from cultivation to end use. The NTA includes all the environmental, social and economic principles developed by Cramer, making the provisions of this Dutch standard significantly more stringent than those required in the EU Directive.

3.3.3 Germany

Germany is currently in the process of setting regulations for the sustainable production of bioenergy (electricity) and biofuels. The *Order on Requirements Pertaining to the Sustainable Production of Liquid Biomass for Generating Electricity (Biomass Flow Sustainability Order)* (Federal [German] Government, 2009) indicates the German response to the recently adopted Directive of the European Parliament on the use of energy from renewable sources for sustainable bioenergy and biofuels (see section 3.2.5). A similar German Order pertaining to biofuels, based on the Biofuels Quota Act is in preparation.

Basically, the Order sets the requirements for entitlement to remuneration per the relevant section of the Act on Renewable Energies – what the sustainability requirements are and the proof in terms of certification to show that they have been met.

The sustainability requirements are:

- protecting areas with a high natural value
- protecting areas with high stocks of carbon
- protecting peat bog
- sustainable agriculture based on current EC requirements
- GHG reduction according to the European Parliament's Directive targets
- other sustainable production, which adds the requirement from Article 18 of the European Parliament's Directive to record measures taken for soil, water and air protection, restoration of degraded lands and the avoidance of excessive water consumption.

Annexes setting the method for GHG calculations, the default values to be use etc. are a direct transposition from the annexes of the European Parliament's Directive.

In response to the need for proof in terms of certification, the Meo Corporation Development GmbH, financially supported by the Ministry of Food Agriculture and Consumer Protection, is undertaking the development of the International Sustainability and Carbon Certification (ISCC) system, which they describe as being practicable and implementable (Meo Corporation Development GmbH, 2009). Currently, there is little information on the proposed ISCC system.

3.3.4 United States of America

3.3.4.1 The Renewable Fuels Standard

Federally, the USA's emphasis has been on mandating the blending of renewable fuel to improve national fuel security. The *Energy Policy Act 2005* amended the *Clean Air Act* to establish a Renewable Fuel Standard (RFS) program. Following a transitional period, the US Environmental Protection Agency (EPA) established in 2007, a comprehensive national renewable fuel program (the RFS) to encourage the use of renewable fuels through blending with fossil fuels. In May 2009, in response to a requirement of the *Energy Independence and Security Act 2007* (EISA) that the RFS be modified, the EPA announced the proposed new regulations for the RFS program for 2010 and beyond (US EPA, 2009).

RFS2 has made a number of significant changes from the initial RFS. It has increased renewable fuel volume requirements, setting the total renewable fuel volume required for 2010 at 12.95 billion gallons (~ 49,000 ML), rising to 36.0 billion gallons (~ 136,000 ML) by 2022. It now divided the renewable fuels into four nested categories – renewable fuel, advanced biofuel, cellulosic biofuel and biomass-based diesel. Mandatory volumes, increasing each year up to 2022, together with mandatory GHG reduction thresholds have been set for each category. GHG emissions will be calculated on the full life cycle, from production of the feedstock to end use of the fuel including land use change then compared to the life cycle emissions of the replaced fuels (gasoline, diesel) at 2005. Life cycle GHG reduction thresholds have been set in the EISA as 20% for renewable fuel, 50% for advanced biofuel, 50% for biomass-based diesel and 60% for cellulosic biofuel. This includes the indirect LUC value in the emissions calculations.

Retained in RFS2 is an incentive scheme in the form of tradeable renewable identification numbers (RINs). This scheme is used not only to provide incentive, but also to track renewable fuels and determine compliance with the current EISA requirements. Each batch of renewable fuel has a unique RIN which carries the energetic value of the fuel. When the renewable fuel is blended, this sets the equivalency value of the blended fuel and the value of the RIN. Under the RFS, RINs can be traded between the regulated entities which are required to acquire a set number of RINs each year.

At this time, the value of a RIN is not dependent upon the GHG mitigation associated with the production of the renewable fuel or any other environmental or social criteria. There is however, an incentive to move to the production and use of cellulosic ethanol through the mandating of cellulosic ethanol as having 2.5 times the energetic content of starch-based ethanol.

3.3.4.2 California and the Low-Carbon Fuel Standard

The State of California, under Governor Schwarzenegger, is developing sustainable bioenergy as part of its renewable fuels program. In 2006, the Preliminary Roadmap for the development of Biomass in California (California Biomass Collaborative, 2006) recommended establishing processes for independent certification of sustainable practices in the production of biomass for bioenergy, including land and water use, environmental impacts, environmental justice, and resource and environmental monitoring.

In 2007, California proposed the establishment of the Low-Carbon Fuel Standard (LCFS), a GHG standard for transportation fuels with the aim of a 10% reduction in the carbon intensity of California's transportation fuels by 2020. The University of California, together with other agencies were requested to develop protocols to measure the life cycle carbon intensity of transport fuels and to consider possible trajectories in the reduction of the carbon intensity of California's transport fuels required to meet the 2020 target. A two-part report *A Low-Carbon Fuel Standard for California - Part 1: Technical Analysis* and *Part 2: Policy Analysis* has been prepared by a group from the University of California led by (the late) Alexander Farrell and Daniel Sperling (Farrell and Sperling, 2007a; Farrell and Sperling, 2007b).

Part 1, the technical analysis, uses scenarios of all the options with low-carbon fuels (biofuels, electricity, hydrogen, CNG) and vehicles (electric, hybrid, fuel cell etc) to assess how the LCFS targets may be met, identify possible trajectories and identify technical problems that require research. Part 2, the policy analysis, considers the specific policy issues needed to achieve the LCFS target, making numerous recommendations designed to assist in the development of the LCFS.

Building on the information contained in these reports, the Proposed Regulations to Implement the LCFS were released by the California EPA in March 2009 and, on the 23rd April 2009, the Californian Air Resources Board (ARB) adopted the Regulations (Air Resources Board, 2009). They are summarised below:

- The LCFS Regulations retain the original goal of a 10% reduction in the carbon intensity of California's transportation fuels by 2020.
- Under LCFS Regulations, fuel providers will be required to reduce the 'carbon intensity value' of their products. As a consequence, the carbon intensity values represent the currency upon which the LCFS is based. The carbon intensity represents the equivalent amount of carbon dioxide emitted from each stage in producing, transporting and using the fuel in a motor vehicle. The unit of measure is grams of carbon dioxide equivalent per megajoule of fuel delivered to a vehicle (gCO_2e/MJ).
- The LCFS will use market mechanisms to drive the introduction of low-carbon fuels based on a system of 'credits' and 'deficits'. Credits are generated from fuels with lower carbon intensity than the standard and may be banked or traded with the LCFS market. The seller of transport fuel (regulated party) meets compliance obligations by ensuring the amount of credits earned or purchased it equal to or greater than the amount of deficits.
- The carbon intensity is calculated in three parts: a) from the life cycle of production, transport, storage and use of the fuel (i.e. direct greenhouse gas emissions); b) the land use changes

associated with the production of biofuels; and c) the energy efficiency of the vehicle using the fuel.

- For example, ethanol from corn, processed through a Midwestern dry mill, with dry distillers grain as the coproduct, has calculated direct emissions of 68.40 gCO2e/MJ, plus an attributed indirect land use change effect of 30 gCO2e/MJ, giving a total of 98.40 gCO2e/MJ. This is greater than the carbon intensity value of gasoline at 95.86 gCO2e/MJ. On the other hand, California electricity has calculated direct emissions of 124.10 gCO2e/MJ. This assumes that there is no indirect land use change. Electric motors are much more efficient than internal combustion engines, and an 'energy economy ratio' (EER) of 3.0 is used to account for the efficiency improvement. This gives a final carbon intensity value of 41.37 gCO_2e/MJ.
- Farrell and Sperling (2007) identified the climatic effect of land use change as 'one of the most challenging issues in the implementation of the LCFS' and recommended that California 'participates in the development of an internationally accepted methodology for accounting for land use change'. In response to this challenge, the Global Trade Analysis Project (GTAP) model, originally developed by researchers at Purdue University to model complex international economic effects, has been extended to be used for land use change modelling.
- The regulations section on environmental impacts focuses on the reduction of GHG from the scheme. On other sustainability issues, the regulations list the sustainability issues associated with biofuels as conservation of high-carbon stock land, conservation of high-biodiversity land, air and water quality, soil conservation, use of genetically modified organisms, labour rights, environmental justice and food price and security. It is concluded that 'there is not enough information available to develop relevant and detailed sustainability strategy or standards' and suggests that a universally-accepted certification standard needs to be developed. The ARB will continue to work with other organisations to develop an appropriate sustainability strategy.

California's LCFS, as adopted (with its mix of low-carbon fuels, its application of EER to allow for and encourage improvements in vehicle technologies, its initial recognition of and allowance for the GHG emissions effect of indirect land use change, and its use of a market-incentive scheme to encourage change), offers potentially the most effective method of reducing the GHG emissions associated with transport. Unlike many others, California has not mandated a percentage of bioenergy or volume of biofuels, a practice that has the potential to affect sustainability practices in the production of bioenergies. Further development to address the direct impacts that can affect the sustainable production of bioenergy and biofuel either produced or imported into California, still need to be enacted.

3.3.5 Brazil

Brazil is a major producer, user and exporter of ethanol derived from sugar cane. Due to the influence of countries importing Brazilian ethanol, there are several publications that examine the sustainability of Brazilian ethanol (Smeets et al., 2006; Barber, et al., 2008; Walter, 2008).

In 2006, the Dutch commissioned a combined team from the Utrecht University, Netherlands and the State University of Campinas, Brazil to compare the Dutch sustainability criteria at that time with Brazilian production practices in the main sugar cane production area of Sao Paulo and the whole of Brazil. Many of the findings were unclear, although the GHG benefits easily met the Dutch criteria of net emission reduction of 30% in 2007.

A report for the New Zealand Energy Efficiency and Conservation Authority (AgriLINK NZ, 2008) took a broad definition of sustainability criteria to include total life cycle energy balance, a number of production, environmental and social parameters but did not include land use changes in GHG emissions due to limited and conflicting published data. Overall, the review concluded that bioethanol from Brazilian sugarcane is sustainable, although the assessment was qualified in a number of key areas, including working conditions and workers' rights. As with the Dutch study, the GHG findings were significant with the report stating that, 'Landed in NZ bioethanol compared to petrol, on an equal energy basis, will achieve GHG emission reductions of 74%...'.

In August 2008, SEKAB Biofuels and Chemicals, a company that imports Brazilian ethanol into Sweden, in conjunction with the Brazilian Sugarcane Industry Association (UNICA), announced the

Verifiable Sustainable Ethanol Initiative that aims to offer Swedish and other European consumers guarantees of the environmental and social sustainability of Brazilian ethanol (SEKAB, 2008). The SEKAB initiative sets requirements for sustainable ethanol, together with a verification process, including full traceability of all physical flows. The requirements address GHG emissions, working conditions, child labour, zero tolerance of felling of rainforests and ecological considerations. SEKAB claim that Brazilian companies delivering ethanol to the Swedish fuel E85 are compliant with the requirements.

3.3.6 New Zealand

The *New Zealand Energy Strategy to 2050* (Ministry of Economic Development, 2007) introduced a biofuels sales obligation (BSO). This was carried forward with the Biofuel Bill with the aim of making the New Zealand transport sector more environmentally friendly through the reduction of GHG emissions and to reduce dependence on imported oil. This came into force in October 2008.

During preparation of the Bill, the local government and environment committee took public submissions on the proposed Bill. As a consequence of these submissions, the committee recommended changes to the proposed Biofuel Bill so that it would amend the *Energy (Fuels, Levies and References) Act 1989*, based on the principles that sustainable biofuels:

- must emit significantly less (no less than 35%) GHG over their life cycles than fossil fuels
- must not compete with food production or be produced using land of high value for food production
- must not, in their production, reduce indigenous biodiversity or adversely affect land with high conservation values.

In addition, the committee recommended that reporting on the sustainability of the biofuels supplied towards the BSO be required.

In response to the BSO and the Biofuels Bill, the Energy Efficiency and Conservation Authority (EECA) (report by Sinclair Knight Mertz, 2008) assessed international initiatives on the sustainability of biofuels, sustainability labelling and how information could be provided to the consumers. The report set out the options for promoting sustainable biofuels in New Zealand with a focus on avoiding negative or social impacts associated with their manufacture, noting that to achieve this may involve:

- assessing environmental and social impacts based on a consideration of a series of criteria or objectives
- determining the life cycle carbon emissions associate with different feedstocks manufacturing and logistics scenarios
- setting acceptable benchmarks for performance against criteria and life cycle carbon emissions.

Four options are considered:

- provide a basis for voluntary reporting against agreed criteria
- develop a voluntary point of sale labelling scheme
- introduce mandatory reporting against sustainability criteria
- require qualifying biofuels to meet sustainability criteria.

The impact, cost and a cost–benefit analysis of each of the options was undertaken. The final recommendation is for a staged approach starting with voluntary reporting based on developed sustainability criteria and carbon accounting methodology appropriate for New Zealand so that could be introduced relatively quickly, followed by labelling and eventually mandatory reporting. Much of the thinking in the report is based on the UK scheme, as outlined above.

Following a change of Government in New Zealand in November 2008, there has been a change in policy with Section 3A of the *Energy (Fuels, Levies and References) Act 1989* (the section that contained the BSO) repealed in December 2008. On 14 May 2009, the NZ Energy and Resources Minister announced a Biodiesel Grants Scheme (with eligibility criteria)(Brownlee, 2009). On 18 June 2009 the NZ Green Party introduced a Sustainable Biofuels Bill into Parliament, requiring all biofuels to meet sustainability criteria as of 1 May 2010 (Fitzsimons, 2009).

3.3.7 Asia

Many Asian countries (including China, India, Japan, Philippines, Thailand, Indonesia and Malaysia) have put in place policies and legislation to facilitate the development of bioenergy and biofuels with the primary aim of improving energy security.

From China, Article 1 of the *Renewable Energy Law of the People's Republic of China* (2006) encapsulates the following reasoning:

> In order to promote the development and utilization of renewable energy, improve the energy structure, diversify energy supplies, safeguard energy security, protect the environment, and realize the sustainable development of the economy and society, this Law is hereby prepared.

Contained within this Law are instructions for energy authorities of the State Council to develop the utilisation of renewable energy as the preferential area of energy development, to set target volumes and prepare plans. The Law encourages 'clean and efficient development and utilisation of biological fuel and encourages the development of energy crops' and under Article 24 sets out development activities that will be supported via the Chinese Government budget. Additional incentives include preferential loans and tax benefits.

While the Law provides encouragement to produce bioenergy and biofuels, there is no acknowledgement of sustainability issues and how these may be addressed. Chinese participation in the UN agencies that have addressed these issues has not been ascertained.

Ram Mohan *et al.* (2006) provide a summary of the policies and legislation around the biofuels in India, Philippines, Thailand, Malaysia, Japan and China up to 2006. As with China, the activities around biofuels in these countries are centred on encouraging the production of biofuels and apparently have not yet addressed sustainability issues.

3.4 International feedstock-specific organisations

3.4.1 The Round Table on Sustainable Palm Oil

The issues to do with palm oil sustainability were set out in section 2.3 of this report. The RSPO describes itself as a global, multi-stakeholder initiative on sustainable palm oil with participants from plantation companies, manufacturers, retailers, social and environmental NGOs and many countries that produce or use palm oil. The RSPO has developed a set of principles and criteria for sustainable palm oil production (RSPO, 2007a), a certification system (RSPO, 2007b), a supply chain certification system (RSPO, 2008) and lists on their web site certifiers approved under the RSPO Audit Programme. The RSPO sustainability certification system is now active, and at least one RSPO Assessment Report is available as a public summary (Ogg and Stegeman, 2008).

The eight RSPO principles are:

1. commitment to transparency
2. compliance with applicable laws and regulations
3. commitment to long-term economic and financial viability
4. use of appropriate best practice by growers and millers
5. environmental responsibility and conservation of natural resources and biodiversity
6. responsible considerations of employees and of individuals and communities affected by growers and millers
7. responsible development of new plantations
8. commitment to continuous improvement in key areas of activities.

Criteria have been established for each of the principles. Following is an example of a principle and associated criterion structure:

> Principle 4: Use of appropriate best practices by growers and millers has the following:
>
> Criterion 4.1: Operating procedures are appropriately documented and consistently implemented and monitored.
>
> - Indicators:
>   - Standard Operating Procedures for estates and mills are documented

    - A mechanism to check consistent implementation of procedures is in place. Records of monitoring & the actions taken are maintained.
- Guidance:
    - For individual smallholders working practices will have to be consistent with documented procedures provided by customers or smallholder organisations. For national interpretation, national codes of practice or Best Management Practices (BMPs) should be referenced.

The RSPO scheme does not include criteria on GHG emissions reduction from the use of palm oil and does not prevent oil palm plantations being located on drained peat land, a practice that dramatically increases the CO_2 emissions associated with the use of palm oil (Beer et al., 2007). The RSPO Criteria Working Group has recommended to the RSPO Executive Board that the RSPO establish a working group to consider all the issues related to GHG emissions in the palm oil sector. The indicators and guidance to Principle 7 (responsible development of new plantings) require information from soil surveys, analysis of land type, and analysis of current land use and foreshadows above and below ground carbon storage assessment as a result of the proposed RSPO GHG working group.

The strong commercial base to its membership has led some (e.g. Friends of the Earth, Greenpeace, the Palm Oil Action Group) to question the RSPO's social and environmental credentials and claim that its sustainability system is not stopping clearing of forests for palm oil production. The segmentation of the markets for palm oil – some of which require sustainability credentials, and some of which do not – means that there is 'leakage', or land use and market substitution (section 2.3). However, as one of the two operating biofuel certification schemes, the RSPO's established processes should be considered during the development of national or other single-source biofuel sustainability frameworks.

3.4.2 The Round Table on Responsible Soy

Like the RSPO, the Round Table on Responsible Soy (RTRS) is a multi-stakeholder organisation. Its membership is predominantly producers, associated finance and trade organisations with some NGOs and observer members. Like RSPO, RTRS has been criticised for failing to address deforestation and local land use issues.

The RTRS has a Principles, Criteria and Verification Working Group that are in the process of developing agreed principles and criteria and a method of verifying their implementation. Their Draft RTRS Principles and Criteria: Second Public Consultation Document (RTRS Working Group, 2008) identifies in its wording where there was disagreement within the group but acceptance that further input would be useful and, lists several options where there was no agreement. This suggests that there is some way to go before there is consensus within the RTRS and implementation of a scheme as has already been achieved by the RSPO.

3.5 Trade – the implications of the application of sustainability requirements to biofuels and bioenergy

The current moves towards applying sustainability criteria to the production of biofuels and bioenergy have implications for the international trading of in these products, as the differentiation of biofuels and bioenergy based on the sustainability of the production process has a potential to impede trade or to be used as a protectionist measure. While WTO member governments consider that the protection of the environment and health are legitimate objectives, there is concern within the WTO about environmental requirements, market access and 'green protectionism' in a wide range of trade sectors. Within the WTO, the Committee on Trade and Environment (CTE) applies particular attention to this subject and its effect on developing countries in areas such as organic agriculture and forest products.

The WTO has recently begun to consider environmental issues in the international trade of biofuels. The CTE was briefed at its November 2008 meeting on biofuel certification by a representative of the

United Nations Conference on Trade and Development (UNCTAD) based on their report *Making Certification Work for Sustainable Development: The Case of Biofuels* (UNCTAD, 2008).

The early part of this report provides an overview of the development of certification by nations (plus the European Commission), NGOs, international bodies and networks such as UN-Energy, FAO, UN-EP, IEA Bioenergy, and various roundtables, and by companies in the industry that have initiated their own standards and certification schemes.

The report then addresses the implications of implementation of these certification schemes for biofuels, in particular the cost-and-effect on small producers from developing countries. The authors state that:

> It is worth recalling that the WTO Agreement on Technical Barriers to Trade (TBT Agreement) mandates WTO members to take into account the special development, financial and trade needs of developing countries when preparing technical regulations, standards and conformity assessment procedures to avoid creating unnecessary obstacles to the expansion and diversification of exports from developing countries.

The report, in a chapter titled 'Implications for the certification for the WTO', deals in-depth with the issue of biofuel certification on trade, noting that certification is expected to become a crucial product requirement and that governments are aiming to provide 'WTO consistency' in the certification programs that they are developing. Although the chapter provides insight into WTO provisions that are specifically relevant to biofuel certification and, through the use of precedence, suggests how they may be addressed, it does contain a reminder of the case-by-case nature of dispute resolution within the WTO, stating that, 'Distinguishing biofuels and feedstocks on the basis of sustainability remains a complex legal issue'. Some points from the report are listed below:

- There is concern that the requirements of non-product related process and production methods, or nrp PPMs (for example, categorisation of goods based on the characteristics of their method of production, e.g. an LCA calculation of the GHG emissions over the whole production chain) rather than the final characterisation of the product could represent undue interference of one country on another, as it could limit the freedom of producers to produce according to their technical capabilities. It could also easily be used to restrict trade.
- Based on findings from earlier WTO debates on the transparency of eco-labelling schemes, there needs to be transparency in developing certification schemes for biofuels.
- There is uncertainty whether the WTO's Technical Barriers to Trade (TBT) Agreement covers nrp PPMs. In the event of a challenge and the implementation of the WTO dispute settlement process, this could move consideration of certified biofuels from the TBT Agreement to the General Agreement on Tariffs and Trade (GATT) rules.
- Sustainability schemes established by 'hybrid entities' such as the RSB raise questions as the whether they could be considered to be international standards that conform to the TBT Agreement or private schemes outside multilaterally agreed trade rules. Such private schemes could be captured under GATT if linked to governments (say, through incentive schemes).
- Under the GATT multilateral trade rules is the concept of 'like' products. In principle, regulations including taxation measures should not discriminate between products that compete with each other in a given market and that share the same physical characteristics and final use (for example, batches of bioethanol).
- GATT Article III requires treatment of imported goods to be no worse than domestically-produced like goods in regard to internal taxes and regulations. A case described in the report would suggest that if there is discrimination between domestically-produced sustainable and non-sustainable products, the same discrimination between sustainable and non-sustainable could apply to imported products without imposing 'less favourable treatment' on the imported product. The transparency in the development of the criteria for the discrimination and the process required for foreign producers to meet these criteria without unjustified costs and delays would also be relevant in assessing 'less favourable treatment'.
- There is a potentially important precedence from an asbestos case where the WTO Appellate Body stated that 'evidence related to the health risks associated with a product may be pertinent in the examination of likeness'. This could allow biofuels to be differentiated on their contribution to mitigating health problems related to climate change.

- It is highly unlikely that WTO would accept discrimination against biofuels based on labour and other social standards criteria, as the WTO has had an agreed policy since 1996 that market access should not be linked to labour standards.
- GATT Article XX provides countries with an opportunity to balance their trade obligations with their non-trade objectives such as the preservation of health, the environment and natural resources through the application of exemptions available under this Article. The report, using precedence, describes how Article XX (b) – which refers to measures necessary to protect human, animal or plant life or health, and Article XX (g) – which refers to the conservation of exhaustible natural resources, could be applied to biofuel certification schemes, particularly those setting GHG emission reduction targets, and environmental protection.

Two other documents that consider trade are the WWF's *Bioenergy Assurance Schemes and WTO Rules* (Gonzales, undated) and GBEP's *A Review of Current State of Bioenergy Development in G8 +5 Countries* (GBEP and FAO, 2008). The GBEP Review, in Section 2.5 regarding trade considerations, points out that:

- The WTO does not currently have a trade regime specific to biofuels, but there are operating regional and bilateral trade agreements (e.g. the United States-Caribbean Basin Initiative that allows some duty-free trade in ethanol), which already deal with trade in biofuels.
- Under the harmonized commodity description and coding system (HS), bioethanol is traded under an agricultural code while biodiesel is traded under an industrial code so that the former would come under the WTO Agreement on Agriculture rules and the later under the Technical Barriers to Trade (TBT) Agreement rules.
- There are other policy instruments that impact on trade. These include tariffs and quotas, barriers due to the complications in dealing with the vast array of products from different feedstock and technologies, technical regulations, sustainability requirements, domestic incentive arrangements and biosecurity.

The overall impression from the United Nations Conference on Trade and Development (UNCTAD) Report and the Global Bioenergy Partnership (GBEP) Review is that the international trade of biofuels and bioenergy (biomass) is a complex and currently uncertain area of jurisprudence and that there is some way to go in negotiating and settling both the general barriers to this trade and the issues associated with any requirement for sustainability certification of biofuels for market access. Despite this, it would appear from the current international activities in establishing sustainability and certification of bioenergy products, that there is a general acceptance that the benefits of environmental protection and consumer confidence outweigh the negatives of new requirements to negotiate trade, dealing with potential 'green protectionism', and the costs to governments and producers of implementating sustainability certification. Uncertified bioenergy and biofuels may not only become less preferable to consumers but also become more difficult to trade as more importing countries implement sustainability requirements and certification systems for these products.

3.6 Key messages and conclusions from this chapter

1. Many countries have promoted bioenergy (with a particular focus on biofuels) in response to the drivers of climate change mitigation, sustainable development, security of energy supply, creation of knowledge-based industries creating jobs, economic growth, competitiveness and regional and rural development.
2. The unintended consequences of the industry expansion have, however led to questions about the sustainability credentials biofuels. Consequently, many countries, transnational organisations and industry bodies are developing various parts of a bioenergy sustainability framework as defined in this report. These efforts are currently scattered along a development pathway. Only the United Kingdom (under the RTFO Reporting scheme) and the RSPO (under its audit and certification scheme) have actually implemented all or part of the schemes and reported on progress.
3. Those countries or organisations that are in the process of developing a sustainability assessment system are using criteria and indicator approaches that reflect economic, environmental and social sustainability principles.
4. Many sustainability frameworks under development identify the indirect effect of land use change on GHG emissions, biodiversity and food as a very significant risk to sustainability,

mainly because of the high degree of uncertainty in the assessment and global control of these effects. Some strongly recommend a slowing in the development of bioenergy until methods of dealing with the indirect effects have been established. Others assign default values based on life cycle assessments factoring in a GHG emissions burden assuming some level of indirect land use change.

5. All countries are struggling with how to implement schemes on the ground, including the scale at which they are applied (national-level targets, rules or guidelines versus project-scale implementation). It is still too early to be able to evaluate the practicality and effectiveness of any scheme.
6. There appears to have been insufficient attention given to how to evaluate differing sustainability outcomes, and how to address trade-offs in the components of sustainability that will inevitably need to be addressed.
7. There is general agreement that it is important to base new systems for assessing sustainability on existing processes and relevant certification systems (such as the FSC) wherever possible; that compliance costs should be minimised; and that schemes should be designed that lend themselves to mutual recognition to facilitate international trade in biomass, bioenergy and biofuels.
8. Many sustainability schemes will probably retain a significant voluntary element until important issues relating the effects of discrimination based on the sustainability of production of biomass and biofuels for international trade have been tested and agreed upon under WTO rules.
9. Sustainability standards should apply to agricultural practices for both food and fuel production, for example Article 17 (6) of the European Parliament's Directive (European Parliament, 2009). This is a significant issue for Australia where future expansion in supply of feedstocks for bioenergy may come from existing agricultural land, for which formal and systematic approaches to sustainability assessment are not currently implemented. Revegetation of agricultural land can often improve sustainability outcomes.
10. Whilst much can be learned from international experiences, it is clear that Australia has a unique set of sustainability issues relating to bioenergy. These relate in particular to our complex and biodiverse native forests, maintenance of fertility of our generally poor soils, protection of scarce water resources, management of fire in our highly fire-prone environments, and social issues associated with major change in management of agricultural landscapes. Australia is also very heterogeneous, meaning the sustainability issues and ways of managing them vary markedly from place to place. As a consequence there is a strong need for processes, and criteria and indicators that can deal with *local* sustainability issues.

In the next chapter, we assess the components of a bioenergy sustainability framework in place in Australia.

Organisation/country	Document ID	Aim of the document	Summary of approach/methodology	Potential relevance to Australia
4.1 Transnational organisations				
4.1.1.1 United Nations Energy	(UN-E, 2007) *Sustainable Bioenergy: A Framework for Decision Makers*	To identify key social, economic and ecological sustainability issues in the development of bioenergy that require attention at national and international levels. Focus on the effect of the identified issues in developing countries and on the poor.	Nine key sustainable issues identified and outlined. For each, the problems in implementing a response at a local or national level are discussed.	Global issues to consider in building a sustainability framework to include imported biofuels. Issues for small biomass/biofuel producers
4.1.1.2 United Nations Environmental Programme, Daimler Chrysler and the State of Baden-Wurttenberg, Germany	(UNEP, 2007) *Working Paper: Compilation of existing certification schemes, policy measures, on-going initiatives and crops used for bioenergy*	A review of existing certification schemes relevant to the certification of biomass for biofuels.	General overview of certification and how it works. Information on existing certification schemes in text. Tables that set out the social, economic, ecological and general criteria against each of the existing certification systems reviewed.	Source of information on existing national and international certification schemes that could be used within a sustainability framework for bioenergy.
4.1.1.3 Global Bioenergy Partnership (GBEP)	(GBEP and FAO 2008; AO, 2008) *A Review of Current State of Bioenergy Development in G8 + 5 Countries*	Information on the development of bioenergy in 13 countries. Also a section on trade considerations under WTO rules.	Overview of biofuels and the issues including sustainability and trade. Good production data and other information on the 13 countries up to 2006.	The Australian Government has observer status on GBEP development of science-based Criteria and Indicators.
4.1.1.3 Global Bioenergy Partnership (GBEP)	(GBEP Task Force on Sustainability, 2008) *Inventory of Current Initiatives on Sustainable Bioenergy Development*	Summary table of sustainability initiatives of the 13 (G8+5) countries. Names and describes each initiative and sets out elements of the initiative.	Limited to 13 countries. Not all listed initiatives are within a sustainability framework for biofuels and bioenergy (e.g. for Australia, lists the Australian Forestry Standard).	Easy–to-access summary, but limited in scope.
4.1.2 IEA Bioenergy	(van Dam et al., 2008) *Overview of recent developments in sustainable biomass certification*	To provide a comprehensive review of all key organisations and their activities; to identify the limitations in biomass certification and to suggest how they may be overcome.	Review and analysis. Provides a useful collection of summary tables and analysis of problems.	Good summary of activities of international organisations, national governments, energy companies and NGOs.
4.1.2 Round Table of Sustainable Biofuels (RSB)	(EPFL, 2008) *Global Principles and Criteria for Sustainable Biofuels Production : Version Zero*	To provide agreed principles and criteria for sustainable biofuel production developed from global stakeholder discussion that could be used in a global sustainability framework. Aspirational.	Twelve months of global consultation to draft principles and criteria based on work already undertaken by many of the leading organisations in this field (FSC, Cramer, UK, RSPO etc.) with the aim of standardisation, harmonisation with existing and developing schemes	Principles and criteria developed through a global consultative process. Principles and criteria aimed at direct impacts only. No indicators at this stage. RSB plans to address indirect impacts over the next year.
4.1.3 International Risk Governance Council (IRGC)	(IRGC, 2008) *Policy Brief: Risk Governance Guidelines for Bioenergy Policies*	To identify the risks and areas of potential failures in governance associated with the development of a bioenergy industry.	Precautionary approach in identifying environmental, social, economic and other risks. Provides suggestions as to how these may be handled.	Provides a good checklist of areas of risk to be considered during the development of a bioenergy industry.

4.1.4 European Union	(European Parliament, 2009) *Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources amending and subsequently repealing Directives 2007/77/EC and 2003/30/EC*	Directive to the European Parliament on the promotion of renewable energy including biofuels. Directives (Articles 1–25) provide instruction to Member States on many associated issues.	Sets EU and Member State targets, specifications for biofuel blends, rules for calculating GHG impacts of biofuels, methodology for GHG calculations, default values. Article 17 sets sustainability criteria and reporting requirements.	Relevant. Sets out the EU policy to be adopted by the 27 listed Member States. Minimum international requirement for export of biomass or biofuels into Europe.
4.1.4 European Union	(BTG, 2008) *Sustainability Criteria and Certification Systems for Biomass: Final Report*	An analysis of existing biomass production sustainability criteria and certification systems with the objective of providing 'a basis upon which the Commission's Services could decide (on) minimum sustainability criteria and certification systems for the production of biomass in the EU and imported biomass'.	Provides a theoretical framework for certification. Overview of existing certification systems. Analyses the barriers to certification – cost, WTO rules etc. Conclusions and recommendations for the EU	Will provide the basis for the next step in certification of biomass production in Europe and those countries exporting bioenergies into Europe.
4.2 National governments				
4.2.1 United Kingdom	(UK Department of Transport, 2008) *Carbon and Sustainability Reporting within the Renewable Fuel Obligation: Requirements and Guidance.*	The UK Government's specific requirements for the initial implementation of a C&S reporting scheme under the RTFO. Includes all necessary information and data that the RFA and suppliers require for the implementation of the scheme.	A mandatory monthly reporting scheme that initially allows some voluntary information. Reports carbon saving from fuel supplied, feedstock/fuel meeting qualifying environmental and social principles under a meta-standard assessment process.	Very relevant. This is a currently operating national scheme that reports on biofuel sustainability against some criteria.
4.2.1 United Kingdom	(Renewable Fuels Agency, 2009) *RFA Quarterly Report 3: 15th April 2008 – 14th January 2009*	Third-quarterly report on the carbon and sustainability performance of renewable fuels supplied under the RTFO.	Reports volume of fuel by type, source country, feedstock and by previous land use. Reports sustainability data capture and GHG savings as graphs and spreadsheets.	Operating UK scheme. Third quarterly report for April 2008 to January 2009.
4.2.1United Kingdom	(Gallagher, 2008) *The Gallagher Review of the indirect effects of biofuels production.* The Renewable Fuels Agency.	To review the indirect effects not captured by the RTFO Reporting scheme. Specific EU and UK recommendations on biofuel targets. Demonstration of uncertainties and need for research.	Analysis using 14 commissioned studies including anticipated demand for biofuels, global land availability, GHG emissions from land use change.	Document (with references and web site) on the indirect effects of biofuels that are not captured under the current sustainability frameworks based on principles and criteria.
4.2.2 Netherlands	(Cramer, 2007) *Testing framework for sustainable biomass*	To provide advice to the Dutch Government for the development of a sustainability framework. Report contains explanation as to why the principles etc. were selected.	Consultative process to formulate themes, principles, criteria, indicators and reporting for a Dutch testing framework for sustainable biomass production and importation	Provides a fully developed set of principles, criteria and indicators with justification for selections.
4.2.2 Netherlands	(NEN Centre for Standardization, 2009) *Dutch Technical Agreement NTA 8080* (March 2009)	Describes the regulations/requirements for sustainable biomass for energy purposes (power, heat and cold, transport fuels).	Utilises all the principles, criteria etc. from Cramer.	Example of EU Member State applying significantly more rigorous requirements in national regulations than the EU Directive (2009).
4.2.3 Germany	(Federal [German] Government, 2009) *Order on Requirements Pertaining to the Sustainable Production of Liquid Biomass for Generating Electricity*	To transpose the requirements of the EU Directive 2009 (see 4.1.4 above).	Applies all the relevant Articles of the EU Directive.	Example of EU Member State applying minimal requirements as set out in the EU Directive.

4.2.4 United States of America	(US EPA, 2009) *EPA Proposes New Regulations for national Renewable Fuel Standard Program for 2010 and Beyond*	Sets rules for the second Renewable Fuels Standard (RDS2), based on four categories of renewable transport fuels. Rules cover mandatory volumes and GHG reductions up to 2022.	Based on policy of replacement of fossil transport fuels through blending of biofuels and GHG reduction. GHG emissions calculations include an allowance for indirect land use change.	Relevant if Australia follows similar path.
4.2.4.1 USA - California	(Air Resources Board, 2009) *Proposed Regulation to Implement the Low Carbon Fuel Standard. Volume 1 Staff Report: Initial Statement of Reasons*	Sets out the regulations around California's goal of a 10% reduction in the carbon intensity of California's transport fuels by 2020.	Combination of fuels (electricity, biofuels, hydrogen etc) combined with vehicle technologies to reduce overall GHG emissions. Fuel carbon intensity calculation allows for indirect land use change and vehicle efficiency.	A robust system for the reduction of GHG emissions from land transport. Not bioenergy or biofuels specific.
4.2.5 Brazil	(AgriLINK NZ, 2008) *The Sustainability of Brazilian Sugarcane Bioethanol: A Literature Review*	Assesses the sustainability of the production of sugarcane ethanol in Brazil using life cycle energy balance, production, social and environmental parameters. Did not include land use change.	Review of literature to assess the potential GHG reductions for NZ through the use of ethanol imported from Brazil.	Description of current practices. Relevant background for importation into Australia of ethanol from Brazil.
4.2.6 New Zealand	New Zealand Biofuel Bill 2008	The Bill implemented the Biofuel Sales obligation and amended other legislation to provide for the introduction of biofuels and biofuel blends. Sets mandated volume targets, requires qualifying biofuels to be sustainable under principles incorporated into the legislation.	Legislation. Passed by NZ Government 4th September 2008 to come into force in October 2008. Repealed December 2008 following change of government.	Example of legislation. Lost relevance when Bill was repealed.
4.2.7 Asia - China, India, Japan, Philippines, Thailand, Indonesia and Malaysia	(Mohan et al., 2006) *Biofuel Laws in Asia: Instruments for Energy Access, Security, Environmental Protection and Rural Empowerment*	To set out the legal and administrative measures in the Asian countries that support production of biofuels	Legal approach to outlining policy and supporting legislation in each country. Mandates and incentives based on volume only. No requirement of environmental benefits such as reduced GHG emissions or environmental and social sustainability.	A summary of Asia the position Asian countries on biofuels in 2006. Relevant to Australia for understanding GHG emissions and trade in the region.
4.3 International feedstock-specific organisations				
4.3.1 Round Table for Sustainable Palm Oil (RSPO)	(RSPO, 2007) *RSPO Principles and Criteria for Sustainable Palm Oil Production*	Working document – principles, criteria, indicators and guidance to be used in the RSPO Certification of palm oil production.	Developed under the RSPO consultative process of stakeholders (plantation owners, manufacturers, retailers, social and environmental NGOs and governments). Implemented - RSPO assessment report available.	Relevant. Information on an operating single-feedstock sustainability certification scheme for biofuel/vegetable oil.
4.3.1 Round Table for Sustainable Palm Oil (RSPO)	(RSPO, 2007a) *RSPO Certification Systems*	Working document – sets out in detail the certification standard based on the RSPO criteria, accreditation requirements of certifiers, the certification process and funding. Contains definitions, checklists, report format etc.	Certification based on criteria. Implemented - RSPO assessment report available.	Relevant. Information on an operating single-feedstock sustainability certification scheme for biofuel/vegetable oil.
4.3.1 Round Table for Sustainable Palm Oil (RSPO)	(RSPO, 2008) *RSPO Supply Chain Certification System*	Working document – sets out the four RSPO supply chain models (identity-preserved, segregation, mass-balance, book-and-claim with certification process, accreditation etc.	RSPO supply chain models (identity-preserved, segregation, mass-balance, book-and-claim	Relevant. Information on an operating single-feedstock sustainability certification scheme for biofuel/vegetable oil.

4.3.1 Round Table for Sustainable Palm Oil (RSPO)	(Ogg and Stegeman, 2008) *RSPO Assessment Report: United Plantations BHD. Peninsular Malaysia,* Control Union Certifications	Full documentation of an audit process and outcome by CUC under the RSPO Certification System.	Formal audit against RSPO P&Cs. Contains summary of findings by criteria.	Relevant. Information on an operating single-feedstock sustainability certification scheme for biofuel/vegetable oil.
4.3.2 Roundtable on Responsible Soy	(RTRS Working Group, 2008) *Draft RTRS Principles and Criteria: Second Public Consultation Document*	Draft RTRS Principles and Criteria for public consultation	Consultative process mainly amongst RTRS membership to develop Principles and Criteria. Second round consultation. Indicators within the document of some disagreement amongst the RTRS Working Group/membership.	Not particularly relevant. Single feedstock and development process is incomplete.
4.4 Trade – implications of the application of sustainability requirements				
4.4 United Nations Conference on Trade and Development	(UNCTAD, 2008) *Making Certification Work for Sustainable Development: The Case for Biofuels*	Provide policy makers with an overview of existing certification schemes, or those being developed. Examine the issues of sustainability certification of biofuels in the context of WTO and GATT.	Framework for certification. A description of the development of certification by organisations. Chapter 4 deals in depth with potential problems under WTO rules in applying sustainable production certification to biofuels. Suggests possible outcomes using precedence.	Significant document as presented at WTO CTE meeting in 2008. Information paper for policy makers with particular emphasis sustainable biofuels and international trade under WTO/GATT.
4.4 World Wildlife Fund (WWF)	(Gonzales, undated) *Bioenergy Assurance Schemes and WTO Rules*	To provide a guide on some of the more important WTO principles and measures relevant to promoting certification and labelling in bioenergy.	Information consistent with UNCTAD document, demonstrating how certified sustainable bioenergies can argue acceptance within WTO and GATT rules.	NGO document that supports other advice on dealing with WTO rules.

Table 3-1 Summary of literature covering international developments in bioenergy and biofuels sustainability

4 Australian policies, legislation, regulations, and other processes relevant to sustainable production of bioenergy

Chapter Summary

In Chapter 3 we reviewed international developments in addressing issues of bioenergy sustainability. In this chapter we turn our attention to Australia. We provide a description of laws, policies, regulations, incentives and other processes which are already in place in Australia and of direct relevance as either the means to achieving or assessing the sustainability of bioenergy production along the value chain.

The parts of the bioenergy sustainability framework addressed in this chapter are summarised in Table 5-1. It is not possible to illustrate the multitude of policies and the full text should be read if a more comprehensive view is required.

Intergovernmental and transnational

Some examples of the intergovernmental binding agreements of relevance to bioenergy and biofuels, to which Australia is party include the World Trade Organisation (WTO), Free Trade Agreement (FTA) and General Agreement on Tariffs and Trade (GATT); International Labour Organisation (ILO); Biological Diversity Convention; United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol (KP); World Heritage Convention; Montreal process.

In addition, the Australian Government may participate in consultative and participatory intergovernmental organisations and mechanisms, along with industry and other groups. Examples include the Food and Agriculture Organisation (FAO); Global Bioenergy Partnership (GBEP); International Energy Agency (IEA); Organisation for Economic Co-operation and Development (OECD); International Organisation for Standardisation (ISO).

The Australian Government

The Australian Government has a range of policy mechanisms in the form of regulations, targets, incentives, tax rules and standards with respect to bioenergy and biofuels.

Policies of direct relevance to biofuel and bioelectricity include:

- Kyoto Protocol obligations
- a Clean Energy Initiative (CEI)
- The *Renewable Energy (Electricity) Act 2000* and the *Renewable Energy (Electricity) Regulations 2001* which contain clear rulings on the biomass material that can be considered eligible for Renewable Energy Certificates
- The *Fuel Quality Standards Act 2000* for setting fuel quality standards fuel quality standard for biodiesel, and ethanol that can be blended up to 10% with petrol; and an ethanol labelling standard
- the expanded Renewable Energy Target (RET) Bill for a target of 20 % of Australia's electricity supply to be generated from renewable sources by 2020, passed in August 2009.

Currently before Parliament at the time of writing this report are:

- the Carbon Pollution Reduction Scheme (CPRS) Bill. Under the CPRS, scheme obligations will not apply to emissions from combustion of biofuels and biomass for energy; they will receive a 'zero rating'.

The status of this Bill is likely to change over the coming months.

The Australian Government has, through the Department Resources, Energy and Tourism and the Department of Agriculture, Forestry and Fisheries, conducted a Biofuels Review. A separate paper, the Energy White Paper will lay out the strategy for energy policy more broadly.

Many policies which have influenced the viability of the industry have been in operation, but have closed or are set to phase out. Fuel tax provisions made in the *Fuel Tax Act 2006* and *Fuel Tax (Consequential and Transitional Provisions) Act 2006* may change during the current extensive tax reform process. Full discussion of the direct financial and broader sustainability implications of all of these policies for the bioelectricity and biofuel industries is beyond the remit of this report.

Policies of broader relevance to the sustainability of bioenergy supply chains are also important at the level of the Australian Government. The bioenergy value chain crosses from biomass production through conversion to distribution (potentially including export and import markets) and therefore a broad range of other policies are relevant along the value chain. These include policies for water, biodiversity, climate change, agriculture, forestry, waste management, transport and regional development.

State and territory governments

State and Territory Governments develop and implement policies at a state-scale across many of the same portfolio areas as the Australian Government. Key differences from Australian Government areas of responsibility are that States have carriage of different areas of the taxation system; they have primary responsibility for land management policies (agriculture, forestry, water and urban development) and carriage of environmental impact statements where a new facility may be proposed.

The Australian States hold plenary powers to legislate on issues to the extent that an instrument will not be inconsistent with Commonwealth law. Where the Australian Government is silent on policies or legislation for bioenergy, the States and Territories possess powers to legislate. Many State Government have targets and mandates for biofuels and bioelectricity at a State level (Table 4-1).

The only legislation in Australia specifically pertaining to biofuels sustainability standards is in NSW. The approach is the Global Principles and Criteria for Sustainable Biofuels Production - Version Zero, published by the Roundtable on Sustainable Biofuels. In aligning with the internationally developing approach the acceptance of the Roundtable on Sustainable Biofuels (RSB) minimises potential impact on importing and exporting of biofuels in relation to meeting acceptable criteria. The RSB Version Zero is not currently sufficiently developed to be able to be implemented.

Local governments

Local governments are responsible for local planning and zoning and therefore have a role to play at the enterprise scale. There will be issues raised around use of local resources, siting a facility, transport impacts, water extraction and job creation which are addressed at the local level.

Industry groups

There are several industry associations and other groups that are relevant to the implementation of biofuels and bioenergy policy and industry development. These groups and associations can be very influential in setting policy at different tiers of governments, as well as providing pathways for implementation of voluntary industry self-regulation.

Policy review for sustainability along a biofuel value chain – a case study from Victoria

There are multiple supporting policies and other mechanisms across the biofuels and bioenergy value chains which operate within each state. A comprehensive review of all of the relevant policies is beyond the remit of this report. We present a case study for Victoria. Relevant policies and processes are identified along each step of the value chain, and the key players and the point of application of each of these are identified. This is summarised in Figure 4-2 and described in the full text of the chapter.

Conclusions and key messages

The conclusions and key messages from this chapter are summarised at the end of the chapter, as well as in the Executive Summary.

4.1 Introduction

In Chapter 3 we reviewed international developments in addressing issues of bioenergy sustainability. In this chapter we turn our attention to Australia. The Australian bioenergy industry is small and most biofuels enterprises are struggling for survival. We provide a description of laws, policies, regulations, incentives and other processes which:

- are already in place in Australia
- are of direct relevance as either the means to achieving sustainability (or lack thereof), or assessing the sustainability of bioenergy production along the value chain.

We look firstly at those aspects of Australia's intergovernmental obligations, policy, and policy mechanisms currently in place at national, state and local levels. A brief case study using Victoria as an example provides an illustration of the array of existing policies, regulations, and other processes that would need to be considered in assessing sustainability along bioenergy value chains.

We conclude by discussing the utility of existing policies and other mechanisms, and discuss the major gaps, conflicts or anomalies that may arise with an emerging bioenergy industry.

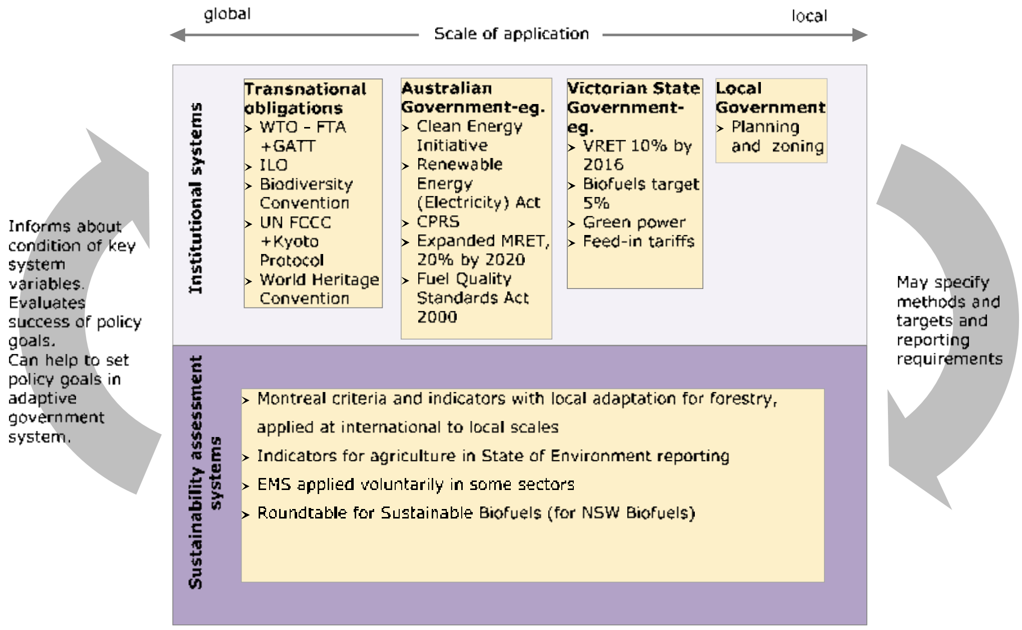

Figure 4-1 Bioenergy sustainability framework showing the institutional components discussed in this chapter

4.2 Intergovernmental and transnational

Some examples of the intergovernmental agreements of relevance to bioenergy and biofuels, to which Australia is party include the:

- World Trade Organisation (WTO), with the relevant binding agreements Free Trade Agreement (FTA) and General Agreement on Tariffs and Trade (GATT)
- International Labour Organisation (ILO), with the relevant binding agreements
- Biological Diversity Convention, with the relevant agreements
- United Nations Framework Convention on Climate Change, with relevant binding agreement Kyoto Protocol
- World Heritage Convention, with the relevant binding agreements
- Montreal process (criteria and indicators, or C&I, for sustainable forest management).

In addition, the Australian Government may participate in consultative and participatory intergovernmental organisations and mechanisms, along with industry and other groups. Examples include the:

- Food and Agriculture Organisation (FAO)
- Global Bioenergy Partnership (GBEP) – currently the Australian Government has an observer status in their bioenergy sustainability task
- International Energy Agency (IEA) – including IEA Bioenergy where Australia (through Bioenergy Australia) currently participates in 5 task groups, and representation on the Executive Committee
- Organisation for Economic Co-operation and Development (OECD) processes
- International Organisation for Standardisation (ISO) where Standards Australia (on behalf of Australia) has observer status on a work item relating to the development of sustainability criteria for biofuels.

4.3 The Australian Government

The Australian Government has a range of policy mechanisms in the form of regulations, targets, incentives, tax rules and standards with respect to bioenergy and biofuels.

4.3.1 Policies of direct relevance to biofuel and bioelectricity

Policies and initiatives of direct relevance to the sustainability of bioelectricity and biofuel production are:

- Kyoto Protocol obligations (refer section 3.2.1.4).
- a Clean Energy Initiative (Department of Resources Energy and Tourism (DRET), 2009a) (CEI) announced in the May 2009 budget. This includes a Renewable Energy Fund which houses a fifteen-million dollar Second Generation Biofuels Research and Development Program (Gen2) (DRET, 2009b) to support research, development and demonstration of new biofuel technologies. Applications are now closed. It will also establish an Australian Centre for Renewable Energy to promote development, commercialisation and deployment of renewable technologies more broadly.
- the *Renewable Energy (Electricity) Act 2000* and the *Renewable Energy (Electricity) Regulations 2001* contain clear rulings on the biomass material that can be considered eligible for Renewable Energy Certificates. These measures are consistent with sustainability principles. They include definitions and rulings on municipal solid waste, wood waste, weeds, agricultural residues and forestry. For example, wood waste from a native forest must be sourced from a harvesting operation for which the primary purpose of the harvesting was NOT to source biomass for energy production. Wastes must be a by-product from a harvesting operation where the primary purpose of the harvesting is a high value process. High value products are defined as sawlogs, veneer, poles, piles, girders, wood for carpentry or craft uses or oil products. To meet the high value test, the company claiming renewable energy certificates in respect of native forest biomass must be able to demonstrate that 51% of the revenue from

the products of the harvesting operation must be gained from the specified high value products in order for the wastes to be eligible. This high value test has been contended by the forest industry as too restrictive and having no basis in clear evidence of sustainability thresholds in forest systems.
- the expanded Renewable Energy Target (RET) (Department of Climate Change, 2009b). The Australian Government has set a target of 20 % of Australia's electricity supply to be generated from renewable sources by 2020. This will be delivered through the Renewable Energy Target (RET) scheme, which has a target of 45 000 gigawatt-hours per year by 2020. A range of biomass types are eligible renewable energy sources under the RET legislation some of which, in particular forest-based sources, are subject to additional eligibility criteria to ensure they have been managed and harvested sustainably. Biofuels may be eligible to create Renewable Energy Certificates under the scheme if they use eligible feedstocks, and where the fuels generate electricity.

Currently before Parliament at the time of writing this report is:
- the Carbon Pollution Reduction Scheme (CPRS) Bill (Department of Climate Change 2009a). Under the CPRS, scheme obligations will not apply to emissions from combustion of biofuels and biomass for energy; they will receive a 'zero rating'.

The status of this Bill is likely to change over the coming months.

The Australian Government has, through Department of Resources, Energy and Tourism and Department of Agriculture, Fisheries and Forestry, conducted a Biofuels Review. This will contribute to the Energy White Paper which will lay out the strategy for energy policy more broadly. The papers released for discussion (May 2009) mentioned biomass in some of the papers, but there was no clear position put forward on the potential of bioelectricity or biofuels to contribute to Australia's future energy mix.

There is Australian Government legislation on fuel standards for biofuels. The *Fuel Quality Standards Act 2000* provides the framework for setting fuel quality standards. Those relating to biofuels include the fuel quality standard for biodiesel, and ethanol that can be blended up to 10% with petrol. An ethanol labelling standard has also been proclaimed under the Act. These measures have improved the consumer acceptance of biofuels by increasing confidence in the product.

Many policies which have influenced the viability of the industry have been in operation, but have closed or are set to phase out. For example the Ethanol Distribution Program to increase the number of service stations selling 10 % ethanol blended petrol, and the Biofuels Capital Grants Program which supported investment in new or additional biofuels production capacity are both now closed. Fuel tax reforms were made in the *Fuel Tax Act 2006* and *Fuel Tax (Consequential and Transitional Provisions) Act 2006*.
The government is also undertaking an extensive tax reform process (known as Review of Australia's Future Tax System) (Treasury 2009).

Full discussion of the direct financial and broader sustainability implications of all of these policies for the bioelectricity and biofuel industries is beyond the remit of this report. The financial viability of the biofuel industry in Australia is strongly influenced by Australian Government policy. The range of policy approaches implemented over the last eight years, and the rate of change which continues, translates to uncertainty for investors and producers.

4.3.2 Policies of broader relevance to the sustainability of bioenergy supply chains

The bioenergy value chain crosses from biomass production through conversion to distribution (including potentially to export and import markets) and therefore a broad range of other policies are relevant along the value chain. These include policies for water, biodiversity, climate change, agriculture, forestry, waste management, transport and regional development.

A full discussion of all of the relevant policies and their interactions and implications for bioenergy sustainability would a very substantial task, and beyond the remit of this report. The international obligations discussed in section 4.2 are expressed in legislation at the level of the Australian Government. For example, obligations under the World Heritage Convention are made operational in the World *Heritage Properties Conservation Act 1983*, the *National Parks and Wildlife Conservation Act 1975* and specific ‘matters of environmental significance’ under the *Environmental Protection and Biodiversity Conservation Act 1999*. The National Strategy for the Conservation of Australia's Biological Diversity fulfils Australia's obligations under the international Convention on Biological Diversity.

With respect to climate change, as discussed in section 4.3.1, the Australian Government plans to implement a comprehensive the Carbon Pollution Reduction Scheme (CPRS) by 2011. While the CPRS will not cover agriculture in the first instance, forestry will be able to ‘opt in’ to the scheme. State Government regulations to limit land clearing significantly limit emissions from biomass production segments of the value chain. With respect to the use of water resources for the production of bioenergy - the Australian and State Governments have signed the National Water Initiative which aims to restore over-allocated water systems to environmentally sustainable levels of extraction. Biosecurity risks to do with import of biological material into Australia, based on assessment of biosecurity risk are managed by Biosecurity Australia. This covers import of harvested biomass, imported species for biomass production which may have weed potential, as well as organisms for conversion from biomass to biofuel or other bioproducts.

Although a full analysis of the relevant policies and their effectiveness in terms of sustainable bioenergy production is out of scope here, we do provide an example of relevant national and state policies through a case study value chain in Victoria (section 4.7).

4.4 State and territory governments

State and territory governments develop and implement policies at a state-scale across many of the same portfolio areas as the federal government. Key differences from Australian Government areas of responsibility are that States have carriage of different areas of the taxation system; they have primary responsibility for land management policies (agriculture, forestry, water and urban development) and carriage of environmental impact statements where a new facility may be proposed.

The Australian states hold plenary powers to legislate on issues to the extent that an instrument will not be inconsistent with Commonwealth law. Where the Australian Government is silent on policies or legislation for bioenergy, the States and Territories possess powers to legislate. Many State Government have targets and mandates for biofuels and bioelectricity at a State level (Table 4-1).

Table 4-1 Targets and mandates for bioelectricity or biofuels in the Australian states

Policy	Purpose
Victoria	
The Renewable Energy Action Plan, containing the Victorian Renewable Energy Target (VRET)	Sets out the actions to accelerate renewable energy development in Victoria. Mandates that Victoria’s consumption of electricity generated by renewable resources be increased to 10% by 2016. The VRET scheme will transition into the expanded NRET around 2010. Also contains a range of other initiatives to reduce GHG emissions from energy in Victoria more generally
Driving growth: A Roadmap and Action Plan for the Development of the Victorian Biofuels Industry.	Contains a biofuels target of 5% of all fuel consumption by 2010. Assists industry plan for the future, attract investment and build critical mass. Contains the biofuels target, including a commitment to consider a mandate should this target not be achieved.
NSW	
NSW – the Biofuel (Ethanol Content) Act 2007 *Amendment of the Biofuel (Ethanol Content) Regulation 2007 (2009 No 335)* *Biofuel (Ethanol Content) Act 2009*	Mandates 2% ethanol across the state. Intending to increase to 6% by the end of 2010. By July 2011 all regular grade unleaded petrol will contain 10%. Also introduces a mandate for biodiesel beginning at 2% and rising to 5% from 2012 onwards. Within the amendments of the *Biofuels (Ethanol Content) Amendment Act 2009* sustainability of production systems was specifically recognised through the need to meet a 'biofuel sustainability standard'. The respective standard required is discussed in the (yet to be released as at July 2009) *Biofuel Regulations* amendments. Within the Biofuel Regulations it is proposed that the Global Principles and Criteria for Sustainable Biofuels Production - Version Zero, published by the Roundtable on Sustainable Biofuels.
NSW Greenhouse Gas	Designed to reduce greenhouse gas emissions from the production and use of

Abatement Scheme	electricity in NSW and ACT. The GGAS establishes a benchmark for the electricity sector with the participants required to meet their respective allocation based on electricity demand. Reduction activities include low-emission generation; demand-side abatement; large-user abatement and carbon sequestration.
WA	
No specific policies	Considering a 5% biofuels target by 2010. The Western Australia Biofuels Taskforce recommended that a mandate of 5% by 2011 be set if the 2010 target is not met.
SA	
No specific policies	
Queensland	
Ethanol Industry Action Plan 2005-2007.	The Queensland Government has committed to a 5% mandate from 31 December 2010. The Queensland Government is reviewing its biofuel policy and is yet to make an announcement about a future direction.
Tasmania	
No specific policies	
NT and ACT	
No specific policies	
Multi-state	
GreenPower	A joint initiative of the ACT, NSW, SA, Qld, Vic and WA governments to provide a voluntary scheme offering consumers renewable electricity with specified environmental credentials.

The GreenPower Scheme is a government accreditation program for renewable energy. GreenPower's accreditation standards include:

- no use of native forest wood waste in biomass generators
- no hydro generation based on the redirection of environmental water flows in rivers
- only allowing generation from facilities built since 1997 in order to create 'new' renewable energy facilities.

Accreditation includes annual audits of GreenPower sales of retailers to check the sources of the electricity, and to check that retailers haven't counted GreenPower purchases towards their mandatory requirements to purchase renewable energy under Mandated Renewable Energy Target (MRET) (GreenPower, 2009a).

4.4.1 Introducing sustainability standards to state-based fuel legislation – a NSW example

The only legislation in Australia specifically pertaining to biofuels sustainability standards is in NSW. The approach is the Global Principles and Criteria for Sustainable Biofuels Production - Version Zero, published by the Roundtable on Sustainable Biofuels (see Table 4-1). In aligning with the internationally developing approach the acceptance of the Roundtable on Sustainable Biofuels (RSB) minimises potential impact on importing and exporting of biofuels in relation to meeting acceptable criteria. Within Australia it is also important that trade between the states is not limited through introduced regulation.

Many of the RSB Principles, introduced in section 3.2.3 and fully listed in Appendix 1, are directly addressed via specific legislation within NSW. For example projects of significance are determined via the processes applied through the *Environmental Planning & Assessment Act 1979* and subsequent amendments. Through meeting these obligations project proponents address Principle 2 of the RSB (Consultation planning and monitoring).

Not all RSB principles are explicitly addressed in the establishment and production of biofuels in Australia. For example there is significant work underway, and still required, to gain a comprehensive understanding of the respective greenhouse gas balances associated with different feedstock and production systems. However, In NSW there is a capacity for the Director General of the Department of Planning to request that proponents meet specific requirements such as GHG (see an example letter at <http://majorprojects.planning.nsw.gov.au/files/21798/Director-Generals%20Requirements.pdf>). The RSB guidelines do not specifically address the issues relating to indirect land use change. Within countries such as Australia, with developed governance, this is of less concern. Existing legislation such as the NSW *Native Vegetation Act 2003* reduces the likelihood of clearing of native species and where different systems may be introduced, such as planted forestry, legislation and regulations are often already in force (e.g., the *Plantations & Reafforestation Act 1999*). The RSB Version Zero is not currently in a state ready to be implemented.

4.5 Local governments

Local governments are responsible for local planning and zoning and therefore have a role to play at the enterprise scale. They may have no responsibility for top level targets but many sustainability issues are local (for example, while there may be broad targets set at a national level, there will be issues raised around use of local resources, siting a facility, transport impacts, water extraction and job creation) and some of these can only be addressed at the local level.

4.6 Industry groups

There are several industry associations and other groups that are relevant to the implementation of biofuels and bioenergy policy and industry development. These include:

- Bioenergy Australia
- Biofuels Association of Australia (BAA)
- Clean Energy Council (CEC).

At other points along the value chain, there are other major industry players and certification schemes of relevance, for example:

- in forestry, National Association of Forest Industries (NAFI), Australian Plantation Products and Paper Industry Council (A3P), Australian Forest Growers (AFG)
- in agriculture, National Farmers Federation (NFF) and various state incarnations of the same
- in waste, Waste Management Association of Australia (WMAA)
- large industry groups or alliances, for example the aviation industry's Sustainable Aviation Fuel Users Group (SAFUG).

These groups and associations can be very influential in setting policy at different tiers of governments, as well as pathways for implementation of voluntary industry self-regulation.

4.7 Policy review for sustainability along a biofuel value chain – a case study from Victoria

There are multiple supporting policies and other mechanisms across the biofuels and bioenergy value chains which operate within each state. A comprehensive review of all of the relevant policies is beyond the remit of this report. In order to illustrate the complexity and interactions between sectors and different levels of government, we present a case study for Victoria. Relevant policies and processes are identified along each step of the value chain, and the key players and the point of application of each of these are identified. This is summarised in Figure 4-2 and described in the following sections. This is not a 'how to' guide for Victoria and is not comprehensive. Thus, this case study should be viewed as illustrative.

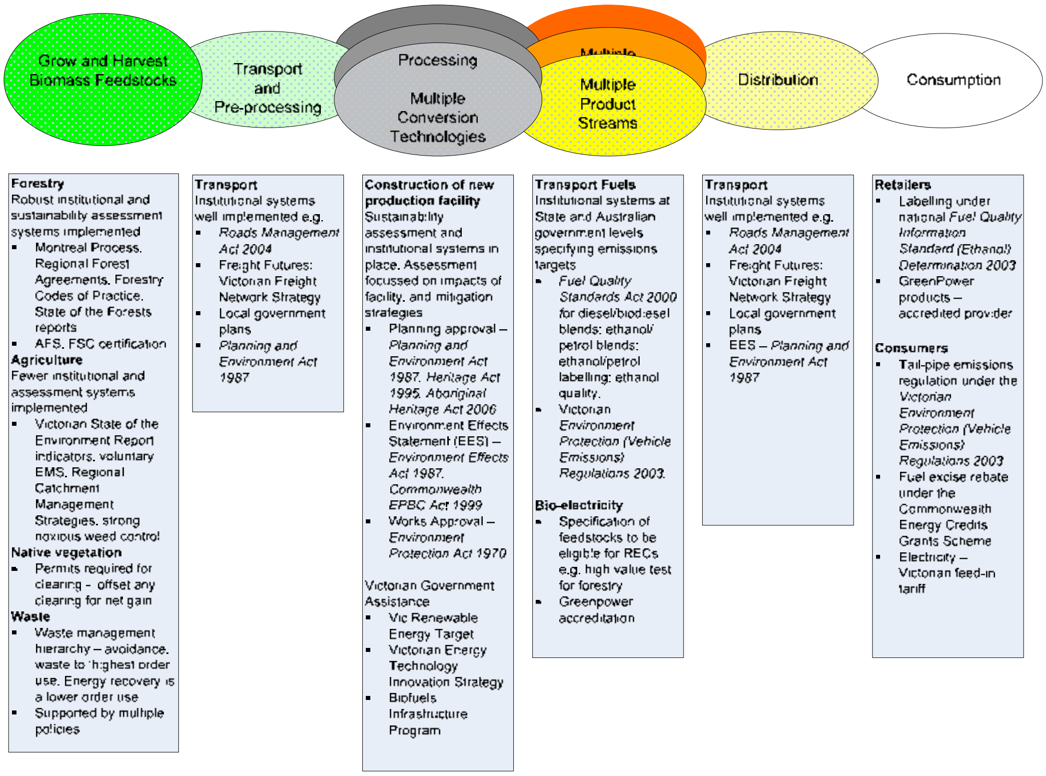

Figure 4-2 A illustration of existing policies, legislation and other activities related to sustainability along the bioenergy value chain: Victorian case study. Note, the diagram is a summary and therefore not comprehensive.

4.7.1 Biomass production

At the biomass-production end of the value chain, the relevant policies and mechanisms differ substantially according to the source of the biomass.

4.7.1.1 Forestry

There are well founded and implemented institutional systems, and established sustainability assessment systems for forestry at international through to local scales. The sustainability criteria for forestry cover the properties and processes occurring in the various parts of forest ecosystems, socio-economics, and the legal and institutional frameworks that support sustainable forest management. Australia is a signatory to the international Montreal Process, and reports every 5 years via the national State of the Forests report. The application, strengths and challenges of the sustainability assessment systems in place for forestry in Australia are covered in detail in a case study example in section 5.4.

Specific policies in Victoria include:

- regional forest agreements that cover most of Victoria's forests are very comprehensive in their legal and policy foundations. For example, the Victorian Statewide Assessment of Ecologically Sustainable Forest Management (Department of Agriculture, Fisheries and Forestry, 2008) is nested within 16 international treaties, conventions and initiatives; 11 separate pieces of Australian Government legislation; 13 Australian Government policies; 28 pieces of Victorian Government legislation; and 5 Victorian government policies
- legislated forestry codes of practice, which apply to native and plantation forests on both public and private land. Compliance with the code of practice is monitored, and breaches can be pursued through legal action by the state
- Monitoring of sustainability of forestry management using the Montreal criteria and indicators and reporting to the Victorian and Australian State of the Forests reports
- Australian Forestry Standard (AFS) and Forest Stewardship Council (FSC) industry certification, which can be obtained by individual enterprises

- voluntary participation by individual enterprises in the proposed CPRS.

Examples of the complexity and comprehensiveness of legal arrangements for Victoria's forest lands, according to tenure, is provided in Table 4-2.

Table 4-2 Policies and regulations applicable to Victoria's forests (Victorian Department of Sustainability and Environment, unpubl.)

Region	Description	Regulations or policies
VicForests administrated commercial harvesting areas	Commercially harvested timber reserves	• *Forests Act 1958* • National Forest Policy Statement 1992 • *Forests (Licences and Permits) Regulations 1999* • Our Forests Our Future 2002 • State Owned Enterprises Act 1992 (State Body – VicForests Order 2003) • *Sustainable Forests (Timber) Act 2004* • Sustainable Forest Management Policy 2005 • Code of Forest Practices for Timber Production • Regional Forest Agreements – various regions • Forest Management Plans – various regions • Timber Release Plans – various regions • Wood Utilisation Plans – various regions
National Parks and Conservation Reserves	Conservation areas	• *Forests Act 1958* • *National Parks Act 1975* • *Crown Land (Reserves) Act 1978* • *Conservation Forests and Lands Act 1987* • *Parks Victoria Act 1998* • Fire Operations Plans – various regions • *Safety on Public Lands Act 2004*
Crown lands	Public land	• *Forests Act 1958* • *Land Act 1958* • *Crown Land (Reserves) Act 1978* • *Flora and Fauna Guarantee Act 1988* • *Conservation Forests and Lands Act 1987* • *Forests (Licences and Permits) Regulations 1999* • Native Vegetation Management Framework 2002 • State Forests Environmental Management System 2004 • *Safety on Public Lands Act 2004* • Code of Practice for Fire Management on Public Land 2006 • Fire Operations Plans – various regions
Private Lands / Plantations	Privately owned/managed lands	• Plantation Incentives Strategy 2005 • Native Vegetation Management Framework 2002 • Timber Industry Strategy – consultation draft released in 2009 • Fire Operations Plans – various regions

It is clear that there are comprehensive institutional arrangements across a range of scales (international, national, state and enterprise) which seek to achieve sustainable forest management in Australia (notwithstanding the limitations discussed in section 5.4.4). This is underpinned by a sound sustainability assessment system and adaptive forest management processes. These assessment systems will, over time, enable judgement of the success of the institutional arrangements in achieving sustainability objectives.

4.7.1.2 Agriculture

Sustainable agriculture is guided by the application of 'best practice' systems, catchment management planning, and by a range of farmer groups. This reflects the situation in most agricultural production systems world wide. But these mechanisms are not well defined, standardised, legislated or applied in a formal or systematic manner.

Indicators to assess the sustainability of Australian agriculture were developed and applied in assessing the sustainability performance of agriculture (Commonwealth of Australia, 1998). The assessment was hampered by the need to use indicators that relied only on existing national level data. Comprehensive national datasets for agriculture are not readily available at appropriate spatial and temporal scales.

Indicators relevant to agriculture were developed for State of the Environment Reporting, based on the pressure-state-response framework (section 5.2). The 'land' indicators are very broad, often poorly defined, overlapping, and often measure 'input' variables (e.g. the area of land subject to management plans, or application of best management practices) rather than outcomes (actual measures of change in land condition). A basis for interpreting changes in the indicators is generally lacking, except in very broad terms (at the level of principles, for example water or soil quality should be maintained or improved). Land indicators include:

- area and proportion of agricultural or forest land under various aspects of 'best practice' management.
- change in land use or land cover
- change in biomass stock
- proportion of land with stable nutrient management by major catchment
- area subjected to fire control measures.

The indicators are meant to be used for large-scale reporting, and cannot be easily applied at regional- or enterprise-scales. The National Land and Water Resources Audit 2008 (NLWRA) agreed on a number of indicators and protocols for their use. Again, these were designed for broad-scale monitoring, rather than to directly support improved management at the enterprise-level.

A natural resources management monitoring, evaluation, reporting and improvement (MERI) framework and toolkit have been developed by the Australian Government to assess the achievements of investments under their funding program Caring for Our Country (Australian Government, 2008a). These list broad principles and activities, rather than providing indicators, and are not suitable for monitoring the sustainability of agricultural production systems.

In Victoria, regional catchment management strategies are developed by Catchment Management Authorities (Department of Sustainability and Environment, 2009a) under the *Catchment and Land Protection Act 1994*. This legislation also requires land owners to prevent the spread of regionally controlled weeds. Many species of biofuel plants (such as *Jatropha* and switchgrass) are declared noxious weeds. Catchment management regional strategies aim to promote sustainable agriculture and land management practices (including conservation cropping, introduction and management of perennial pasture species, regeneration of remnant vegetation and tree planting) by providing guidelines on best management practices (Department of Primary Industries, 2009a). Some of the best practice guidelines include minimum tillage and stubble retention – and thus removal of stubble for bioenergy would be in direct contradiction of the guidelines.

Environmental Management Systems (EMS) have been developed for application at these scales by the Victorian Department of Primary Industries. Take-up of EMS by different sectors of Victorian agriculture remains voluntary, and the extent of application is unclear. There are a range of EMS guidance materials and projects underway within specific areas including grazing, dairy, grains, viticulture, horticulture and cross-industry activities (Department of Primary Industries, 2008).

There are a number of mixed land uses that could emerge for biomass production on agricultural land – including grass production, short rotation forestry, alley farming, mosaic farming or other forms of farm forestry. There is potential to achieve complementary food and energy production on productive land (such as oil mallee strips in wheat growing areas e.g. Bartle et al. 2006). The use of lower-productivity or under-utilised agricultural land is an attractive option, but the current policy and economic settings are not conducive to encouraging the use of this land.

The current institutional systems and lack of systematically-implemented sustainability assessment systems for agriculture mean that:

- bioenergy producers using biomass from agricultural land systems may contribute to the improved sustainability of agricultural land (e.g. in oil mallee systems), or inherit or exacerbate the issues of degradation of soil, water and biodiversity resources in agricultural landscapes (e.g. if stubble is extracted without sufficient left behind to provide soil cover). Without an implemented sustainability assessment system, it will be difficult to quantify sustainable levels of biomass extraction and adjust management accordingly

- higher productivity agricultural land (rather than lower-productivity, under-utilised land) could potentially switch to energy production (or carbon sequestration), under certain policy and economic settings. This could be problematic – especially if the sustainability goals were to ensure minimal impact on food production
- if a biomass or bioenergy producer wishing to access a global market which expected producers to comply with current development of sustainability standards (Chapter 3), it would be very difficult for an Australian producer using biomass from agricultural land to meet the standard due to lack of assessment systems in place.

4.7.1.3 Clearing of native vegetation

The Native Vegetation Management Framework 2002 (Department of Sustainability and Environment, 2007) aims to achieve a reversal, across the entire landscape of the long-term decline in the extent and quality of native vegetation, leading to a net gain. Net gain is defined as when overall gains in native vegetation are greater than overall losses and where individual losses are avoided where possible. There are three steps for land managers and owners to address when considering vegetation clearing:

- avoid adverse impacts, particularly through vegetation clearance;
- if impacts cannot be avoided, minimise impacts by careful planning, design and management; and
- if clearing must occur, the clearing must be offset.

A planning permit is required to remove native vegetation, and the three step approach is outlined above is used to decide on the issue of permits.

Thus even in the case of strong economic or policy incentives for bioenergy development, broad-scale clearing of native vegetation would not result if assessed under the Native Vegetation Management Framework. All states in Australia have similar policies.

4.7.1.4 Waste

Waste is defined in the current Australian Government review of the national waste policy (Waste Policy Taskforce, 2009a) as:

> Any discarded, rejected, unwanted, surplus or abandoned matter; or otherwise discarded, rejected, unwanted, surplus or abandoned matter intended for recycling, reprocessing, recovery, reuse, or purification by a separate operation from that which produced the matter; or sale, whether of any value or not (National Environment Protection [Movement of Controlled Waste between States and Territories] Measure, as varied December 2004).

A major difference between older definitions and current definition of waste is the changed emphasis of waste as something which is discarded, to include the potential for the matter to be intended for recycling or reuse. The waste hierarchy is used to manage priorities for waste – avoidance is the most preferred option and disposal is the least preferred (Figure 4-3).

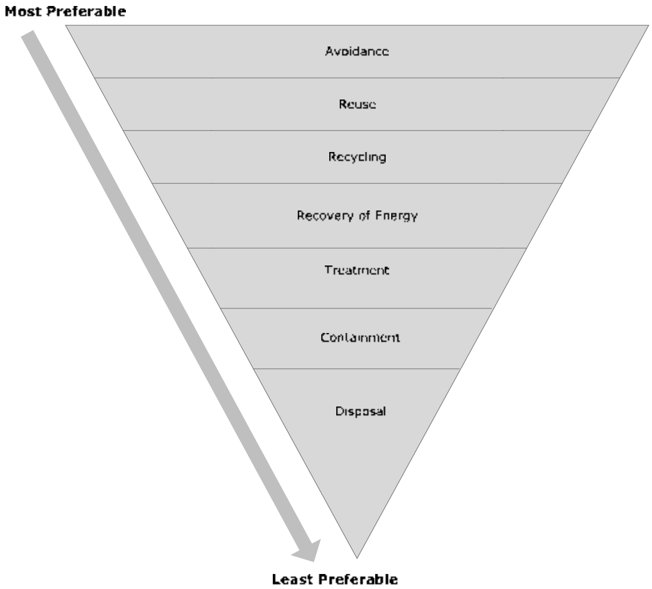

Figure 4-3 Waste management hierarchy (adapted from Environmental Protection Agency Victoria, 2009)

Wastes are managed according to their classification. Municipal wastes are typically collected from households by local councils through kerbside collections. Commercial and industrial wastes (arising from commercial, industrial or trade activities) pose a low risk to the environment. Prescribed industrial wastes are generated by a commercial or industrial site and have the potential to be hazardous to human health or the environment. Wastes which may be considered as biomass production inputs will be either municipal (most likely) or commercial/industrial wastes because of the higher percentage of organic wastes generally found in these waste classifications.

In Victoria, the minimisation or diversion of waste streams is driven by the landfill levy applied under the *Environment Protection Act 1970*. Levies apply to municipal, commercial, industrial and prescribed wastes deposited onto land at licensed facilities in Victoria (Environmental Protection Agency Victoria, 2008). The landfill levy structure reflects the difference in the magnitude of environmental risk posed by the different waste streams, and also seeks to accommodate regional differences.

Many of the following policies are underpinned by the action of the landfill levy, and in some cases funded by the proceeds from it, including:

- Towards Zero Waste Strategy 2005 (Department of Sustainability and Environment, 2005)
- Metropolitan Waste and Resource Recovery Strategic Plan (Department of Sustainability and Environment, 2009b)
- Victorian Advanced Resource Recovery Initiative (Department of Sustainability and Environment, 2009c)
- Resource recovery funding (Sustainability Victoria, 2009a) (which is not currently focused on biomass but may be relevant in the context of improving the ‘purity’ of waste streams to serve as production inputs)
- Waste Wise Program (Sustainability Victoria, 2009b) (which provides guidance rather than funding on how to go about reducing and/or managing waste streams).

At a national level, National Waste Management Association of Australia guidelines exist. They are a voluntary industry Code of Practice.

The current thinking behind the creation of a National Waste Policy Framework (Waste Policy Taskforce, 2009b) is to align the separate state policies on waste minimisation and disposal by a national policy framework. Although the vision maintains the promotion of the minimisation of wastes, a focus on creating fewer regulatory inconsistencies and market impediments is a focus of the framework.

4.7.2 Transport to processing facilities or other markets

Transportation of biomass or liquid biofuels (or other bioproducts or processing inputs) is a necessary component of the value chain linking producers to customers. It adds value by enabling trade rather than by changing the nature of the tradeable commodity itself. Accordingly, minimisation of transport to link markets should be sustainability objective, and may be achieved through either proximity or efficiency.

Planning and zoning laws at state and local government levels dictate the location of either the origin or destination of production facilities (agricultural, industrial etc. – see section 4.7.3), and also play a large part in the 'designation' of the surrounding transport infrastructure. The designation of transport infrastructure reflects the volume and nature of the foreseeable transport activity. It will take into account the overall transport network configuration in the vicinity, aiming for maximum efficiency. In Victoria, designations, and the corresponding infrastructure design and management, are made by various bodies under the powers of the *Roads Management Act 2004*. Decisions to upgrade infrastructure may be made as a result of increased transport activity, with most industrial activity likely to influence the transport network only at a very local level in the vicinity of the facility itself (e.g. due to so-called 'last mile' issues between the facility and the principle freight network). The existing transport infrastructure, particularly access to the principal freight network of arterial roads or railways, is taken into account during the planning stages for any new development. In Victoria, the principal freight network has been recently identified through Freight Futures: the Victorian Freight Network Strategy (Department of Transport, 2008).

Upgrades to infrastructure in the immediate environs of a production facility may be necessary to allow (for example, B-double freight vehicle movement in and out of the site). Parking facilities may be required for the workforce for large industrial facilities. Decisions at this scale will generally be taken in consultation with local government planners during the planning application stage.

Facilities of significant magnitude may be referred for an Environment Effects Statement (EES) under the *Planning and Environment Act 1987*. In the event of an EES being required, the proponent must satisfy the Minister for Planning that the relevant conditions have been met or community concerns addressed including considerations relating to the foreseeable transport activities.

Biofuels producers may obtain assistance for supporting infrastructure through the Victorian Government's Regional Infrastructure Development Fund (Business Victoria, 2008) and/or the Biofuels Infrastructure Program (Business Victoria, 2009). An example of where this assistance may be applied could be in the upgrade of a bridge in a regional location that connects the biofuel production facility to the principle freight network.

Transport impacts can rarely be ascribed to only one value chain such as bioenergy. A transport network will usually service multiple uses. There are complex interactions between costs, efficiency improvement, attribution of impacts to multiple users as well as between new and existing transport networks.

4.7.3 Production facility

A biofuel producer seeking to establish a new production facility may deal with the following review or approval processes:

- planning approvals to be gained under the *Planning and Environment Act 1987*, which are generally dealt with at the local government level for all but the largest facilities, and will take into account impacts upon the surrounding environment and consistency with the approved activities for the location in question
- planning approvals may also be subject to the requirements of the *Heritage Act 1995*, as well as the *Aboriginal Heritage Act 2006*, which seek to protect items of cultural significance
- referrals for Environment Effects Statements under the *Environment Effects Act 1987* may be required for proposals that are capable of having a significant effect on the environment
- referrals for assessment under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* may be required where matters of national environmental significance are present (e.g. threatened species and ecological communities, cultural places) – notably

powers exist under the EPBC Act for bilateral agreements with the states such that approvals made under an EES confer an approval against the EPBC requirements

- a works' approval under the *Environment Protection Act 1970* will be required where the industry or process is prescribed under the Act, which will in turn lead to a licence requirement for the site. These approvals are a combination of minimum standards which may not be exceeded (e.g. regulations for some pollutants) and best practice (e.g. risk identification and mitigation for water, noise emissions)
- a works' approval application will also be required where changes are planned to an existing industry that will have an effect on wastes discharged to the environment.

Aside from the review/approval processes above, the biofuel producer may also be eligible for assistance or be able to factor the following into their business model:

- carbon abatement – for example, conversion of waste to energy may generate a revenue stream directly through the Carbon Pollution Reduction Scheme (if it is introduced)
- the Carbon Pollution Reduction Scheme will also improve the business case for bioenergy and biofuels (section 4.3.1)
- energy-from-waste projects may receive assistance under the various waste management programs (section 4.7.1.4)
- the Victorian Renewable Energy Target (VRET) (Essential Services Commission, 2007) Australian Government's Mandatory Renewable Energy Target (MRET) (Office of the Renewable Energy Regulator, 2009), which indirectly support the business case for bioenergy
- the Victorian Energy Technology Innovation Strategy (Department of Primary Industries, 2009b) which provides significant funding for large-scale sustainable energy demonstration projects
- funding and other support programs of the Australian Government (section 4.3.1).

In the example outlined above, the planning and approvals process for production facilities is rigorous in assessment of social, environmental and economic impacts, and where appropriate, mitigation strategies. The various approvals may be construed (e.g. an EES) may be the subject of more scrutiny and rigour than any other part of the value chain (and may actually include other segments of the value chain such as transport). This level of process is effective at the local scale, but is not set up to deal with indirect effects or other long-term or broader-scale sustainability issues that may be engendered by a large industry expansion (section 2.2 and 2.3).

4.7.4 Different product streams

Depending on the product stream, the following requirements will be relevant:

- transport fuels, as covered by the Australian Government *Fuel Quality Standards Act 2000*
- *Fuel Standard (Biodiesel) Determination 2003* and the *Fuel Standard (Diesel) Determination 2001*, which applies for diesel/biodiesel blends containing not more than 5 percent biodiesel
- *Fuel Quality Information Standard (Ethanol) Determination 2003*, which requires labelling of fuel dispensers by retail suppliers of ethanol-containing petrol
- additional standards are under consideration for the *Fuel Standard (Petrol) Determination 2001*, which includes a fuel quality standard for ethanol that can be blended up to 10% with petrol.

The *Victorian Environment Protection (Vehicle Emissions) Regulations 2003* contain requirements on the permitted maximum vapour pressure of petrol or petrol-blends. These standards are designed to safeguard the consumer by guaranteeing product quality and providing transparent information, and to protect the environment more broadly. Compliance with the requirements of the standards is administrated under strict reporting and audit schemes. The intended outcomes of improving consumer confidence and air quality standards appears to be successful with these standards.

For bio-electricity, the feedstocks which are currently eligible to qualify for RECs under the Australian Government *Renewable Energy (Electricity) Act 2000* and the *Renewable Energy (Electricity) Regulations 2001* are closely specified as discussed in section 4.3.1 . Greenpower accreditation is the responsibility of the bioelectricity provider, and is discussed in detail in section 4.4.

4.7.5 International and domestic markets

Within the domestic market, it is a requirement for the biofuel retailer to provide labelling of ethanol-containing fuels. To be eligible to sell GreenPower product/s, a retailer must source energy from an accredited GreenPower provider (GreenPower, 2009b)(as discussed in section 4.4).

If Australia is to engage significantly with the international markets for biomass and/or biofuels, there are some issues that need further consideration. For example, there is an emerging market for export of wood pellets for energy purposes. This may raise some additional complexities around demonstration of sustainability credentials for the exporter, depending on which international market is being accessed. Biomass and biofuel imports and exports will be subject to WTO (FTA and GATT) rules (section 3.5). Many of the issues around sustainability in trade are currently unresolved and may in future be subject to formal challenge within WTO processes, but in the meantime the Australian Government is responsible for ensuring compliance.

4.7.6 Consumption

There are a few policies which are relevant to biofuel/bioenergy consumers, for example:

- the *Victorian Environment Protection (Vehicle Emissions) Regulations 2003* contain provisions as relate to tailpipe emissions from motor vehicles – the influence of fuel choice on this outcome is significant and therefore is of relevance to biofuels users
- the Commonwealth Energy Credits Grants Scheme (Australian Taxation Office, 2009) provides a rebate on fuel excise for users of biofuels, which is due to be phased out in 2010
- the Victorian standard feed-in tariff (Department of Primary Industries, 2009c) which applies to homes and business operators of renewable biomass energy generation systems who supply their excess energy back into the grid.

These measures are generally designed to promote the uptake of bioenergy or biofuels, and in some cases contain environmental protection criteria. Currently, policy and economic settings to drive demand are either cautious (e.g. voluntary targets); under development (e.g. CPRS); or are recent and the effects of stimulating the demand have not yet been fully expressed (e.g. feed-in tariffs). The impacts of the current or developing policy settings, as well as future potential changes in economic settings that may arise from, for example, long-term increases in the price of oil, are not adequately assessed in this report and require further analysis.

4.8 Key messages and conclusions

1. The Australian Government and various State Governments have a range of policy mechanisms in the form of regulations, targets, mandates, incentives, tax rules and standards with respect to bioenergy and biofuels. There are initiatives for clean and renewable energy and an expanded Mandated Renewable Energy Target in place, as well as an emissions trading scheme (Carbon Pollution Reduction Scheme) and an expanded Mandated Renewable Energy Target before Parliament at the time of writing.
2. The bioenergy value chain crosses from biomass production through conversion to distribution (potentially including export and import markets) and therefore a broad range of other policies are relevant along the value chain. These include policies for water, biodiversity, climate change, agriculture, forestry, waste management, transport and regional development.
3. Emerging bioenergy and biofuel value chains require reference to and compliance with this array of policies, legislation and regulations from Australia's three levels of government, often with additional industry specific codes of practice, agreements and requirements. This makes for a complex policy environment. However, the large number of policies, regulations etc. through the value chain indicates that there are many building blocks in place for a bioenergy sustainability framework, if they could be systematically aligned and synthesised. There will be gaps, and these could be addressed in a targeted manner.
4. Continual changes in biofuels policy, regulation, and funding arrangements over the last ten years has created considerable uncertainty for biofuel producers and investors. There are a number of reviews currently being undertaken by the Australian Government which could

substantially change the investment and financial viability of enterprises and the overall industry.

5. The biomass production segments of the value chain are very heterogeneous and often very contentious. The biomass can come from native forests, plantation forests, agricultural systems (food or residues), changed land uses (which may be complementary or competitive with agriculture), and waste streams. There are important differences in the complexity and restrictiveness of the policy and regulatory environments from these different production systems:
    a. Native forests have relatively comprehensive, robust and mature policy frameworks which aim to achieve sustainable forest management in both public and private native forests. Plantations establishment and management is also relatively well regulated. In addition, there are robust sustainability assessment systems which seek to evaluate whether the policy mechanisms achieve their sustainability goals. There are two internationally accepted certification schemes for forestry operating in Australia.
    b. Agriculture does not have a comparable policy and regulatory framework with respect to setting and achieving sustainability goals. There are many ‘best practice guidelines’ encouraged through catchment management plans, EMS and other initiatives which are voluntary, and as such are not systematically and comprehensively implemented. There are no widely-adopted sustainability assessment systems or internationally-recognised certification schemes for agricultural products (apart from organic produce).
    c. All Australian States have legislation which would not allow the broadscale clearing of native vegetation for bioenergy plantings.
    d. Waste is not considered a scarce resource – indeed a sustainable outcome for the waste domain would be less generation of waste, which may run contrary to the needs of energy-from-waste value chains. There is an implemented and effective set of policies at Australian and State Government levels for management of wastes, and to safeguard against combustion of inappropriate materials.

    This continuum of policy and regulation is possibly related to the perceived scarcity and value of the resource – native forests are considered scarce and deliver a wide range of non-market values; whereas waste is perceived as having no or little value. Agriculture has not been perceived as providing strong market or non-market values – although recent debates about future food security may mean that the perception is changing and that agriculture may in future be accorded more value by society in general.
6. There are robust national and state policies and regulations pertaining to the development of a processing facility for bioenergy or biofuels. Environmental Impact Assessment – which requires regulatory consent and therefore references all of the relevant state and national legislation – is a well established approach but it is focused on assessing impact risks and mitigations. It provides for community consultation. It generally does not deal with the source of the biomass feedstock in established biomass production systems, or with whole of chain direct effects, or indirect effects.
7. There is no specific implementable sustainability assessment system in place in Australia for bioenergy (although NSW has legislated the use of Roundtable for Sustainable Biofuels Version Zero, which is not currently operational). The State of the Environment reports, Montreal or other criteria and indicators currently used (Chapter 5) are not sufficient for bioenergy, because they do not have adequate capacity to deal with:
    a. direct life cycle impacts through a value chain
    b. indirect land use change and the effects thereof, product substitution or other issues which are raised as key sustainability issues in the biofuels arena.
8. The potential implications for Australia of the lack of a cohesive and comprehensive bioenergy sustainability framework in Australia include:
    a. Australian biomass, bioelectricity and biofuel producers might not have access to international markets if they are not able to certify product according to an internationally recognised scheme based on a detailed life cycle analysis
    b. Australia risks being the recipient of biomass or biofuel products that do not meet the sustainability requirements of other nations
    c. Biomass exporters may have different sustainability reporting requirements for exporting the same product depending on the market into which they are selling – for example, wood produced in Australia would technically be able to access a European market (e.g. packaging or paper) if they had Forest Stewardship Council (FSC) or

Australian Forestry Standard (AFS) certification, but with exactly the same certification (and the same sustainability outcomes in the forest in Australia), may in the future not be able to access the energy market in Europe without complying with several extra sustainability assessment and reporting criteria

d. Bioelectricity and biofuel producers may struggle to obtain sustainability certification of biomass coming from heterogeneous sources (i.e. they can obtain FSC or ASF certification for biomass from forests, whereas they currently will not able to certify biomass from agriculture)
e. Australian and State Governments may encounter issues with the FTA and GATT. Biomass and biofuel imports and exports which may be subject to 'sustainable production' descriptions will have either no definitions, disparity of definitions, or lack of clarity in definitions of what qualifies as 'sustainably produced'. Australian industry and government may address this in part by engaging with international activities
f. Loss of opportunity to build confidence in communities of consent (including government, NGOs and consumers) that bioelectricity and biofuels are being sustainably produced
g. Loss of opportunity to differentiate those bioelectricity and biofuel products with poor sustainability credentials from those with sound credentials, thereby limiting an opportunity for the whole industry to develop in a sustainable fashion. The proposed CPRS accords all biofuels a zero carbon burden and does not encourage low emission biofuels.

9. An adequate institutional system should ensure that stimulation of the industry via policy and other financial incentives at the demand end of the value chain would not drive unsustainable use of resources in the upstream end of the value chain – i.e. other policy mechanisms operating at a broader scale across multiple sectors such as the National Water Initiative should prevent unsustainable use of water *per se*, including use of bioenergy production. It is beyond the remit of this report to provide definitive conclusions. Based on the points raised above, however, there do appear to be gaps and vulnerabilities arising from existing arrangements.

In the following chapter we examine some possible pathways along which a sustainability assessment system could be developed in Australia.

5 Bioenergy sustainability assessment systems

Chapter Summary

In this chapter we discuss bioenergy sustainability assessment systems from theoretical and practical perspectives. The elements comprising a sustainability assessment system, along with the inputs and feedbacks that occur with other parts of the full bioenergy sustainability framework, are shown in Figure 5-1.

General approaches to sustainability assessment

There are multiple approaches and methods developed to assess sustainability. The different forms of sustainability assessment each have their own languages, epistemologies and theoretical constructs. More intensive integrative approaches may be appropriate for assessment of sustainability of large-scale, high-impact or contentious projects or industry sectors.

Input-based and outcome-based assessment, risk and effort

Sustainability assessment approaches can be broadly grouped into two basic categories:

- input-based approaches, which assume that certain inputs or activities provide sustainable outcomes
- outcome-based approaches, which use measurement and monitoring of key system variables to enable assessment of system condition and trends, and comparison with defined sustainability objectives and targets.

Input-based systems (such as setting targets, specifying processes without monitoring the outcomes) may be appropriate where the risk (i.e. likelihood and consequence) is very low, or where the systems are predictable and well-defined (Table 5-1). In situations where the risk is high (or uncertain), these approaches do not have a high likelihood of ensuring sustainable outcomes.

In natural systems where relatively little is known about system response over the long term, and widespread loss of ecosystem function would have major consequences, an outcomes-based approach is critical. Any such assessment system must be embedded in effective process with feedback mechanisms to allow improvement of the assessment system itself, as well as the resources being managed. This provides a sound basis for continuous improvement in management decisions and resource use, and can therefore underpin a transition towards sustainable management of socio-ecological systems.

Outcome-based approaches are therefore more robust in terms of ensuring sustainability, but they also require more effort (and cost more) to implement. They are desirable at a sector level in situations where there is a high degree of stakeholder concern, when there is potentially high (or uncertain) level of risk of damage to socio-ecological systems from that sector. If Australia is to participate in international trade of biomass or bioenergy, then implementation of a sustainability assessment system which is compatible with, and mutually recognised by international trading partners will be necessary.

Criteria and indicators – a common currency

Criteria and indicators (C&I) are used as a common expression of several different sustainability assessment methods. If well specified to capture key system outcomes, they can gauge the essential ecosystem functions as well as the human values that a system should deliver. They provide a common currency which can be used to express the key attributes of the system which are to be sustained.

New and emerging sustainability assessment systems being developed internationally use a C&I approach to capture these benefits. Effective systems embed C&I within an explicit conceptual framework of how the system under assessment functions at specified scales, and what drives it. The C&I should also be linked to processes for setting goals (sustaining what, for whom, for how long?), selecting methods for measurement and calculation of indicators, and evaluating and reporting. All of these processes will ideally be framed by open and transparent consultation with relevant stakeholders and communities of consent.

Sustainability criteria and indicators in Australia – an example from forestry

Elements of the Australian forestry sustainability framework have been in place for >10 years, and have been applied across a wide range of environments. Certification under the Australian Forestry Standard has been possible since 2003.

We provide a description of the C&I systems currently used in Australian forestry, focussing on C&I as a fundamental component in adaptive forest management. We outline the use of C&I for reporting at all levels from individual enterprise, through industry, to state and national level, and describe the application of C&I as a basis for certification. This adaptive management approach described here can be applied to any production system, including the value chains for bioenergy and biofuels.

Strengths of the C&I system for the forestry industry include its:

- applicability at range of scales from enterprise through to international
- robust scientific basis to C&I
- processes to build a shared view (or in some cases a mediated or compromise view) between stakeholders of valid local indicators, appropriate targets, and how monitoring and review will be conducted
- monitoring of outcomes provides the foundation for ongoing review and improvement, which is essential for 'adaptive' management and progress towards sustainability goals (Figure 5-2).

Ongoing issues with the application of C&I in forestry include:

- the scientific methods for cost-effective monitoring and assessment (especially dealing with trade-offs) remain an ongoing challenge.
- data for large areas of the forest estate remains sparse or non-existent.
- systems to date have not specifically considered production of feedstocks for bioenergy. This may involve significant land use change (LUC), increase in land area, and more frequent and intensive harvesting that can create additional threats to sustainability.
- ongoing resistance to forestry by some sections of the community creates a lack of confidence and commitment by government and industry.

Designing sustainability assessment systems for bioenergy

Setting up a process

- structured processes to develop and test, implement, and formalise recognition of the sustainability assessment and any associated verification systems are necessary.

Selecting sustainability criteria:

- criteria are descriptions of the components of sustainability that are to be assessed
- many emerging systems for assessing the sustainability of bioenergy (mostly focused on biofuels) attempt to deal with the full range of sustainability issues including biodiversity, changes in soil and water values, GHG emissions from LUC and land management, effects on food security, or the indirect effects of LUC, substitution of products (e.g. using grain to produce fuel rather than using it as food), and impacts of land use change on biodiversity
- new C&I assessment systems for bioenergy will need to go beyond the established C&I assessment systems for forestry in order to address these issues
- criteria for assessment will vary across regions and countries. At an international scale, the range of C&I must be comprehensive to deal with the full range of issues that may arise in any given production situation around the globe. At regional and local scale, criteria may be more focussed on specific priority environmental or socio-economic issues
- technical expertise will be required to provide a robust science basis, especially in relation to ecosystem maintenance.

Indicators for monitoring change in criteria

- criteria across different systems will likely address similar themes, but appropriate indicators will vary widely, depending on the nature of threats to sustainability, scale of assessment, and available technologies and costs of collecting data.
- indicators should be a reliable measure of the criterion (repeatable and unambiguous), easy to measure and record, and sensitive to change. For efficiency in monitoring, evaluation and reporting, indicators should be specified by technical experts with knowledge of the available data, technology platforms, methods and costs of acquiring new data.
- methods and metrics for measuring some indicators are well understood and mature, while others have immature methods, a lack of data or very complex underlying conceptual models – especially when the scale and local context are critical. For example, it is difficult to express biodiversity in simple units, because it is fundamentally a scale related interpretation.
- life cycle assessment (LCA) methods for calculating direct GHG emissions are well-developed. However, there are challenges in application and interpretation of LCA for bioenergy systems: the results are affected by which elements are included in the analysis (system boundary), the allocation method used, and the model approach applied.
- methods to assess emissions due to indirect land use change are developing rapidly, but are still immature. The data to support the assessments are very sparse. To incorporate the emissions due to indirect land use change (i.e. the losses in biomass and soil carbon stock and emissions of methane and nitrous oxide) into estimates of life cycle GHG emissions, two approaches have been suggested:
    1. expansion of the system boundary to include the indirect effects. For example this is proposed for the USA's *Renewable Fuels Standard.* Models are used to calculate the impact on GHG emissions from expansion of biofuel production, including indirect LUC within and beyond the USA. The model results are used to check whether a particular biofuel meets the GHG reduction target specified by the USA's *Energy Independence and Security Act (2007)*.
- use of default figures to estimate impacts of indirect LUC, which are then added to estimates of direct emissions across the value chain. For example, the indirect land use change (iLUC) factor approach uses historic data for the trade to calculate an average emissions factor per ha of displaced land.

Choice of targets to support the application of C&I

- hard targets *must* be met in order for key goals to be achieved. They may be in the form of prescriptive rules which must be followed (e.g. national and international laws and obligations that must be abided by, such as thresholds for quality of drinking water). They are desirable where international law, other obligations or critical requirements for ecosystem maintenance must be met
- the ecosystem maintenance targets may be difficult to specify in indicators because of the challenges of insufficient knowledge, definition of system boundaries, complexity associated with long lags in ecosystem responses, and where common resources, such as water, are shared between several different (and often competing) uses. For many aspects (e.g. biodiversity) the appropriate target value is difficult to define. Key questions of 'what and how much should be sustained, and for whom?' are often value judgements rather than scientifically-derived
- Soft targets are those which have less prescriptive guidelines (e.g. efforts must be made to minimise erosion, or improve the quality of life for the local residents). They may be more qualitative or aspirational, and it may be difficult to evaluate whether the indicator has been met. For these reasons it is better to avoid use of soft targets.

Evaluation of C&I

Evaluating information to judge performance against agreed objectives and goals is a key component of sustainability assessment systems. Judgements must be made across multiple C&I (representing the different dimensions of sustainability), at different scales, and synthesised and interpreted for a range of purposes or audiences:

- there are scientific challenges in integrating across multiple facets of C&I, as well as with the social processes that may support the evaluation. Multicriteria analysis and optimisation methods can be useful, and there is a range of social processes to interpret and use the information across multiple C&I
- the evaluation of many landscape-based C&I is scale related – for example for biodiversity and net energy metrics. A net energy example is provided in this chapter
- the example illustrates that sustainability of a system can only be truly assessed at a whole-of-system scale. And that the metrics that contribute to the evaluation must be carefully selected in the context of scale, trade-offs against other metrics, and the broader objective of the assessment.

Reporting

Reporting can be used for a range of purposes, and at many levels (enterprise, state, national and international). Examples include:

- to assess whether enterprise level sustainability objectives have been met
- to monitor and evaluate the importance of any measured trends (linear and non-linear) in, for example, an environmental or socio-economic variable, providing the basis for adaptive management
- to support certification process of a particular product or production pathway
- to report against obligatory transnational agreements
- to feed back into the setting of policy, legislation and other institutional systems in the design of sustainable energy solutions.

Formalising sustainability assessment via certification

- C&I can form the basis for formal certification of sustainability (e.g. AFS)
- the process of auditing methods of production and the tracking of products allows certification in terms of specified sustainability requirements. These two steps to certification form the basis of the label that guarantees that the product has been sustainably produced
- there are a number of existing certification systems operating at various scales around the world for forest products, fair-trade, organic foods and sustainable agriculture, some of which contain elements that would be suitable for part of the sustainability assessment of bioenergy and biofuels. Two of these organisations relevant to bioenergy (FSC and RSPO) are described in more detail in this chapter.

Essential characteristics of a sustainability assessment system

This chapter provides insight into some broad theoretical constructs and implementations of sustainability assessment systems which are already established (e.g. for forestry), or under development for biomass and bioenergy. We propose twelve ideal characteristics of a sustainability assessment system which are listed in section 5.6.

Conclusions and key messages

The conclusions and key messages from this chapter are summarised at the end of the chapter, as well as in the Executive Summary.

5.1 Introduction

In Chapter 3 we reviewed international activities in the development of bioenergy sustainability frameworks – including the institutional systems, and the sustainability assessment systems. There is complexity in the multitude of sustainability assessment systems that are under development at different scales by different organisations. For example, as seen in Chapter 3, the Roundtable for Sustainable Biofuels is an initiative of a Swiss University intended for international application (section 3.2.3). The Global Bioenergy Partnership (GPEB) is a transnational intergovernmental group developing a set of global science-based Criteria and Indicators (section 3.2.1.3). The Netherlands has put detailed effort into developing the Testing Framework for Sustainable Biomass (Cramer, 2007 see section 3.3.2), while industry groups have also developed their own approaches (see section 3.4.1 for palm oil and section 3.4.2 for soy). This will lead to different specifications and methods which could potentially lead to higher costs, confusion amongst biomass and bioenergy producers and consumers, as well as other unintended outcomes which would lead to the systems being ineffective.

In this chapter we discuss bioenergy sustainability assessment systems from theoretical and practical perspectives. We briefly review a broad range of approaches, before focussing on the 'criteria and indicator' (C&I) systems being developed internationally. We describe the elements comprising a sustainability assessment system, noting the inputs and feedbacks that occur with other parts of the full bioenergy sustainability framework. We give an example of a well-established system for sustainability assessment developed for forestry. We briefly describe the general characteristics of assessment systems under development worldwide for bioenergy, and conclude by listing the ideal characteristics of a sustainability assessment system for bioenergy.

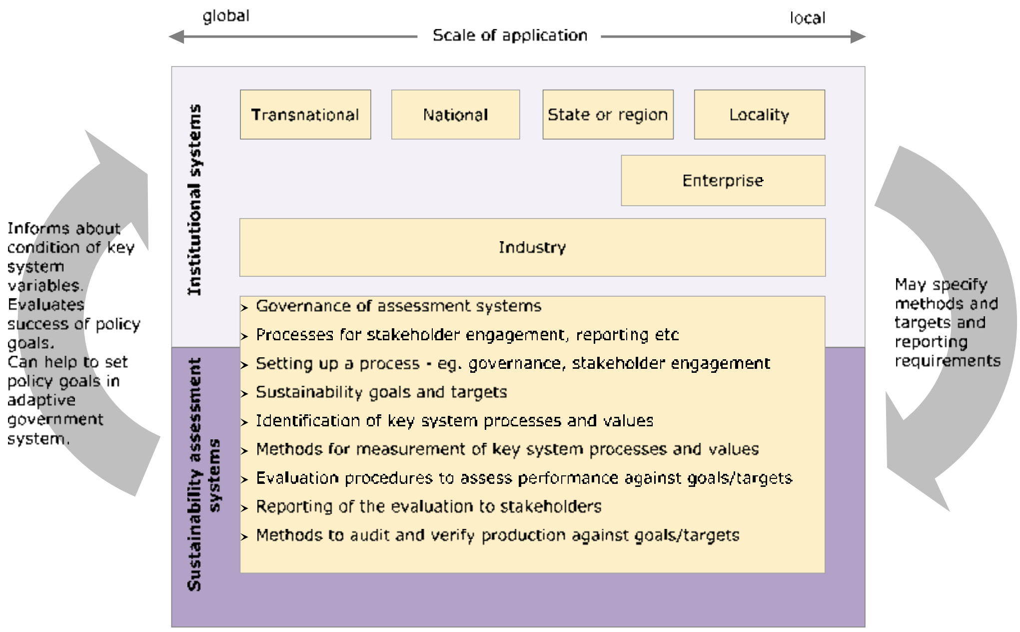

Figure 5-1 The sustainability framework, highlighting the sustainability assessment component

5.2 General approaches to sustainability assessment

There are multiple approaches and methods developed to assess sustainability. They include:

- extent of adherence to prescribed approaches (e.g. best management practice) (British Biogen, 2003; Oil Mallee Association of WA Inc., 2007; OECD/IEA, 2007)
- (Driver) – Pressure – State – (Impact) – Response approaches (usually referred to as Pressure – State – Response, or PSR). This framework, proposed by the Organisation for Economic Co-operation and Development (OECD) in the 1980s, uses indicators that reveal direct and indirect drivers (pressure) and societal responses (response), as well as trends in the environmental condition (state). These have been applied in a variety of forms in Australia in the State of the Environment reporting, and assessment of sustainability in agriculture and forestry. (Commonwealth of Australia, 1998; Smith and McDonald, 1998; SCARM, 1998; ANZECC State of the Environment Reporting Taskforce, 2000)
- resilience approaches. Ecosystem resilience is defined as the capacity of an ecosystem to tolerate disturbance without collapsing into a qualitatively different state that is controlled by a different set of processes. Resilience in socio-ecological systems has the added capacity of humans to anticipate and plan for the future. Resilience is considered to be a property of linked social–ecological systems and has three defining characteristics:
    - the amount of change the system can undergo and still retain the same controls on function and structure
    - the degree to which the system is capable of self-organization
    - the ability to build and increase the capacity for learning and adaptation.

  Full reviews of the topic can be found in (Gunderson and Holling, 2001; Walker and Salt, 2006) or on the Resalliance website <http://www.resalliance.org>
- system simulations (e.g. examining relationships between production and environmental degradation, and time trends in a system state where assessments are made in terms of direction and degree of measurable changes in system properties) (Eigenraam et al., 2000; Smith and McDonald, 1998)
- life cycle assessment, which considers environmental impact of options for making products or performing tasks over the complete life cycle (e.g. Cherubini et al., 2009).
- ecological footprint analysis, which estimates resource consumption and waste assimilation requirements of a defined human population or economy in terms of a corresponding productive land area (Wackernagel and Rees, 1996; Krotscheck and Narodoslawsky, 1996; Krotscheck et al., 2000)

- threat identification model (TIM), which considers spatially explicit links between defined hazards and the environment, and land practice options that can address these hazards for specific land units (Smith et al., 2000)
- environmental management systems (EMS) which help to achieve continuous improvement through a 'plan, do, check, improve' cycle that can include best management practices and codes of practice. They provide a structured approach to help farmers assess and improve their environmental performance on their own farms. The business (farm) identifies environmental impacts and legal responsibilities, then implements and reviews changes and improvements in a structured way. An EMS can be self-audited (first-party audit) or externally audited (second- or third-party audit) and may be certified to the international ISO 14001 standard, or to specific customer or industry requirements (Victorian Department of Primary Industries, 2009).

The literature listed here represents a broad range of approaches, scales, and levels of detail (and therefore effort, time and expense) in measuring and assessing sustainability. The forms of sustainability assessment each have their own languages, epistemologies and theoretical constructs. Some approaches were initially developed for national level reporting of trends (e.g. Montreal Process Criteria and Indicators were developed to assess sustainability of forest management (Anon, 1995; Commonwealth of Australia, 1998). Other approaches have been developed for a specific sector (for example, the Oil Mallee Association of WA Inc. Code of Conduct sets out best practice guidelines for a of an emerging bioenergy industry in a specific region (Oil Mallee Association of WA Inc., 2003)). The best practice guidelines have had detailed subsequent scientific studies into various aspects of sustainability management, including the economics of the system (Abadi et al., 2006), the nutrients (Grove et al., 2007) hydrology (Wildy et al., 2004) and biodiversity (Smith, 2009).

More intensive integrative approaches (e.g. Eigenraam et al., 2000; Krotscheck et al., 2000) may be appropriate for assessment of sustainability of large-scale, high-impact or contentious projects or industry sectors. The different methods may (or may not be) compatible with each other. For example, LCA and simulation models of different types can be used to provide estimates of some indicators.

5.2.1 Input-based and outcome-based assessment, risk and effort

These and other approaches can be broadly grouped into two basic categories:

- input-based approaches, which assume that certain inputs or activities provide sustainable outcomes. For example, it was assumed for many years in Australia that fencing native vegetation maintained or improved its condition, yet in reality fencing is useful in improving vegetation condition IF grazing pressure is the key driver of degradation, AND fencing keeps reduces grazing pressure effectively. These are most often flawed (or at least untested) assumptions. Most input-based best practice methods assume intended outcomes, without actually measuring or monitoring
- outcome-based approaches, which use measurement and monitoring of key system variables to enable assessment of system condition and trends, and comparison with defined sustainability objectives and targets.

The analogy for these approaches could be found in, for example, a manufacturing process such as making vehicles. An input-based approach assumes that if the inputs and process met a certain standard (e.g. individual components of the vehicle were sound, the machinery for assembly was working correctly, and the people working in the factory were being well managed), then the vehicles would be of the required standard without ever testing the performance of those vehicles. While this may be a sufficiently robust approach in some manufacturing processes, it is problematic especially when the consequence of failure is high , or (as in most natural systems) the effects of inputs on outcomes is not well understood.

Input-based systems (such as setting targets, specifying processes without monitoring the outcomes) may be appropriate where the risk (i.e. likelihood and consequence) is low, or where the systems are predictable and well-defined (Table 5-1). In situations where the risk is high (or uncertain), these approaches do not have a high likelihood of ensuring sustainable outcomes.

In natural systems where relatively little is known about system response over the long term, and widespread loss of ecosystem function would have major consequences, an outcomes-based approach is critical. Key system variables must be defined and they (or surrogates) must be monitored over the long term in order to assess system condition and trends. Any such assessment system must be embedded in effective process with feedback mechanisms to allow improvement of the assessment system itself, as well as the resources being managed. This provides a sound basis for continuous improvement in management decisions and resource use, and can therefore underpin a transition towards sustainable management of socio-ecological systems.

Table 5-1 Appropriate approaches to sustainability assessment systems depend on level of risk, effort and the level of value required in terms of ensuring sustainable outcomes from a given activity or sector

<table>
<tr><th></th><th>Approach to sustainability assessment</th><th>If the sustainability risk of the bioenergy sector is…</th><th>Effort required to implement sustainability assessment</th><th>Likelihood of achieving more sustainable outcomes</th><th>Appropriatenes s of approach</th></tr>
<tr><td rowspan="4">Both input and outcome-based must be embedded in effective process</td><td rowspan="2">Input-based</td><td>Low</td><td>Low</td><td>Low</td><td>Appropriate low investment</td></tr>
<tr><td>High (or uncertain)</td><td>Low-Medium</td><td>Low</td><td>An under-investment of effort</td></tr>
<tr><td rowspan="2">Outcome-based</td><td>Low</td><td>High</td><td>Medium-High</td><td>An over-investment of effort</td></tr>
<tr><td>High (or uncertain)</td><td>High</td><td>Medium-High</td><td>Appropriate high investment</td></tr>
</table>

Outcome-based approaches are therefore more robust in terms of ensuring sustainability, but they also require more effort (and cost more) to implement. They are desirable at a sector level in situations where there is a high degree of stakeholder concern, when there is potentially high (or uncertain) level of risk of damage to socio-ecological systems from that sector.

Currently in Australia, the bioenergy industry is small (section 2.1.1), although the drivers are in place for the industry to grow. A full evaluation of the sustainability risks in Australia, and the adequacy of existing institutional systems in terms of managing this risk is beyond the scope of this report.

If a due consideration showed that the risks were high and the existing input-based measures were insufficient to ensure agreed sustainability outcomes, then outcome-based sustainability assessment systems would be the most effective approach. If Australia is to participate in international trade of biomass or bioenergy, then implementation of a sustainability assessment system which is compatible with, and mutually recognised by international trading partners will be necessary.

In the remainder of this chapter, we evaluate outcomes-based criteria and indicator (C&I) systems, due to compatibility with international systems (reviewed in Chapter 3), as well as with current Australian approaches in forestry, agriculture and State of Environment reporting processes (reviewed in Chapter 4).

5.3 Criteria and indicators – a common currency

Criteria and indicators (C&I) are used as a common expression of several different sustainability assessment methods. If well specified to capture key system outcomes, they can gauge the essential ecosystem functions as well as the human values that a system should deliver. They provide a common currency which can be used to express the key attributes of the system which are to be sustained, while allowing flexibility in the specific indicators to be adapted for local context, as well as in the methods used to estimate them. These factors have lead to widespread implementation of C&I as the common currency of sustainability assessment and reporting. New and emerging sustainability assessment systems being developed internationally use a C&I approach to capture these benefits.

Meaningful assessments of sustainability need more than a list of C&I specifying the scientific content aspects for evaluation. Effective systems embed C&I within an explicit conceptual framework of how the system under assessment functions at specified scales, and what drives it. The C&I should also be linked to processes for setting goals (sustaining what, for whom?), selecting methods for measurements and calculation of indicators, and evaluating and reporting. All of these processes will ideally be framed by open and transparent consultation with relevant stakeholders and communities of consent (section 2.4).

5.3.1 The terminology

There is a confusing tangle of terminology and theoretical constructs within the bioenergy sustainability literature, even within the subset focussed on C&I systems. In this report, we will use the terms as described here.

'Criteria' are used to describe the components of sustainability (e.g. biodiversity, social considerations) that are nominated for any particular assessment system. Sometimes criteria are described in terms of the desired condition (e.g. 'erosion is avoided', 'soil health is maintained or improved') and sometimes as a category for assessment (e.g. 'soil health').

'Indicators' are used to track temporal change in aspects of the criteria. Various types of data can be collected to inform/calculate the indicators. Such data are sometimes referred to as 'verifiers'.

'Targets' fall into two categories:

- Hard targets may be specified within C&I numeric values or rules which must be met in order for key goals to be achieved.
- Soft targets are those which are less prescriptive guidelines (e.g. 'efforts must be made to minimise erosion', or 'improve the quality of life for the local residents').

'Standards' are agreed approaches to which producers must adhere or report against. Lewandowski and Faaij, 2006 – defined 4 types of standards used:

- technical standards, which describe the requirements of the physical or chemical characteristics of a product, or change in the environment
- methodology standards, which describe requirements and procedure for the production of a defined output (e.g. the Clean Development Mechanism under the Kyoto Protocol describes a standard method for the calculation of GHG emission reduction attributable to a project)
- good practice guidelines, which describe the required manner to undertake an activity (e.g. the desired handling of pesticides in agriculture)
- sustainability standards, which describe the requirements to be fulfilled by a sustainable product or process.

'Certification schemes' are formalised third-party accreditation that a sustainability standard has been met. They must have:

- rules for certification and accreditation
- standards which define the aim of the certification, and describe the product or production processes to be fulfilled by certification (Lewandowski and Faaij, 2006).

'Reporting' as a term is used variously through the literature. In some cases, it means that the entity must report (but does not have to achieve) in a particular way. Reports can range from:

- enterprise-level reporting against C&I and agreed targets for stakeholders, or to a third-party assessor in order to achieve certification
- national, transnational, or aggregate reporting of trends etc.

'Evaluation' means the step of interpretation of information relating to either individual or collective C&I (i.e. the elicitation of meaning from the collection of information for individual C&I). Evaluation is usually against previously specified objectives and targets.

5.4 Sustainability criteria and indicators in Australia – an example from forestry

Elements of the Australian forestry sustainability framework have been in place for >10 years, and have been applied across a wide range of environments. Certification under the Australian Forestry Standard has been possible since 2003.

In this section we describe the Criteria and Indicators (C&I) systems currently used in Australian forestry. We focus on the application of C&I as a fundamental component in adaptive forest management. We outline the use of C&I for reporting at all levels from individual enterprise, through industry, to state and national level, and describe the application of C&I as a basis for certification. This adaptive management approach described here can be applied to any production system, including the value chains for bioenergy and biofuels.

5.4.1 Montreal Criteria and Indicators

The sustainability criteria for forestry cover the properties and processes occurring in the various parts of forest ecosystems, socio-economics, and the legal and institutional systems that support sustainable forest management. Australia is a signatory to the international Montreal Process, which has developed the C&I for the conservation and sustainable management of temperate and boreal forests, based on the 'Statement of principles for a global consensus on the management, conservation and sustainable development of all types of forest'. This document arose from the 1992 'Earth Summit', and Australia reports against the Montreal Criteria every 5 years via the national State of the Forests report. The most recent report was released in 2008.

The Montreal Criteria cover:

- biodiversity
- productive capacity
- ecosystem health
- soil and water
- carbon stocks
- socio-economics
- legal and institutional frameworks.

Sets of indicators have been developed for each of these criteria at an international level, and adapted to meet Australian needs (Forests Australia, 2009). The indicators aim to be surrogates for important properties and processes important to sustainability. They aim to be sufficiently sensitive so as to be able to detect change and inexpensive to measure, so that they can be used to track temporal change in ecosystem condition and output (Raison et al., 1997).

5.4.2 Reporting and management processes which use the Montreal C&I

The Montreal C&I can be used to support a range of processes, for several specific reporting and management purposes at local through to international scales. There are many ways that the Montreal C&I can be used in the assessment of condition of the forests, and within processes to design sustainable forest management.

5.4.2.1 Enterprise-level

At the enterprise or estate level, Montreal C&I form the basis for third-party independent audits of the sustainability of forest management under the Australian Forestry Standard (AFS). The Forest Stewardship Council (FSC) uses a different (but somewhat consistent) set of C&I as a basis for a separate forest certification scheme that is also used in Australia and internationally.

The Montreal C&I are used for reporting progress against the goals and conditions specified in Regional Forest Agreements (RFAs), or codes of forest practice. Whilst the C&I used for this purpose differ for individual RFAs, they are broadly consistent with the intent expressed in the Montreal C&I.

The Montreal C&I can also be used by forest managers to support forest planning and management. C&I can be used to help forest managers meet the growing community expectation that they should demonstrate sustainable forest management by quantifying progress against agreed goals and outcomes (targets). Essential to achieving this is consultation with stakeholders as to what indicators are valid, appropriate targets, and how monitoring and review will be done (Raison et al., 2001). Monitoring of outcomes provides the foundation for ongoing review and improvement, which is essential for 'adaptive' forest management. This will lead to sustainable forest management if the stakeholder goals are consistent with the needs of future generations. The pullout box on adaptive forest management and environmental management systems (EMS) provides further insight into the practical application.

5.4.2.2 Sub-national and national level

Some State Governments (e.g. Victoria, Tasmania, NSW) report on the sustainability of forest management on the basis of Montreal C&I. These use a wide range of available data, but do not use information from certification reports. The five-yearly State of the Forests Report constitutes Australia's report to the international Montreal Process. It is based on a synthesis of many types of data, ranging from national remotely-sensed estimates of forest disturbance and cover change (deforestation, reforestation), to regional case studies, to research studies at specific sites. There is a lack of data for large areas of Australia's forests and woodlands. Interpretations of sustainability presented in the State of the Forests Report are broad because the focus is on national-level reporting.

Pullout Box Adaptive forest management and environmental management systems in forestry

The achievement of 'adaptive' forest management is supported by the components of an EMS, such as that developed by the International Standards Organisation (ISO) that help to ensure structured, consistent and auditable processes. The principles of transparency (clarity to stakeholders about decision-making processes), openness (capacity of interested parties to participate in decision-making) and accountability (identification of who is responsible for implementing agreed decisions) are critical. The components of EMS are listed below.

Commitment, legislation and policy framework
The legislative and policy framework for forest management should ensure that all forest values are protected and maintained in a balanced manner. Obligations to international agreements, treaties and conventions, environmental legislation, and other regulatory instruments must be met.

Planning
Sustainable forest management principles should be reflected in goals and objectives clearly stated in plans. Transparency and openness in planning processes is essential at scales ranging from local (forest management unit) to regional and national. The adequacy of the information base for environmental risk assessment and planning is a critical issue.

Implementation
Effective implementation of practices to achieve sustainable forest management requires having the capabilities and support mechanisms required to achieve the objectives and targets specified in policies and plans. Key issues are designation of responsibility, capacity to implement (adequate resourcing), operational control, documentation, and knowledge and skill levels of staff.

Information, monitoring and evaluation
Sustainable forest management needs to be supported by information at relevant levels of detail and scale. This information is critical to risk assessment and planning, to assessing compliance with management guidelines, and very importantly to quantifying the outcomes of forest management practices on the ground. Independent audit is becoming increasingly important, as is the reporting of environmental performance to stakeholders. Evaluation of the importance of any environmental change is critical to adapting forest management, and to the reporting of environmental performance.

Review and Improvement
Commitment and capacity for review and improvement of forest management plans and practices is an important element of sustainable forest management. Appropriate data must be collected as a basis for the review. Processes to facilitate utilization of recent advances from research and development to improve management are needed. The capacity to respond to changing community expectations or legislation, and past environmental incidents is also very important.

In practical terms, forest management plans are often implemented via codes of forest practice that contain a set of goals and guidelines for achieving environmental care. These give broad direction as to how management practices should be planned and conducted, and often focus on roading, harvesting, regeneration, and the protection of soil and water values. Key supporting documents to codes of forest practice are local management prescriptions (guidelines) that specify actions needed to protect the environment in contrasting situations (e.g. the variation in the width of buffers along classes of streams that are needed to protect aquatic habitat or to maintain water quality in relation to risk of soil erosion, which varies with soil type, slope and storm intensities).

Monitoring
A key question in the forest management cycle is: Have objectives and targets for environmental care been met? Answering this question requires the monitoring and evaluation steps shown in Figure 5-2 The application of indicators, monitoring and evaluation procedures to underpin an adaptive forest management system (Raison et al., 2001). Monitoring must consider both spatial (i.e. range of ecosystem types and environments) and temporal considerations. From a spatial viewpoint, monitoring should focus on areas where there is likely to be greatest risk to environmental values caused by forest operations. A risk analysis based on available information and expert input should form part of the development of forest management plans. Monitoring will need to be varied temporally according to likely rates of change in environmental values, to capture the effects of changing forest practices, and to allow an assessment of the effectiveness of so-called 'best management practice'. Thus a strategic approach to monitoring is required that focuses on representative higher-risk situations, and tests the effectiveness of practices used to mitigate risk.

Evaluation
Evaluation of the importance of any measured trend in environmental values provides the basis for adapting forest management. Ideally, the evaluation should be guided by a performance measure or target that has been agreed upon during the forest management planning process. Definition of performance measures is a neglected area, but generally performance measures or targets take the form of (Raison, 2001):

- scientifically-based standards, currently rare in forestry
- interim standards, based on the balance of scientific opinion and adopted until better scientifically-based standards are available. These need to be calibrated for specific forest ecosystems
- compliance with plans, guidelines and prescriptions. This is the most common approach that focuses more on management inputs than environmental outcomes.

Figure 5-2 The application of indicators, monitoring and evaluation procedures to underpin an adaptive forest management system (Raison et al., 2001)

The evaluation step must take account of the area of forest affected by important environmental change, the temporal pattern of change, and integrating the consequence of change in a number of values. These issues have been discussed from the perspective of soil resources by Burger (1999) and Kelting et al. (1999).

5.4.3 Some strengths of the C&I system for forestry

Strengths of the C&I system for the forestry industry include its:

- applicability at range of scales from enterprise through to international
- robust scientific basis to C&I
- processes to build a shared view (or in some cases a mediated or compromise view) between stakeholders in valid local indicators, appropriate targets, and how monitoring and review will be done (Raison et al., 2001). Ongoing stakeholder interaction can help to build understanding of the changes in the distributions and costs resulting from alternative management strategies and practices.
- monitoring of outcomes provides the foundation for ongoing review and improvement, which is essential for 'adaptive' management and progress towards sustainability goals).

5.4.4 Ongoing issues with the application of C&I in forestry

Although there is a well-established system for use of C&I for forestry in Australia, some issues are still outstanding:

- The scientific methods for cost-effective monitoring and assessment (especially dealing with trade-offs) remain an ongoing challenge (Raison et al., 2001).
- Data for large areas of the forest estate, including for much of the private forest estate which is undergoing rapid change and which could be a very important land base for an expanded bioenergy industry, remains sparse or non-existent.
- Systems to date have not specifically considered production of feedstocks for bioenergy. This may involve significant land use change (LUC), increase in land area, and more frequent and intensive harvesting that can create additional threats to sustainability.
- Ongoing resistance to forestry, especially native forestry and major conversion of farm land to tree crops, by some NGOs and other sections of the community. This creates a lack of confidence and commitment by government and industry.

Ongoing effort is need to address all of the issues discussed here if the bioenergy industry seeks to expand in Australia.

5.5 Designing sustainability assessment systems for bioenergy

5.5.1 Setting up a process

Structured processes to develop and test, implement, and formalise recognition of the sustainability assessment and any associated verification systems are necessary. This is a major undertaking. It can be conducted by industry based groups (e.g. RSPO), broader transnational non-governmental groups (e.g. RSB, IEA Bioenergy Task 40), or by intergovernmental groups (e.g. GBEP). These international processes and activities were reviewed in detail in Chapter 3.

5.5.2 Selecting sustainability criteria

Criteria are descriptions of the components of sustainability that are to be assessed. They break down the sustainability objectives into assessable components. Lewandowski and Faaij (2006), Van Dam et al. (2008) and Fehrenbach (2008) have all provided excellent summaries of principles, objectives, and C&I used to assess sustainability across a range of reviewed certification and reporting systems of relevance to biomass. Many emerging systems for sustainability of bioenergy (mostly focused on biofuels) attempt to deal with the full range of sustainability issues including biodiversity, changes in soil and water values, GHG emissions from LUC and land management, effects on food security, or the indirect effects of land use change (Fehrenbach, 2008). It is evident that between various systems there is a confusing and unstructured mix of goals and objectives, C&I, 'rules' and various documentation requirements. Lewandowski and Faaij's (2006) table provides a useful check list when designing a sustainability assessment system.

In section 5.4, well established and implemented C&I assessment systems for forestry were described. C&I approaches for bioenergy can build on such approaches, but will need to go beyond those which have been developed, tested and implemented for forestry in order to address major issues emerging, such as:

- GHG emission reductions (whole-of-value chain or life cycle, including indirect LUC)
- indirect socio-economic effects due to substitution of products (e.g. using grain to produce fuel rather than using it as food) and indirect LUC effects (clearing of rainforest to accommodate displaced agriculture)
- impacts of LUC on biodiversity.

Criteria for assessment will vary with different situations because the landscapes, threats to environmental values, types of bioenergy production systems and socio-economic circumstances will vary across regions and countries. At an international scale, the range of C&I must necessarily be comprehensive in order to deal adequately with the full range of issues that may arise in any given production situation around the globe. At regional and local scale, criteria may be more focussed on specific priority environmental or socio-economic issues. Nevertheless, it is likely that criteria will cover similar themes, irrespective of scale or situation to achieve:

- maintenance of ecosystem function in the production systems under assessment. This is largely a scientific process because the system functions, thresholds and lags must be clearly defined, and methods and datasets developed to support their evaluation. However, for many values (e.g. biodiversity), the key issue is how much should be maintained. This is often a value judgement rather than a scientifically-derived quantity
- delivery of values of importance to the stakeholders and communities of consent, such as bioenergy products and coproducts, social conditions and economic benefits.

The processes to develop C&I will take different forms depending on the scale of the assessment (enterprise-level assessment versus industry- or national-level). For example, at the government level it may involve structured consultation with different sectors of government and industry, including proposing options (in Australia via a 'green' paper) and inviting public comment before finalising as a policy. In terms of an enterprise, this may involve structured, open and transparent consultation with neighbours, interest groups, supply chain and regulatory authorities (Raison et al., 2001; O'Connell et al., 2005). Technical expertise will be required to provide a robust science basis, especially in relation to ecosystem maintenance.

5.5.3 Indicators to track change in sustainability criteria

Bioenergy sustainability assessment systems need a limited number of sound Indicators that can be used to monitor change in aspects of each sustainability criterion (Raison et al., 2001). While criteria across different systems will likely address similar themes, appropriate indicators will vary widely, depending on the scale of assessment, and available technologies and data. Indicators should be a reliable measure of the criterion (repeatable and unambiguous), easy to measure and record, and sensitive to change. For efficiency in monitoring, evaluation and reporting, indicators should be specified by technical experts with knowledge of the available data, technology platforms and methods.

Methods and metrics for measuring some indicators are well understood and mature, while others have immature methods, a lack of data or very complex underlying conceptual models – especially when the scale and local context are critical. For example, indicators which reflect financial viability can be relatively easily quantified. It is much more challenging (and expensive) to survey biodiversity across space and time. It is difficult to express biodiversity in simple units, because it is fundamentally a scale related interpretation. An action that results in a poor biodiversity outcome in a small patch of land, as reflected in the metric, may not affect biodiversity at a broader scale – it depends on the management of the landscape as a whole, and the dynamics of the population under threat. Spatial linkages add to or detract from the biodiversity value of a particular tract of land.

Direct and indirect GHG emissions across the value chain are of particular interest in emerging sustainability assessment systems for bioenergy. Life cycle assessment (LCA) methods for calculating direct GHG emissions are well-developed. However, there are challenges in application and interpretation of LCA for bioenergy systems: the results are affected by which elements are included in the analysis (system boundary), the allocation method used, and the model approach applied (for more information, see pullout box on LCA). It is important that system boundaries are appropriately defined; that biomass and soil carbon stock changes, and non-CO_2 greenhouse gas emissions are included; and that the appropriate fossil reference energy system is used for comparison. LCA results are specific to a particular situation, being dependent on biomass feedstock, conversion technology, fossil fuel displaced, and transport distance (Cherubini et al., 2009).

Many bioenergy policies require prospective biofuels or bioenergy systems to meet targets for minimum GHG emissions reduction (see Chapter 4). Some of these policies provide prescriptive methods for calculation of GHG reduction (i.e. they prescribe a part of the sustainability assessment system).

Methods to assess emissions due to indirect land use change are developing rapidly, but are still immature. The data to support the assessments are very sparse. By definition, conventional LCA (‘attributional LCA’ – see box) does not include indirect effects. To incorporate the emissions due to indirect land use change (i.e. the losses in biomass and soil carbon stock and emissions of methane and nitrous oxide) into estimates of life cycle GHG emissions, two approaches have been suggested:

1. expansion of the system boundary to include the indirect effects
2. use of default figures to estimate impacts of indirect LUC, which are then added to estimates of direct emissions across the value chain.

An example of the first approach is that proposed for the USA’s *Renewable Fuels Standard.* In this approach, partial equilibrium economic models, LCA models and GHG accounting models for land use and biofuels are used to calculate the impact on GHG emissions from expansion of biofuel production, including indirect LUC within and beyond the USA. The model results are used to determine whether a particular biofuel meets the GHG reduction target specified by the USA’s *Energy Independence and Security Act (2007)*. The analyses will need to be reviewed regularly, and updated to reflect changed situations or inaccuracies in assumptions, or changes in technology.

The indirect LUC (iLUC) factor approach developed by Öko Institut is an example of the second approach. This method uses an analysis of historic Food and Agriculture Organisation (FAO) land use and trade data for the major agricultural products traded by the major trading countries to calculate an average emissions factor per ha of displaced land. Objections to the iLUC factor approach have been raised by some groups, including criticism that:

- it is not sufficiently transparent
- it is overly simplified – estimation of the impacts should not be based on averages but should be system-specific
- the emissions from indirect LUC may not be linearly related to the amount of biofuel produced
- simple approaches could become embedded in policy and the factors may not be reviewed, so changes would not be detected.

Pullout Box LCA as a method to assess GHG emissions

Life cycle assessment (LCA) quantifies the impacts on the environment of producing a product or a service, over the entire life cycle to genesis to disposal, or 'cradle-to-grave'. The international standard for LCA (ISO 14040) defines life cycle assessment as,
'Compilation and evaluation of the inputs and outputs and the potential environmental impacts of a product system throughout its life cycle'.

The output from LCA studies of biofuels varies widely. Caution is required in the interpreting the results of any given LCA, and comparing between LCAs. Results of LCAs must be interpreted with consideration of four aspects that affect the outcome, as listed below.

First, it must consider the particular system being studied. For example, to assess life cycle GHG emissions for ethanol from wheat in Australia (Figure 5-3), we may include as inputs:

- the fossil fuels used by the farmer in the preparation of land, maintaining the crop and harvesting the wheat
- the fossil fuel use in manufacture of fertilisers and herbicides and the transport of these to the region
- nitrous oxide released from applied fertiliser
- the fossil fuel used in transport of the harvested grain to the ethanol facility
- the inputs used in the conversion process of wheat to ethanol, including electricity, gas, and the energy used in producing other inputs such as enzymes
- the blending and distribution of the ethanol
- the combustion of the fuel in the engine.

The impacts can be viewed in terms of upstream, or precombustion, impacts (that is, the emissions released in production of the fuel up to the point of combustion), and the combustion, or tailpipe, impacts (which happen as the fuel is used in the vehicle). It follows that an LCA based on a very different production system (e.g. a different crop, or the same crop in another country where the farm management and transport regimes are very different), or from the use of a very different type of technology in the conversion process (e.g. thermochemical compared to fermentation processes), or in a different types of vehicle (e.g. a small passenger vehicle compared to a bus or truck) will give very different results.

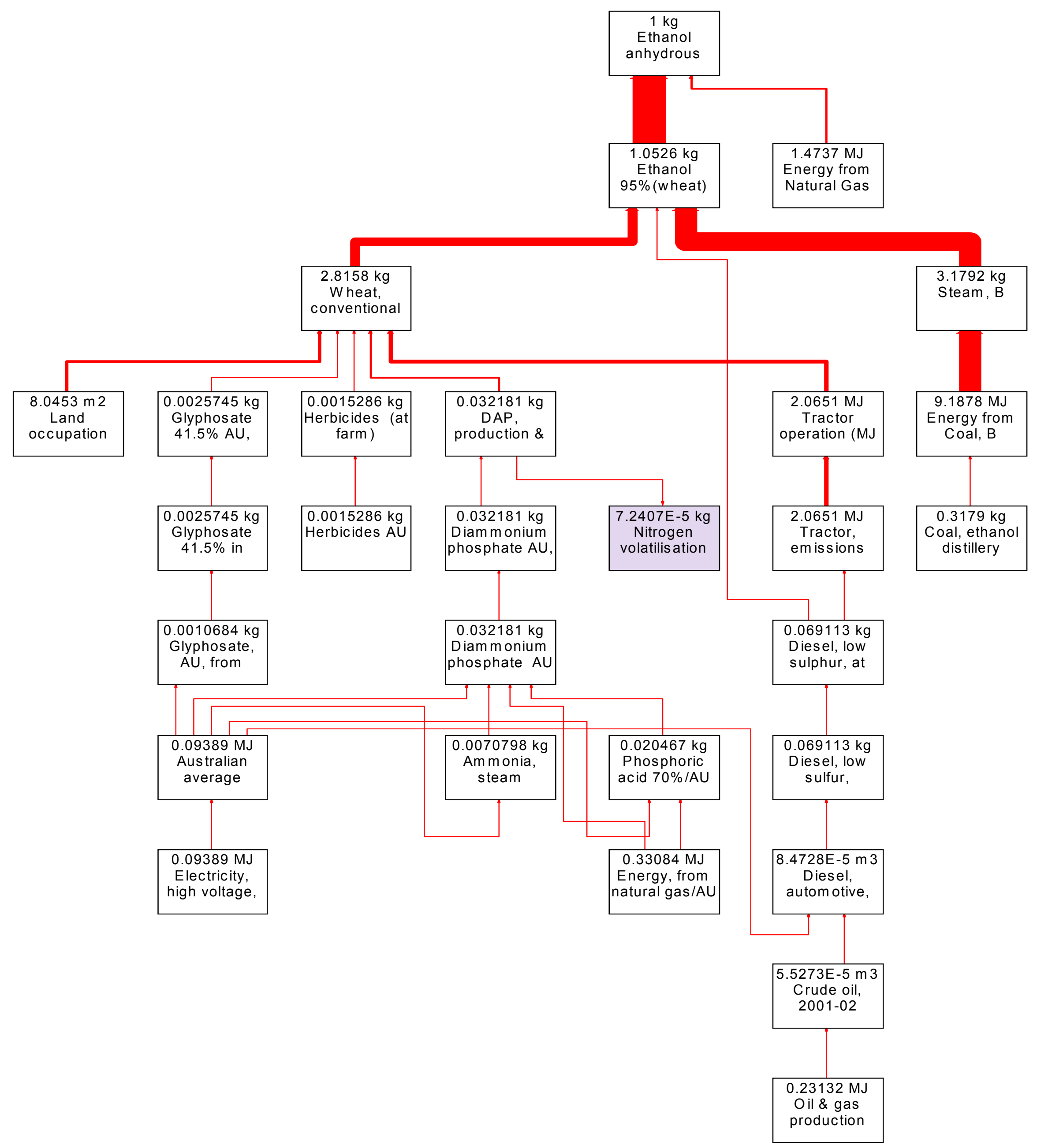

Figure 5-3 Process tree showing the life cycle GHG emissions for ethanol from wheat. The upstream processes contributing to wheat production are shown, as well as the conversion of wheat to ethanol. The thickness of the red arrows indicate the proportion of the GHG emissions from each step

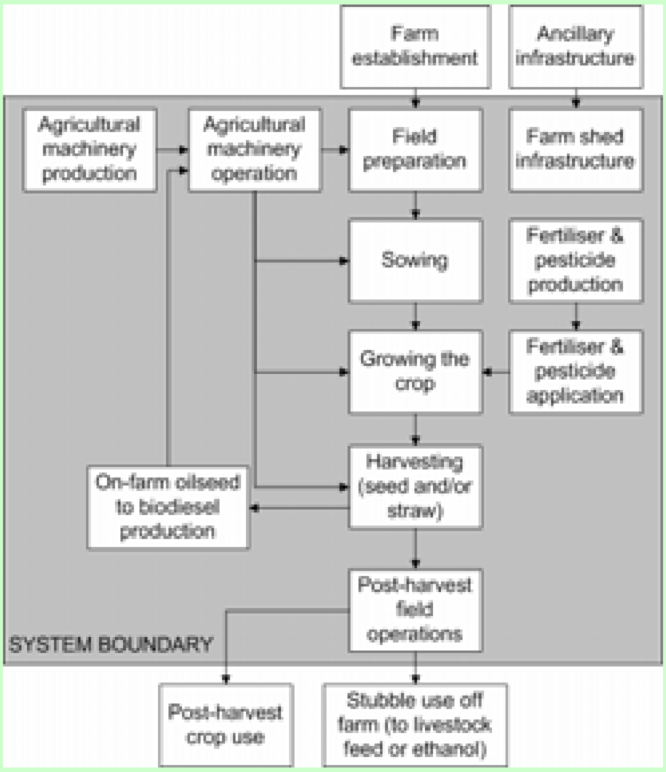

Figure 5-4 Systems boundaries for LCA analyses. These boundaries define the scope of the analysis and include the cumulative sum of inputs and processing of each component (Farine et al., 2009)

The second aspect that affects the outcome is the way the particular study defines the 'system boundaries'. Studies vary in which of the upstream impacts are included. The inclusion (or not) of initial land clearing, manufacture of agricultural machinery, or oil and gas platform infrastructure can have a dramatic influence on the results. The international literature varies substantially in this area, with some authors even including energy from the sun within the system boundary – which makes comparison across studies of impacts such as energy balances or GHG emissions very difficult.

The third aspect that affects the outcome is the allocation method. Where a process has multiple products, the impacts of the production process have to be allocated between the products. Allocation can be done using a variety of methods (e.g. according to economic value, mass or energy content). Alternatively, allocation can be avoided by expanding the system boundary to include output of the product that is displaced by the coproduct of the bioenergy system. The results might differ substantially. For example, in the case of wheat stubble, if allocating by economic value the impact attributed to the stubble compared to the grain would be much lower than if impacts were apportioned on the basis of the relative mass of stubble and grain.

The final aspect that affects an LCA's outcome is the model applied to assess impacts. Models include:

- attributional LCA, which uses average data for the component processes across the value chain to estimate the direct impact of the product or process
- consequential LCA, which examines the effect of a change in the level of output of a product, including impacts that result indirectly such as through displacement of other processes (Weidema, 1999). For example, land use substitution to produce biofuels may result indirectly in deforestation to provide more land for the displaced process. Consequential LCA relies on economic models of supply and demand relationships for the product and coproducts, and is therefore subject to high uncertainty. Nevertheless, consequential LCA is useful for decision-makers wishing to understand the consequences of policy options.

Choice of targets to support the application of C&I

Hard targets may be specified with numeric values or rules which *must* be met in order for key goals to be achieved. They may be in the form of prescriptive rules which must be followed (e.g. national and international laws and obligations that must be abided by, such as thresholds for quality of drinking water). These sorts of targets are relatively easy to assess and verify. Some other hard targets require quantitative measurements and calculations to be made (e.g. GHG emissions abatement must be at least a 40% improvement over a reference fossil fuel system). The data and methods may make assessment more difficult (and increasingly, standard methods are prescribed), but the evaluation of whether the goal or target has been met is clear and simple.

Hard targets are desirable where international law, other obligations or critical requirements for ecosystem maintenance must be met. The ecosystem maintenance targets may be difficult to specify in indicators because of the challenges of insufficient knowledge, definition of system boundaries, complexity associated with long lags in ecosystem responses, and where common resources, such as water, are shared between several different (and often competing) uses. Furthermore, for many aspects (e.g. biodiversity) the appropriate target value is difficult to define. Key questions of 'what should be sustained, and for whom?' are often value judgements rather than scientifically-derived.

Soft targets are those which have less prescriptive guidelines (e.g. efforts must be made to minimise erosion, or improve the quality of life for the local residents). They may be more qualitative or aspirational, and it may be difficult to evaluate whether the indicator has been met. For these reasons it is better to avoid use of soft targets.

5.5.4 Evaluation of C&I

Evaluating information collected when using the C&I approach to judge performance against agreed objectives and goals is a key component of sustainability assessment systems. Judgements must be made across multiple C&I (representing the different dimensions of sustainability), at different scales, and synthesised and interpreted for a range of purposes or audiences.

5.5.4.1 Evaluating across multiple C&I

There are scientific challenges in integrating across multiple facets of C&I, as well as with the social processes that may support the evaluation. Multicriteria analysis and optimisation methods can be useful (Diakoulaki and Karangelis 2007), and there is a range of social processes to interpret and use the information across multiple C&I (Cannon and Surjadi, 2004; Dyer et al., 2008). For example, a particular industry may have a negative impact on local water quality, and a large positive impact on the regional economy. From a utilitarian perspective based on welfare maximization, this may be an acceptable outcome for the stakeholders and communities of consent as long as targets for ecosystem maintenance in terms of water quality have been met.

People can have deontological attitudes (i.e. they consider that the moral content of an action is not wholly dependent on its consequences) towards the environment. In such cases, their moral commitments may be in conflict with the expected welfare maximization behaviour, creating tension between the rationality of individuals and that of the social group. This problem, added to the incommensurability of different values, suggests the need to broaden the base for decision-making to include justice and democracy, and promote public participation to deal with the problem of multiple values (de Marchi and Ravetz, 2001).

5.5.4.2 Evaluation of C&I across scales

The evaluation of many landscape-based C&I is scale related, and this has been briefly discussed in other sections (e.g. biodiversity metrics across scales in 5.5.3). The evaluation of net energy metric at different scales and the implications of scale in relation to setting hard targets is provided here as an illustration of the issues and approaches (see pullout box on net energy).

Pullout Box Net Energy

Fossil fuels are a concentrated form of solar energy and have a high net energy – which is why they are such a cheap source of energy and underpin many modern economies (Cleveland et al., 1984; Ayres et al., 2007; Poldy, 2008a). Net energy was defined by (Poldy, 2008a), following (Hall et al., 1986), in the following terms:

C = A – B where

C is the net output of energy provided to the economy for purposes other than energy supply,

A is the gross output of the energy supply activity

B is all of the energy consumed by the activity in providing that gross output.

The energy return on investment (EROI) (sometimes referred to as the energy return on energy investment, or EROEI) is the ratio A/B (Poldy, 2008a).

The metric indicates the relative energy cost required to provide energy in the economy for purposes other than energy supply itself. If net energy is negative and EROI is less than 1, the source becomes a sink (Poldy, 2008a). If EROI is only slightly above 1, this may be acceptable for certain decisions or circumstances, but may be problematic once that energy source reaches a certain scale of running an entire economy (Poldy, 2008a; Poldy, 2008b). Currently conventional petroleum is approximately 15:1 (down from 25:1 in the 1970s), with oil sands less than 4:1, and oil shale less than 1:1; coal to liquids less than 1:1 (Downey, 2009). In comparison, the EROI of ethanol from corn is approximately 1.34:1 (Shapouri et al., 2002). The EROI for mallee systems is promising in comparison, although the published value of 41.7:1 (Wu et al. 2007) does not include the conversion to energy – the system boundary only includes the total energy value of the crop outputs compared to inputs – therefore is not directly comparable.

This section focuses on the use of the metric in attaining sustainability goals – i.e. its utility in making certain types of decisions at various scales and for specific purposes. The net energy EROI is only one aspect of sustainability. Some forms of energy may be in a particular form that is not easily replaceable by other forms of energy (for example, liquid fuels in aircraft are harder to replace than in passenger vehicles which can use electricity or natural gas) (Dale, 2007, 2008). Using this logic, even a relatively small net energy gain (e.g. 1.34 for corn from ethanol) may be acceptable if transforming an abundance source of energy into a scarce or less replaceable form.

At a broader, whole-of-system scale, however, it is critical that net energy is substantially greater than 1 (Poldy, 2008a; Poldy, 2008b). Modern economies are dependent on high net energy. Within a diverse energy portfolio there may be low (or even negative) net energy sources that are valued for some special quality as measured by some of the other metrics. These will need to be subsidised (in energy terms) by the high net energy sources in the portfolio. To that extent, they are a drain, and contribute to energy demand rather than energy supply. Thus, the sustainability of a system can only be truly assessed at a whole-of-system scale. And the metrics that contribute to the evaluation must be carefully selected in the context of scale, trade-offs against other metrics, and the broader objective of the assessment.

5.5.5 Reporting

As demonstrated in the forestry example (section 5.4.2) reporting can be used for a range of purposes, and at many levels.

At the enterprise level, it can be used to:

- to assess whether enterprise level sustainability objectives have been met
- to monitor and evaluate the importance of any measured trends (linear and non-linear) in, for example, an environmental or socio-economic variable, providing the basis for adaptive management
- to support certification process of a particular product or production pathway
- to provide triple bottom line reporting to shareholders, banks and other investors who may require it.

At the state or national scale, it can be used to:

- to assess whether state and national sustainability objectives have been met
- to monitor and evaluate the importance of any measured trends (linear and non-linear) in, for example, key environmental or socio-economic variables
- to report against obligatory transnational agreements
- to support reporting to stakeholders, communities of consent and the general public
- to feed back into the setting of policy, legislation and other institutional systems in the design of sustainable energy solutions.

At the transnational scale, it can be used to:

- to monitor and evaluate trends in measures of sustainability (e.g. effects of indirect land use change), and to underpin development of policies and programs to mitigate threats to sustainability
- to provide information to stakeholders, communities of consent and the general public
- to feed back into the setting of policy, legislation and other institutional systems in the design of sustainable energy solutions.

5.5.6 Formalising sustainability assessment via certification

C&I can form the basis for formal certification of sustainability. The process of auditing methods of production and the tracking of products allows certification in terms of specified sustainability requirements. These two steps to certification form the basis of the label that guarantees that the product has been sustainably produced. There are a number of existing certification systems operating at various scales around the world for forest products, fair-trade, organic foods and sustainable agriculture, some of which contain elements that would be suitable for part of the sustainability assessment of bioenergy and biofuels. Two of these organisations relevant to bioenergy (FSC and RSPO) are described in more detail in the pullout box on FSC and RSPO certification.

In broad terms, global certification systems consist of:

- a governance structure that sets the standards and rules under which certification and accreditation will be carried out
- some decentralisation of parts of the international system to national bodies
- the accreditation of the auditors or certification bodies
- the on-the-ground auditing of the production process by the accredited auditors or certification bodies
- the application of a tracking system for certified product
- recording and reporting.

Existing certification systems based on independent third-party auditors could become the basis of the assessment and certification of sustainable bioenergy and biofuels in order to minimise costs, particularly to small producers of biomass, and to avoid the imposition of more than one certification system on producers who feed products into more than one value chain (e.g. agriculture). However, all organisations that have developed criteria for bioenergy and biofuels have set some target for the reduction of GHG emissions through the use of these renewable energies. None of the existing international certification schemes such as FSC, RSPO or the Sustainable Agricultural Standard under the Rainforest-Alliance have a process for dealing with this issue. It would appear that a combination of existing certification schemes and new schemes designed specifically for the production and use of bioenergy and biofuels will be necessary for the certification of these products. The Roundtable for Sustainable Biofuels (RSB) (section 3.2.3) is proposing to do this, but thus far there is limited international acceptance or sign on to this process.

Reporting the outcomes of monitoring and audit processes is a vital requirement for feedback to improve the performance of production chains in terms of the agreed environmental, social or economic targets. Reporting can be local (i.e. reporting the outcome of audits to individual producers and processors), at an enterprise level or at a macro scale. The reporting of audit outcomes and the traceability of certified products could also provide a basis for the accurate aggregation of information from many certified production pathways. International certification systems for sustainable bioenergy and biofuels would not only provide reliable information for consumers and assist in the global trade of these products, but could become the basis for an understanding of the global aggregate effects of these renewable energy systems.

Pullout Box FSC and RSPO certification

Two global organisations, the Forest Stewardship Council (FSC) and the Roundtable on Sustainable Palm Oil (RSPO), operate certification systems that can be used to illustrate the structure of existing systems.

Both organisations were initiated by industry stakeholders in recognition of the need to promote good environmental, social and economic practices in their industries, and the need to demonstrate this to consumers through the production of certified products. Membership and use of their certification schemes is not mandatory and there are several other forestry certification systems in Europe and North America. Both the FSC and the RSPO have a similar overarching governance structure consisting of members, a general assembly, a board of directors, a secretariat and working groups that develop the contents of the certification systems. In both organisations there has been, and continues to be, an extensive consultation process undertaken by the working groups to develop and review the criteria and indicators to be used for certification.

FSC International has decentralised some of its functions through its National Initiative program into more than fifty countries around the world including Australia. Under the National Initiative, organisations such as FSC Australia promote the activities of FSC International, develop and test regional forest stewardship standards and consult with certification bodies. The RSPO is yet to decentralise to the same extent, retaining its international RSPO criteria as the basis of its certification, but allowing some RSPO-endorsed national interpretation.

In both organisations, the accreditation of certification bodies is retained within the central international organisation. FSC International retains operation of accreditation through Accreditation Services International (ASI), a company of which FSC International is the only share-holder. ASI provides accreditation of National Initiatives, FSC National Standards and Certification Bodies. RSPO, in its Certification System specifies that accreditation of certification bodies must conform with International Organisation for Standards (ISO) requirements including: ISO Guide 65 (General requirements for bodies operating product certification systems), ISO 17011(Conformity assessment – General requirements for accreditation bodies accrediting conformity assessment bodies), and ISO 19011 (Guidelines for quality and /or environment management systems auditing). Also, the accreditation body itself must operate in accordance with the appropriate International Accreditation Forum or be a member of the International Social and Environmental Accreditation Labelling Alliance (ISEAL).

Assurance to the end-user that a bioenergy end-product is produced in accordance with specified sustainability requirements can only be verified through the auditing and certification of the production process and then tracking certified product through the production chain from the biomass to end-user. There are several established methods for tracking and keeping account of certified product:

- The 'identity-preserved' system preserves the identity of each batch of certified product throughout the production chain. It is used in the food industry for paddock-to-plate quality certification. It requires physical separation and certification of each batch of product through the production and supply chain. It provides the highest level of traceability and claim, but has the highest implementation costs.
- The 'segregation' or a 'track-and–trace' system separates certified product from uncertified product, while allowing the mixing of batches of certified products. All certified product must go through the certified production and supply chain. This provides a high level of traceability and claim with slightly lower costs.
- The mass-balance system administratively monitors the supply of certifiable product. It allows the mixing of certified with non-certified product. For example, certified and non-certified sustainably produced biomass can be mixed prior to transportation or processing. The amount (or mass) of sustainable bioenergy or biofuel produced for use that can be certified must be directly proportional to (or balance) the amount of certified biomass going into the system. This system has a significantly lower level of traceability and claim than the separation systems, but does allow the recording of the amount of certified product in the supply chain.
- The book-and–claim system is based on negotiable or tradeable certificates, introduced into the system by certified producers. End-users required (by Government) to support the production of certifiable product must buy certificates to meet a target for the amount of certifiable product used.

The RSPO allows the use of any of the four methods outlined above to support a claim of sustainable production of palm oil while the FSC uses segregation in its chain of custody certification and mass-balance for FSC certified mixed wood products such as paper. The FSC has three types of certifications that relate to one another. FSC Forest Management certification involves the third-party audit of forest management against all the internationally agreed FSC principles and criteria. This type of certification allows for the production of FSC certified timber. This timber can then go into the FSC Chain of Custody certification for the production of timber products bearing the FSC trademark. At a lower level of requirement than FSC Forest Management is the FSC Controlled Wood certification where forest management is audited against five FSC Controlled Wood criteria. Timber thus certified can be mixed with FSC Certified timber to produce wood products bearing the FSC Mixed Source label.

5.6 Essential characteristics of a sustainability assessment system

This chapter has provided insight into some broad theoretical constructs and implementations of sustainability assessment systems which are already established (e.g. for forestry), or under development for biomass and bioenergy. We have provided some critical review on strengths and limitations of these approaches, and the key elements of design of a system for bioenergy.

A sustainability assessment system will ideally:

1. be embedded in a policy and legal framework that supports the sustainable development and maintenance of a sustainable bioenergy industry at enterprise through to international levels
2. be comprehensive, to cover the range of social, economic and environmental risks, costs and benefits, and the concerns of stakeholders and the community of consent
3. facilitate the engagement of stakeholders and communities of consent during the development, implementation and improvement of the assessment system. It is critical that sound processes exist to deal with important 'local' sustainability issues
4. use robust science to underpin appropriate scale of application of C&I, scale dependency, non-linearity, irreversibility, cumulative impacts and lag effects, as well as processes to adapt C&I and data collection methods to local circumstances

5. identify hard targets (well justified by underpinning science) to maintain ecosystem function and other targets (hard or soft) for delivery of values that society cares about
6. consider scientific and social processes for evaluation, trade-off and negotiation of the balance of sustainability outcomes according to the specific situation. Very few industries or projects have positive sustainability benefits across every single dimension of sustainability, and a means of negotiating the balance of positive and negative aspects is necessary
7. specify system boundaries to take account of the full range of impacts across a range of relevant scales (from enterprise to international scales in some cases) and value chains. Evaluation of the effects of individual projects through to cumulative (often non-additive) effects of scaling-up to form large industries.
8. employ methods to assess, and evaluate the feedback mechanisms for indirect effects that may occur in different locations or industries
9. identify mechanisms for independent audit and certification, and for reporting the outcomes of bioenergy projects. Third-party independent audit and certification are now seen by some as 'beyond question' for biofuels (Fehrenbach, 2008), but others believe a cost–benefit and risk analysis is necessary at the appropriate scale in order to justify the cost of certification
10. identify clear processes and incentives for the review and improvement of the sustainability assessment system itself
11. build on existing processes and/or provision of new incentives, with well-defined responsibility and governance
12. be compatible with international agreements (such as the Kyoto Protocol and the Convention on Biodiversity), other sustainability assessment systems for bioenergy, and World Trade Organisation (WTO) rules, to assist mutual recognition and thus facilitate international trade in biofuels or renewable energy certificates. There could be multiple accreditation systems that each conform to an agreed 'meta-standard' (Fehrenbach, 2008).

5.7 Key messages and conclusions from this chapter

1. There are many different approaches to sustainability assessment, most of which have their own epistemologies, cultures, languages and methodologies.
2. There are two basic approaches that are used to assess sustainability:
    a. input-based which assume that certain inputs or activities provide desired outcomes
    b. outcome-based in which monitoring is used to enable comparison of the condition of key system variables and trends with agreed sustainability objectives and targets.
3. Input-based systems (such as setting targets, specifying processes without monitoring the outcomes) may be appropriate where the risk (i.e. likelihood and consequence) is low, or where the systems are predictable and well-defined. In situations where the risk is high (or uncertain), these approaches do not have a high likelihood of ensuring sustainable outcomes.
4. In natural systems where relatively little is known about system response over the long term, and widespread loss of ecosystem function would have major consequences, an outcomes-based approach is critical. Any such assessment system must be embedded in effective process with feedback mechanisms to allow improvement of the assessment system itself, as well as the resources being managed.
5. If a due consideration showed that the sustainability risks of bioenergy were high and that existing input-based measures were insufficient to ensure agreed sustainability outcomes, then outcome-based sustainability assessment systems would be the most effective approach. If Australia is to participate in international trade of biomass or bioenergy, then implementation of a sustainability assessment system which is compatible with, and mutually recognised by international trading partners will be necessary.
6. A sustainability assessment system includes a process for governance of the assessment system itself; effective ways of engaging a wide range of stakeholders, including communities of consent, in defining sustainability objectives; methods for defining, measuring and reporting C&I; evaluation methods and processes; and mechanism for feedback, review and improvement.
7. Criteria (to describe the components of sustainability) and indicators (to track change in the criteria over time) approaches are being widely used to underpin ‘outcome-based’ assessments of sustainability.
8. The criteria and indicators (C&I) approach can be effectively embedded within an adaptive management approach (e.g. EMS) to provide a structured process for assessing sustainability, for system improvement, for reporting to a range of stakeholders, and for independent third-party accreditation against requirements for product certification. When used in this way, C&I can underpin an effective sustainability assessment system. However, the application of the C&I approach to bioenergy is in its infancy, and many challenges remain.
9. The major challenges for the scientific assessment of the sustainability of bioenergy and biofuels value chains are:
    a. defining indicators relevant to the local context, but compatible with international approaches
    b. quantifying irreversible thresholds in natural systems, so that targets can be set to avoid these
    c. scale issues, especially moving from assessing the effects of single projects to assessing the often non-linear effects of scaling-up on landscapes (e.g. on water values) and beyond (e.g. the indirect effect on LUC in other regions or countries)
    d. quantifying trade-offs between different dimensions of sustainability – which are sometimes positive, and sometimes negative
    e. using C&I in designing sustainable solutions across sectors, where the data are sparse and several driving variables (climate, population) are outside of previous known ranges.
10. Sustainability assessment systems should build on existing activities and processes wherever possible, and require well defined governance and responsibilities. It is important that new systems are, as far as possible, compatible with other systems to assist mutual recognition, and thus facilitate international trade in biofuels or renewable energy certificates.
11. The extent to which a rigorous sustainability assessment can or should implemented for bioenergy in Australia as an individual sector requires further discussion amongst stakeholders and communities of consent. There are clear expectations in the international arena that formal sustainability assessment is a requirement for biomass or bioenergy to be

traded in many markets such as the EU. A system by which sustainability could be demonstrated or certified would be an enabler to industry expansion and international trade in Australia. However, there are outstanding issues to be resolved around the burden of proof of sustainability being placed on bioenergy especially in situations where land and water resources are shared between many production systems; the drivers for land use change are many-fold and the causal linkages to indirect effects are not clear.

In the following chapter, we discuss the mechanisms by which a bioenergy sustainability assessment system – if developed – could be implemented and adopted.

6 Options for Australian industry to develop and implement a sustainability assessment system

Chapter Summary

In this chapter we discuss:

- the options for developing a bioenergy sustainability assessment system for Australia
- the mechanism by which a bioenergy sustainability assessment system – if developed – could be implemented
- the pathways to implementing the range of mechanisms

Options for the development of a bioenergy sustainability assessment system

Options include:

- do nothing – wait and see how international developments on sustainability unfold
- conduct a comprehensive analysis of the risk to sustainability from the bioenergy industry, and the costs and benefits (across private and public interests) of developing and implementing a sustainability assessment system either at sectoral or cross-sectoral levels
- implement (via voluntary or compliance mechanisms) one of the international systems under development (e.g. RSB Version Zero, GBEP)
- industry to follow one of the self-regulation pathways described in this chapter
- Governments work individually or through COAG or one or more of the Ministerial councils to develop an approach.

A conclusion as to what is the best option for development of an approach is beyond the remit of this report – there are many stakeholders through the value chain who have differing agendas and opinions on constructive ways forward.

Mechanisms for the implementation of a bioenergy sustainability assessment system

There are a number of mechanisms for the deployment of a bioenergy sustainability assessment system. These include industry self-regulation, purchase specifications, and third-party compliance schemes.

Industry self-regulation includes:

- Codes of conduct, applied by industry;
- consumer information mechanisms (labelling, trademarks, websites), applied by industry

Industry self-regulation mechanisms such as these may be underpinned by independently developed and maintained standards, or third-party assessment/endorsement through agencies. In Australia, one such agency is the Australian Competition and Consumer Commission (ACCC).

The benefits of industry self-regulation include:

- low costs of administration (particularly for government)
- short lead-time to implementation or adoption
- effective endorsement or promotion at key points in the supply-chain (e.g. at the point-of-purchase decision).

These features mean that effective industry self-regulation is often preferred to government regulation. The important point is that the process should be effective, and that this can be demonstrated to all interested stakeholders.

The drawbacks include:

- there may be a real or perceived conflict of interest in the design and operation of the scheme, which may undermine the credibility of the scheme with its target audience
- the voluntary compliance basis of many schemes allows industry to 'pick and choose' where and when to apply the obligations of the scheme
- the industry association may lack the expertise or resources to design and operate a compliance scheme
- there may be a lack of transparency in the operation of the scheme, including compliance assessment, reporting and enforcement of non-compliance provisions.

Purchase specifications are:

- applied by purchasers of biomass or biofuel to specify requirements that are not addressed through existing standards or regulatory mechanisms
- effective where the purchasers have sufficient buying-power to be able to exert influence on the supply market.

The points of application of purchase contracts specifying sustainability credentials in a biofuel and bioenergy value chain could include the intermediate markets specifying sustainability credentials required from the biofuel and bioenergy producers, including aviation and mining industries, government vehicle fleet managers, oil majors purchasing biofuel for blending and distribution or fuel and electricity retailers.

Third-party compliance schemes can be comprised of:

- Codes of conduct, as applied by industry/third-party partnership, or independent third parties
- consumer information mechanisms, including certification schemes, applied by independent third party or industry/third-party partnership
- government regulation, applied by government/s.

Industry partnerships have emerged as an important blend of attributes from the standalone industry and third-party compliance models, as they:

- ensure ownership by industry
- improve the likelihood of gaining critical mass in terms of industry coverage
- allow industry to expedite development and implementation of the model
- generally lead to lower costs of compliance for industry
- ensure that appropriate rigour exists
- minimise development and administration costs to the public
- inspire greater levels of consumer confidence than standalone industry models.

Third-party compliance mechanisms are likely to inspire higher levels of consumer confidence and, should the compliance mechanism take the form of a regulation, compliance may be mandatory and therefore maximised. However the costs associated with the design and administration of a third-party compliance mechanism may be significantly higher for industry, the consumer and the administrator alike.

Pathways to implementation

There are numerous adoption pathways, with different points of application through the bioenergy or biofuels value chain.

Codes of conduct:

- a code of conduct is generally developed by an industry association in consultation with its members and often other stakeholders more broadly
- the ACCC encourages development of voluntary, non-prescribed industry codes of conduct in order to deliver effective compliance with the *Trade Practices Act*
- the ACCC may be required to administer an industry code of conduct that is prescribed (i.e. made law) by the Australian Government. The decision to prescribe a code of conduct is only made when certain criteria have been met – for example, if the code would remedy an identified market failure or promote a social policy objective
- a prescribed mandatory code of conduct is binding upon all industry participants, whereas a prescribed voluntary code of conduct is binding for only those who are signatories to the code
- for a biofuels and bioelectricity sustainability assessment system, the relevant peak industry bodies would be likely lead the development and administration of an industry code of conduct.

Consumer information mechanisms:

- the Productivity Commission recognises that consumers are now paying more attention to labels than they have in the past, and there are several other positive attributes of labelling schemes
- using the bioenergy sustainability assessment system as a starting point, it may be possible to design or develop labelling, certified trademarks and websites
- ACCC approval is required before a certified trademark can be registered. An entity would be free to use the bioenergy sustainability assessment system as the basis for a trademark application to the ACCC
- development of a consumer information mechanism could be done either by the industry association or an independent third party, with or without a regulatory imperative from government. The effectiveness of the consumer information mechanism will be significantly influenced by the extent to which it captures the range of products on the market. Accordingly, the most effective scheme will be a mandatory compliance program underpinned by government regulation.

Purchase specifications:

- the incorporation of product or service requirements into a purchase specification uses market forces to achieve a desired policy objective
- purchase specifications may provide the simplest pathway to adoption of a sustainability assessment system, and achieve influence in the market most rapidly IF the purchasers have sufficient market influence.

Australian standards:

- Standards Australia develops standards where a net benefit to the community as a whole can be demonstrated. Net benefit is defined as, ‘having an overall positive impact on relevant communities’, and takes into account the costs and benefits relating to public health and safety, social and community impact, environmental impact, competition, and economic impact
- once a net benefit has been demonstrated, there is a choice of five development pathways through which the standard can be delivered. Each of these development pathways will incur transaction costs and ideally these should be factored into the assessment of net benefit
- standards are not laws – but because of their rigour, they are often called up into legislation by government and become mandatory
- in the case of the any sustainability assessment system, it is preferable to formalise the measurement methods as a standard, rather than formalising specific targets.

Regulation:

- regulation can be used as a means to achieve sustainability either through setting goals and targets, or specifying the implementation of a sustainability assessment system to measure progress against the targets. This is usually the last resort where the other less costly approaches (industry self-regulation or consumer information mechanisms) do not meet a demonstrated public need or policy objective
- the Council of Australian Governments (COAG) has agreed that all governments will ensure that their regulatory processes are consistent with a specific set of principles, and the preparation of a regulatory impact statement (RIS), and guidelines for effective consultation with stakeholders
- regulation is preferred when there is a high net benefit, and success of sustainability measures is of high importance.

Conclusions and key messages

The conclusions and key messages from this chapter are summarised at the end of the chapter, as well as in the Executive Summary.

6.1 Introduction

The aims, scientific constructs, and ideal characteristics of sustainability assessment systems were discussed in Chapter 3. International approaches were discussed in Chapter 4, and the policy framework for Australia was discussed in Chapter 5. This chapter discusses:

- the options for developing a bioenergy sustainability assessment system for Australia
- the mechanism by which a bioenergy sustainability assessment system – if developed – could be implemented
- the pathways for implementing the range of mechanisms.

6.2 Options for development of a bioenergy sustainability assessment system

There are many potential options for developing the broader bioenergy sustainability framework, as well as the sustainability assessment system component of it. Australian Governments and industries could:

- wait and see how international developments on sustainability to unfold
- conduct a comprehensive analysis of the risk to sustainability from the bioenergy industry, and costs and benefits (across private and public interests) of developing and implementing a sustainability assessment system either at sectoral or cross-sectoral levels
- implement (via voluntary or compliance mechanisms) one of the international systems under development (e.g. RSB Version Zero), without engaging in the development phase
- implement (via voluntary or compliance mechanisms) one of the international systems under development (e.g. RSB Version Zero), while seeking early engagement to influence the development of international approaches, and setting up parallel Australian processes to adapt international approaches to the local context
- independently develop their own approaches. Industry could follow one of the self-regulation pathways described in this chapter. They could work as individual enterprises, or in a coordinated fashion through industry associations. Governments could work individually or through COAG or one or more of the Ministerial councils to develop an approach.

A conclusive discussion of the options for development of an approach is beyond the remit of this report – there are many stakeholders through the value chain who have differing agendas and opinions on constructive ways forward. To this end, Victoria Department of Sustainability and Environment has commissioned the authors of this report to broadly consult with potential stakeholders during July to September 2009 in order to inform consideration of the various options.

Despite a lack of clarity around the preferred options for developing an approach suited to Australia, it is possible to identify potential mechanisms for implementation of a bioenergy sustainability assessment system (if one were indeed developed), and the potential pathways for its adoption. These will be discussed in the remainder of this chapter.

6.3 Mechanisms for implementation of a bioenergy sustainability assessment system

Some mechanisms for implementation discussed in this chapter are:

1. industry self-regulation, including:
    a) codes of conduct, applied by industry
    b) consumer information mechanisms (labelling, trademarks, websites), applied by industry.
2. purchase specifications, applied by purchasers of biomass or biofuel
3. third-party compliance schemes, including:
    a) codes of conduct, as applied by industry/third-party partnership, or independent third parties

b) consumer information mechanisms, including certification schemes, applied by independent third party or industry/third-party partnership
c) government regulation, applied by government/s. The regulations may include compliance with items under 3a and 3b.

6.3.1 Industry self-regulation

Many industries develop or apply self-regulatory approaches to address issues of product quality or community concern – goals which ultimately seek to inspire consumer confidence. Industry self-regulation may take a number of forms, for example codes of conduct or consumer information. Here we provide examples from other industries operational in Australia. Most of them are administered through an industry association.

Some examples of industry self-regulation mechanisms are provided in Table 6-1.

Table 6-1 Examples of industry self-regulation mechanisms

Self-regulation mechanism	**Examples**
Codes of practice / conduct	General insurance code of practice[1] as developed/applied by the Insurance Council of Australia
	Voluntary code of practice for motor vehicle advertising[2] as instituted by the Federal Chamber of Automotive Industries
Consumer information mechanisms	Forest Stewardship Council trademarks, including the 'Forest Stewardship Council', 'FSC' and 'checkmark-and-tree' logos[3]
	Australian Certified Organic[4] certification and labelling scheme, delivered through a fully-owned subsidiary of the Biological Farmers of Australia

Industry self-regulation mechanisms such as these may be underpinned by independently developed and maintained standards, or third-party assessment/endorsement through agencies. In Australia, one such agency is the Australian Competition and Consumer Commission (ACCC).

The benefits of industry self-regulation include:

- low costs of administration (particularly for government)
- short lead-time to implementation or adoption
- effective endorsement or promotion at key points in the supply-chain (e.g. at the point-of-purchase decision).

In recognition of these attributes, the Australian Government has stated its 'commitment to effective industry self-regulation as an alternative to government regulation' (The Treasury, 2009). Conversely, the drawbacks of an industry self-regulation scheme are significant:

- there may be a real or perceived conflict of interest in the design and operation of the scheme, due to the pressure on the industry association to design or administer its scheme in accordance with the interests of its members only, rather than all stakeholders
- any perceived conflict-of-interest may undermine the credibility of the scheme with its target audience, and in doing so defeat the purpose of the exercise
- the industry association may not capture the majority of its industry, and therefore the scheme may lack sufficient coverage to be effective
- the voluntary compliance basis of many schemes allows industry to 'pick and choose' where and when to apply the obligations of the scheme
- the industry association may lack the expertise or resources to design and operate a compliance scheme
- there may be a lack of transparency in the operation of the scheme, including compliance assessment, reporting and enforcement of non-compliance provisions

[1] (Insurance Council of Australia, 2007)
[2] (Federal Chamber of Automotive Industries, 2004)
[3] http://www.fscaustralia.org/about/fsc-in-australia/policies-and-standards-/trademark-use/, viewed 29th Dec 2008
[4] (Australian Certified Organic, 2009)

- there may not be adequate drivers or resources to ensure that the design of the scheme is updated to reflect advances in technology, knowledge base or community values.

6.3.2 Purchase contract specifications

A common means by which the characteristics or bona-fides of a product or service are influenced is through the purchase contract between a purchaser and a supplier. This can occur in instances where the purchaser has specific requirements that are not addressed through existing standards or regulatory mechanisms, and they possess sufficient buying-power to be able to exert influence on the supply market.

The points of application of purchase contracts specifying sustainability credentials in a biofuel and bioenergy value chain could include the intermediate markets specifying sustainability credentials required from the biofuel and bioenergy producers, including:

- aviation industries
- mining industries
- government vehicle fleet managers
- oil majors purchasing biofuel for blending and distribution
- fuel and electricity retailers.

It could also be applied by biofuel and bioelectricity producers, who could specify sustainability credentials required from the biomass producers.

Whilst a huge range of specific requirements are contained within commercial-in-confidence agreements out of the public domain, some examples already in operation are given in Table 6-2. Notable here is the SEKAB-UNICA purchase agreement, which clearly specifies required sustainability characteristics. The sustainability requirements specified in the contract are underpinned by a verified sustainable ethanol initiative.

Table 6-2 Examples of purchase contracts specifying characteristics of fuel

Purchase agreement	Relevant criterion
City of Hume specification for the supply and delivery of B20 biodiesel[5]	The Biodiesel component shall be a renewable fuel as defined by the Australian Fuel Standards Regulations 2001 and comply with the (US) ASTM D 6751 fuel quality standard for B100 Biodiesel and Biodiesel blends up to 20%: The biodiesel component shall contain not less than 40% recycled material sourced locally. The remaining component shall be locally (south eastern quarter, Australia) sourced non-GMO agricultural crop.
SEKAB-UNICA 115 ML ethanol purchase agreement, underpinned by the verified sustainable ethanol initiative[6]	• At least 85 per cent reduction of fossil carbon dioxide compared with petrol when compared with well-to-wheel • At least 30 per cent mechanised harvesting today and a plan to increase to 100 per cent by 2014 • Zero tolerance for felling rain forest • Zero tolerance for child labour • Rights and safety measures for all employees according to UN guidelines • Ecological practices according to UNICA's environmental initiative • Continual control to ensure that the criteria are met by Brazilian producers
NSW Government contract no.366 – Fuel and Associated Products	Pricing for Biofuel (10% ethanol blended fuel, or E10) Using Cards United Petroleum Pty Ltd and Manildra Park Pty Ltd – The contract price is same as the pump price and there are no discounts applicable. United Petroleum and Manildra Park charge a monthly admin fee. There are no establishment or transaction fees[7] (extract from the contract user guide).

[5] (ICLEI Local Governments for Sustainability, 2007)
[6] (Sustainable Ethanol Initiative, 2009)
[7] (NSW Department of Commerce, 2006)

Purchase agreement	Relevant criterion
NSW Government contract no.506 – Office Supplies	Both suppliers on this contract have a range of Environmentally Sustainable Products. When you engage with a supplier under this contract they should forward to you a list of the environmentally sustainable products that they have available[8] (extract from the contract user guide).
Victorian Government Standard Motor Vehicle Policy	With the exception of approved hybrid vehicles, only vehicles that are substantially manufactured in Australia are permitted for lease or purchase under the Government's motor vehicle acquisition policy. 'Substantially manufactured in Australia' is defined as having a minimum of 60 percent content in parts and labour[9].

A direct link between product attributes and a purchase agreement is a powerful means by which the market can be influenced. In addition to this, they may be adopted by the purchase market at the time of procurement, thereby providing the shortest lead-time to implementation.

Conversely, a proliferation of different requirements across various fuel purchasers can significantly drive up costs to industry. Accordingly, harmonization between purchase agreements is strongly advocated for by various supply industries. This in itself is often a driver for development of standards or regulations.

6.3.3 Third-party compliance schemes

A large number of third-party designed, validated or administrated compliance programs exist. Most often, these revolve around government regulation, but they also originate from special interest groups. Examples of third-party compliance mechanisms are set out in Table 6-3.

Table 6-3 Examples of third-party compliance mechanisms

Third-party compliance mechanism	Examples
Codes of practice / conduct	The Food Standards Code[10] as developed by the independent statutory agency Food Standards Australia New Zealand under the Food Standards Australia New Zealand Act 1991 is a collection of mandatory food standards for the supply of food that is enforced by the individual state and territory governments and the federal government of New Zealand
	The Oilcode[11] prescribed mandatory industry code of conduct under the *Trade Practices Act 1974* to regulate the conduct of suppliers, distributors and retailers in the downstream petroleum retail industry. It was developed by the Australian Government in conjunction with industry, the ACCC, the Treasury and other key stakeholders, and administrated by the ACCC.
Consumer information mechanisms	Water Efficiency Labelling and Standards (WELS) scheme[12] as administrated by the Commonwealth and funded by industry registration fees and contributions from federal, state and territory governments.
	Energy Rating Label scheme[13] as administrated as a joint initiative of the federal, state and territory governments of Australia.
	The Fairtrade Label[14] as administrated by Fairtrade Labelling Australia and New Zealand, a not-for-profit organisation.
	GreenPower[15] government accreditation and marketing program for retail-end renewable energy.

[8] (NSW Department of Commerce, 2005)
[9] (VicFleet, 2009)
[10] http://www.foodstandards.gov.au/thecode/foodstandardscode.cfm, viewed 29th Dec 2008
[11] (Australian Competition and Consumer Commission, 2007)
[12] (Australian Government, 2008b)
[13] (Department of the Environment Water Heritage and the Arts, 2009)
[14] (Fair Trade Association of Australia and New Zealand, 2009)
[15] (GreenPower, 2009c)

Third-party compliance mechanism	Examples
	Heart Foundation Tick[16] certified trademark, owned and administrated by the Heart Foundation NGO.
	Green Vehicle Guide[17] consumer information website run by the Commonwealth Government, providing information on the environmental performance of passenger vehicles sold into the Australian market.
	GreenWheels[18] consumer information website run by the Low Emission Vehicle partnership, a not-for-profit group, providing information on the greenhouse gas emissions performance of passenger vehicles sold into the Australian market.
	Biofuels certification schemes under development, such as RSB Version Zero, which could eventually provide an mechanism for independent certification to any enterprise that signed up (section 0).
Regulation	NSW *Biofuel (Ethanol Content) Act 2007* providing for a minimum ethanol content requirement in respect of the total volume of petrol sales in the state; and Biofuel (Ethanol Content) Regulation 2007 to make provision for various matters under the aforementioned Act.
	Commonwealth *Fuel Quality Standards Act 2000* providing a basis for national fuel quality and fuel quality information standards; and Fuel Quality Information Standard (Ethanol) Determination 2003 applicable to fuel suppliers for the purposes of informing consumers that the fuel they are purchasing contains ethanol.

The main difference between industry's and government's role as a third-party is that governments tend to have legislative mechanisms to back up their regulatory frameworks (e.g. enforcement measures within the *Environment Protection Act 1970*), whereas industry organisations can only enforce their framework through a civil action. Conversely, there are significant efforts on behalf of government towards user-pays third-party audit schemes such as site assessment and remediation. This blurs the distinction between the government scheme and a true independent third-party scheme.

Industry partnerships have emerged as an important blend of attributes from the standalone industry and third-party compliance models, as they:

- ensure ownership by industry
- improve the likelihood of gaining critical mass in terms of industry coverage
- allow industry to expedite development and implementation of the model
- generally lead to lower costs of compliance for industry
- ensure the appropriate rigour exists
- minimise development and administration costs to the public purse
- inspire greater levels of consumer confidence than standalone industry models.

Third-party compliance mechanisms are likely to inspire higher levels of consumer confidence based upon the separation of interests between the industry and the designers/administrators of the compliance mechanisms. Also, should the compliance mechanism take the form of a regulation, compliance may be mandatory and therefore maximised.

Conversely, the costs associated with the design and administration of a third-party compliance mechanism may be significantly higher for industry, the consumer and the administrator alike. Furthermore, delivery of a compliance mechanism through government, even in instances where industry support is unanimous, may be inconsistent with broader government priorities and take a long time to achieve implementation.

[16] (National Heart Foundation of Australia, 2009)
[17] (Australian Government, 2008c)
[18] (Greenwheels, 2009)

6.4 Pathways to implementation

Section 6.2 discussed the types of mechanisms that are available to the industry in order to adopt any bioenergy and biofuel sustainability assessment system once it were developed. This section will explore the pathways to adoption in Australia of each of these mechanisms.

6.4.1 Codes of conduct

The ACCC defines a code of conduct as setting out, 'specific standards of conduct for an industry in relation to the manner in which it deals with its members as well as its customers' (Australian Competition and Consumer Commission, 2005).

A code of conduct is generally developed by an industry association in consultation with its members and often (but not always) other stakeholders more broadly. It should include provisions defining coverage or scope, assessment of compliance and other items which allow for practical application of the code. The code will usually include sanctions for businesses that breach the code, examples of which are:

- having to pay a fine
- being expelled from the industry association
- having to advertise that they have breached the code and explain what they are going to do to resolve a complaint (Australian Competition and Consumer Commission, 2008a).

The ACCC encourages development of voluntary, non-prescribed industry codes of conduct in order to deliver effective compliance with the Trade Practices Act. In support of this, the ACCC provides guidance for effective development of voluntary industry codes of conduct (Australian Competition and Consumer Commission, 2005), and has even taken on an observer role on code administration committees. The ACCC can also provide authorisation for certain conduct on public benefit grounds.

Under section 51AE of the Trade Practices Act, the ACCC may be required to administrate an industry code of conduct that is prescribed (i.e. made law) by the Australian Government. The decision to prescribe a code of conduct is only made once the following criteria have been met:

- the code would remedy an identified market failure or promote a social policy objective
- the code would be the most effective means for remedying that market failure or promoting that policy objective
- the benefits of the code to the community as a whole would outweigh any costs
- there are significant and irremediable deficiencies in any existing self-regulatory regime
- a systemic enforcement issue exists because there is a history of breaches of any voluntary industry codes
- a range of self-regulatory options and 'light-handed' quasi-regulatory options have been examined and demonstrated to be ineffective (The Treasury, 2009).

A prescribed mandatory code of conduct is binding upon all industry participants, whereas a prescribed voluntary code of conduct is binding for only those who are signatories to the code. In both instances a breach of the code of conduct represents a breach of section 51AD of the Trade Practices Act, following which the ACCC may take action. Industry participants may also take private action where a breach of a prescribed code has occurred.

In the instance of the biofuels and bioelectricity sustainability assessment system, the relevant peak industry bodies would be likely lead the development and administration of an industry code of conduct. It is foreseeable that the code would require all member organisations to comply with the range of requirements within the sustainability assessment system. If this were the case, membership of the peak industry body by an individual bioenergy or biofuel producer would serve as evidence of their compliance with the code.

Some obvious drawbacks in this scenario include:

- the extent and variety of producers and retailers within the bioenergy and biofuels industry, many of whom will be outside the coverage of any one peak body
- the disincentive effect of compliance with the sustainability assessment system on membership of any peak body. This would potentially undermine the coverage of the

scheme, and the ability of the industry peak body to effectively advocate for and inform their industry
- the potentially significant costs for the industry peak body associated with administration of a complex scheme
- the core role of an industry peak body is as an industry advocate, and their current expertise is probably not in design and administration of a compliance regime.

The decision to pursue a code would be taken by any peak industry body on behalf of their membership. Development of the code would be expected to include a period of consultation with the membership (and perhaps, at their discretion, major purchasers of the product). The final design of the code would be presented for adoption by the membership of the peak body. As the process design and delivery would be undertaken at the discretion of the industry, estimating likely lead-times for completion is difficult.

The development and adoption of a code would carry a relatively small cost. Guidance for effective development of a code is available from the ACCC. Ongoing assessment of compliance with the code would entail an operating cost for the industry association, which presumably would be recoverable from the membership.

Once agreed, a code could be used by industry to underpin additional consumer information mechanisms (including the use of certified trademarks), government–industry partnerships, and individual purchasing agreements (refer to the relevant sections below for more details).

6.4.2 Consumer information mechanisms

Using the bioenergy sustainability assessment system as a starting point, it may be possible to design or develop labelling, certified trademarks and websites. The Productivity Commission, an independent agency of the Australian Government, stated in its review of the cost effectiveness of improving energy efficiency that, 'there is some evidence to suggest that consumers are now paying more attention to labels than they have in the past' (Productivity Commission, 2005). Other positive attributes of labelling schemes noted by the Commission include:

- direct targeting of 'a source of market-failure – the asymmetry of information between buyers and sellers of energy-using products'
- provision of information to the consumer that is readily accessible and easily understood, thereby helping the consumer make better-informed choices
- a high likelihood that they have produced net benefits for consumers (refer to Australian Standards section 6.4.4)
- labels in themselves do not directly limit consumer choice
- labels can be used to warn consumers of poorly performing products (through a disendorsement label), which could be effective in discouraging (but not preventing) consumers from buying that product.

Conversely, it was noted by the Commission that labelling involves both administration and compliance costs, and is most suited to instances where there is a wide range of performances of comparable products (particularly in instances where comparison is possible).

The fuel purchasing decision does not usually involve prior research, and labelling derived from the sustainability assessment system would therefore be well-suited to application at the point-of-sale. The effectiveness of the labelling would be dependent upon a number of factors, including the extent and rigour with which the labelling is applied. A certification trademark provides an indication to consumers that a product or service meets a particular standard, which could indicate that a product is:

- of a particular quality
- has been manufactured in a particular location, or by using a particular process
- is made from particular materials or ingredients
- is suited to a particular task (Australian Competition and Consumer Commission, 2008b).

ACCC approval is required before a certified trademark can be registered under the *Trade Marks Act 1995*. The ACCC assesses and approves the rules for the use of the certified trademark, including:

- assessing the requirements that the goods, services or persons must meet in order to the eligible to have a certified trademark applied to them
- assessing the proposed process by which compliance with the certification requirements will be judged
- examining the rules to ensure that they are not in themselves anti-competitive, misleading or deceptive.

An entity would be free to use the bioenergy sustainability assessment system as the basis for a trademark application to the ACCC. A logo could be designed and included within this trademark application to act as a consumer information device, indicating compliance of a bioelectricity or biofuel product with the requirements of the framework. The use of the trademark (including the logo) would then occur at the discretion of the trademark owner, in accordance with the requirements of the trademark as approved by the ACCC.

The *Fuel Quality Standards Act 2000* (s22A) contains fuel quality information standards, which could be proclaimed under the Act in instances where the minister is satisfied that information should be provided in the public interest.

Costs associated with the design and development of the trademark would be expected to be relatively low. Assessment of compliance with the trademark would obviously come at some cost, which would be determined by the nature of the requirements and their means of assessment.

Websites which provide a directory of products along with their performance against an agreed standard create an artificial ‘marketplace’ for consumers, allowing them to compare products directly. This is particularly useful where the consumer is likely to undertake research prior to the purchasing decision. Conversely, as the information mechanism is likely to be located remotely from the point-of-sale, influence on consumers is likely to be far less than for labelling where prior research by the consumer is not generally undertaken.

Development of a consumer information mechanism could be done either by the industry association or an independent third party, with or without a regulatory imperative from government. The effectiveness of the consumer information mechanism will be significantly influenced by the extent to which it captures the range of products on the market. Accordingly, the most effective scheme will be a mandatory compliance program underpinned by government regulation.

Detailed design of a scheme should include a thorough assessment of the supply chain such that the most appropriate point for implementation of the consumer information mechanism is well understood. Similarly, the means by which the information is expressed should be informed by a good understanding of the target audience.

6.4.3 Purchase specifications

The incorporation of product or service requirements into a purchase specification uses market forces to attain a desired policy objective. As outlined in section 6.3.2, this is most effective in a scenario where the buyer possesses sufficient purchasing power to be able to influence the supplier market. Conversely, increasing specification complexity or variance from the current market offering may drive up costs for all concerned or significantly restrict buyer choice.

Influence within the market will be incremental, and will depend upon the number of discriminating purchasers. A purchase specification with new sustainability requirements for the supplier base is unlikely to result in immediate change – even when there are enough purchasers to have an influence, the suppliers may take a while to come to terms the changes. By way of example, the end goal of embodied greenhouse gas (GHG) labelling of consumer products by the UK’s largest supermarket retailer Tesco was first announced in January 2007 (Leahy, 2007). With a dedicated budget of £5 million and support from the UK Government and an independent academic research group, Tesco unveiled a pilot project range of 20 products with carbon labelling in April 2008[19]. This

[19] http://www.carbontrust.co.uk/News/presscentre/29_04_08_Carbon_Label_Launch.htm, viewed 30th Dec 2008

demonstrates the cost and time required for 20 products – changes across the entire spectrum will not happen overnight even with significant effort.

Purchase specifications may provide the simplest pathway to adoption of a sustainability assessment system, and achieve influence in the market most rapidly. Governments may adopt the sustainability assessment system not only within their procurement policies for fuel and electricity, but also within their grant programs in support of bioenergy projects more broadly. Private sector organisations striving towards an environmental policy or marketing objective are also likely to be receptive to a means to verifying the environmental bona-fides of biofuels products. This may see application of the sustainability assessment system directly through their own purchase agreements, indirectly within their supply-chain agreements, or through recommendations to users of biofuels products within their customer base (e.g. in the case of vehicle manufacturers).

6.4.4 Australian standards

According to Standards Australia (SA), standards are, 'published documents setting out specifications and procedures designed to ensure that products, services and systems are safe, reliable and consistently perform the way they were intended to' (Standards Australia, 2009a). There are Australian standards covering everything from consumer products and services, construction, engineering, business, information technology, human services to energy and water utilities, environment and more.

SA develops standards where a net benefit to the community as a whole has been demonstrated. Net benefit is defined as, 'having an overall positive impact on relevant communities', and takes into account the costs and benefits relating to the following criteria:

- public health and safety
- social and community impact
- environmental impact
- competition
- economic impact (Standards Australia, 2009b).

Once a net benefit has been demonstrated, there is a choice of five development pathways through which the standard can be delivered (Standards Australia, 2009c):

- committee-driven – highly autonomous committees develop standards with defined technical and secretarial support from SA
- bureau – an enhanced version of the committee driven pathway, where most responsibilities are held by the proposing organisation
- collaborative – stakeholders and SA jointly drive and resource the project through a negotiated sharing of responsibility
- SA-driven – SA drives and resources the project with a high degree of engagement from stakeholders and a commitment to the project outcomes (only available in instances where an extremely high degree of net benefit has been demonstrated and an alignment with national priorities)
- via an accredited standards development organisation other than SA.

Each of these development pathways will incur transaction costs and ideally these should be factored into the assessment of net benefit.

The development process for a standard is clear and rigorously defined (Standards Australia, 2009d):

1. request for a standard – must come from the community, industry body or government department, as SA does not initiate new standards projects
2. project approval – the new standards project is approved by the appropriate technical committee and standards sector board on the basis of whether:
    a. there is genuine community support for standard
    b. it will deliver economic efficiency
    c. it will show a net benefit
    d. it is in the national interest.

3. formation of a technical committee – membership must be balanced and represent the broadest possible spectrum of interests, with the chair to be an unpaid external figure and the secretariat to provided by SA
4. preliminary draft – to be completed by the committee before any drafting work is undertaken to ensure that the standard will:
    a. in no way act as a barrier to trade, competition or innovative development
    b. adopt international standards to the maximum extent possible.
5. committee draft – done offline by subcommittees and expert working groups, feeding into the committee who seek to maintain consensus on the technical content
6. draft for public content – including a two- to three-month consultation period
7. consideration of comment – feeding into further drafting by the committee
8. draft for postal ballot – committee votes on the final draft, where the ballot must demonstrate substantial agreement with no major dissenting interests
9. publication – the final process approval is given by the relevant standards sector board on behalf of the Council of Standards Australia, and the standard is prepared for publication.

Notably, standards are not laws within themselves. However, because of their rigour, they are often called up into legislation by government and become mandatory. This decision is made at the discretion of individual governments. Similarly, standards are often incorporated into legal contracts (such as purchase specifications) (Standards Australia, 2009e).

In the case of the any sustainability assessment system, it is preferable to formalise the measurement methods as a standard, rather than formalising specific targets. For example, a standard for measuring an indicator can be specified, and a purchase agreement, a policy or a code of conduct can then specify a target, referencing the standard method by which this target should be assessed.

In order to instigate a standards proposal, a net benefit argument would need to be demonstrated – which in itself would require a significant body of work. Of the five development pathways (a–e above), the committee-driven pathway would be most likely. This is because SA have a preference for this approach due to internal capacity and expertise constraints. A committee could be assembled would have technical expertise and divergent opinions to examine arguments from all angles as part of the standards development process.

Should an Australian standard be both possible and desirable, the outcome would be a formalised, standalone document with sufficient rigour to support all further applications such as regulation or purchase specifications. SA currently has observer status in the ISO process for biofuel sustainability standards.

An additional consideration in the design of a standard relates to Australia's obligations as a member of the World Trade Organisation (WTO). The WTO Agreement on Technical Barriers to Trade tries to ensure that regulations, standards, testing and certification procedures do not unnecessarily create obstacles to trade, and effectively serve as a form of protectionism (World Trade Organization, 2009). Aspects of the sustainability framework are likely to require detailed explanation in order to address these issues.

6.4.5 Regulation

Regulation can be used as a means to achieve sustainability either through setting goals and targets, or specifying the implementation of a sustainability assessment system to measure progress against the targets. This is usually the last resort where the other less costly approaches (industry self-regulation or consumer information mechanisms) do not meet a demonstrated public need or policy objective.

The Commonwealth Office of Best Practice Regulation defines regulations as including, 'laws or other government-endorsed 'rules' where there is an expectation of compliance' (Department of Finance and Deregulation, 2009). A goal for the design of regulation is for it to be 'effective in addressing an identified problem and efficient in terms of maximising the benefits to the community, taking account of the costs'. These drivers of 'effectiveness' and 'efficiency' are the cornerstones for the justification and design of regulation.

The Council of Australian Governments (COAG) has agreed that all governments will ensure that their regulatory processes are consistent with the following principles:

1. Establish a case for action before addressing a problem, including identification of the problem to be addressed and whether there is a case for government intervention.
2. Consider the range of feasible policy options to achieve the objective of the intervention, including 'no action/status quo', self-regulatory, co-regulatory and non-regulatory approaches, along with an assessment of their benefits and costs.
3. Adopt the option that generates the greatest net benefit for the community, as identified through rigorous regulation impact assessment of all the feasible policy options.
4. Ensure that legislation will not restrict competition unless it can be demonstrated that:
    - the benefits of the restrictions to the community as a whole outweigh the costs
    - the objectives of the regulation can only be achieved by restricting competition.
5. Provide effective guidance to the relevant regulators and regulated parties in order to ensure that the policy intent and expected compliance requirements of the regulation are clear, and all the key features of good regulation are observed.
6. Ensure that the regulation remains relevant and effective by designing in a means for assessing the outcomes from the regulation and instituting periodic reviews.
7. Consult effectively with affected key stakeholders at all stages of the regulatory development cycle.
8. Ensure that government action is effective and proportional to the issue being addressed, judged in terms of meeting the desired objective.

The COAG-endorsed document, Best Practice Regulation: A Guide for Ministerial Councils and National Standards Setting Bodies (Department of Finance and Deregulation, 2008), provides extensive guidance on all aspects of the regulatory development process in accordance with the principles above. This includes the elements required for inclusion in the preparation of a regulatory impact statement (RIS), and guidelines for effective consultation with stakeholders.

6.4.6 Effort and likelihood of success

The various mechanisms and their adoption pathways discussed in this chapter are summarised in Table 6-4 in terms of the effort and likelihood of success.

Table 6-4 Summary of mechanisms and adoption pathways in terms of effort and likelihood of success

Mechanisms and pathways to adoption	Point of application	Effort	Likelihood of success*
Purchase specifications	Purchasers	Low	Medium
Code of conduct	Industry	Medium	Low
	Industry/third-party partnership	High	Medium
	Independent third-party	Medium	Medium
Certification schemes	Independent third-party	Medium	Medium
Australian Standard	Industry	High	High
	End-user	High	High
Consumer information mechanisms (labelling, trademarks, websites)	Industry	Low	Medium
	Industry/third-party partnership	Medium	High
	Independent third-party	Low	Medium
Regulation	Government/s	High	High

* success of ensuring bioenergy sustainability assessment system is applied broadly and rigorously

6.5 Key messages and conclusions from this chapter

1. There are many options that could be explored in response to assessing and achieving sustainability in the bioenergy domain, and some of these have been presented in this chapter. Further discourse amongst stakeholders and communities of consent is needed in order to identify the most attractive, likely or necessary options. Further analysis on the risks to sustainability from the bioenergy industry, the opportunity costs of developing (or not) or adopting a sustainability assessment system, and the costs and benefits to public and private interests will be required in order to support industry and government decisions.
2. Once options are identified and an approach is developed, there are a number of mechanisms which could be used to implement the system. These include:
    a. Industry self-regulation
        i. Codes of conduct, applied by industry;
        ii. Consumer information mechanisms (labelling, trademarks, websites), applied by industry.
    b. Purchase specifications, applied by purchasers of biomass or biofuel
    c. Third-party compliance schemes
        i. Codes of conduct, as applied by industry/third-party partnership, or independent third parties
        ii. Consumer information mechanisms, including certification schemes, applied by independent third party or industry/third-party partnership
        iii. Government regulation, applied by government/s. The regulations may include compliance with items under 3 a) and 3 b).
3. However, useful observations from the discussion are readily apparent:
    a. Codes of conduct and consumer information mechanisms are likely to be feasible policy options, thereby negating the need for regulation until it can be demonstrated otherwise.
    b. an Australian Standard would be suited to formalisation of the means by which the sustainability of bioenergy and biofuels can be assessed (i.e. not for evaluating whether sustainability goals are achieved, but for the assessment methods by which such determinations are made).
4. If there is a community expectation that the sustainability of bioenergy must be ensured, then a regulatory approach is warranted (subject to the demonstration of net benefit for the community).
5. The development of a standard is likely to be required in parallel to regulations.
6. Australia's WTO obligations are likely to require consideration in the design of a regulation relating to the bioenergy sustainability assessment system, as was described in the section relating to Australian standards above.

7 Synthesis and conclusions

7.1 Introduction

In this synthesis chapter, we draw together the findings from the various chapters, and provide some overview of gaps and challenges for industry, science, policy and society in terms of addressing the sustainability of bioenergy production and the issues that arise from this consideration.

There is global recognition of a convergence of peak oil and global oil security due to geo-political factors, a growing population with aspirations of increased affluence (clean water, food and energy), and climate change and its impact on agricultural production. Sustainability is high on the political agenda – but it remains challenging to implement the general principles, especially as the scale and urgency of these emerging issues becomes apparent.

Bioenergy is potentially an effective response to the emerging global recognition of the sustainability issues of energy security and greenhouse gas (GHG) emissions. A bioenergy industry based on highly efficient combustion of wood for heat and power with closed loop eco-industrial design operates successfully in Scandinavia (Wahlund et al., 2002; McKormick and Kåberger, 2005). It is based on sustainable use of their forests and has shown the potential to reduce reliance on foreign energy, and reduce fossil fuel dependence. The bioenergy industry has potential to reduce GHG emissions, and contribute to greater energy security and sustainability if deployed with sustainable use of natural resources following ecological principles, and using state of the art technologies.

Significant and rapid international expansion of first-generation biofuels has, however, resulted in minimal GHG reductions because they are generally based on high-input agricultural systems. Unintended perverse consequences (e.g. indirect effects of land use change) have meant that instead of alleviating sustainability concerns, biofuels have triggered a further set of sustainability threats. The capacity for bioenergy to address key sustainability issues depends on the way natural resources are used in different regions of the world, and on the development of different strategies of eco-industrial design for deploying the biomass and the technologies.

The biofuels and bioelectricity industries are in their infancy in Australia, with biofuels representing only 0.45% of the total amount of automotive gasoline and diesel used in 2008, and electricity generated from biomass represented only 0.7% of the total electricity generated in 2007. The biofuels industry is based on ‘waste’ streams such as used vegetable oil, tallow and C molasses, and therefore has not (until recently) raised sustainability concerns. However, there is a limit on the amount of these feedstocks, and further industry expansion of first-generation biofuels to meet the current mandate in New South Wales will necessarily start to use crops which are currently used for human food or animal feed, or necessitate imports of sugar, starch or fuel.

There is potential for rapid expansion of second-generation biofuels and bioelectricity based on non-food crops, due to the new and emerging Australian policies setting significant targets for expansion of renewable electricity generation and the proposed Carbon Pollution Reduction Scheme. The extent to which these drivers will stimulate industry development is unclear.

There is significant potential for second-generation technologies based on lignocellulosic feedstocks or algae to reduce emissions and address oil security concerns. The capacity for sustainable production of biomass at large scale, and the technologies for cost-efficient conversion have not, however, been adequately assessed in Australia. There is potential to apply further pressure to land and water resources, which will be increasingly contended for food and fibre production, habitat provision to increase biodiversity, and other services. These are critical issues for Australia, where climate change will increase the scarcity of productive land and restrict agricultural production in the south-eastern parts of the country. Biomass produced in certain Australian landscapes – for example planting mallee eucalypts – may enhance existing agricultural landscapes by alleviating salinity and improving biodiversity, as well as providing enterprise diversification for farmers and new industries for regions. The potential of algal ponds associated with waste water treatment plants, or using CO_2

streams from coal fired power stations, have yet to be adequately assessed but may also offer significant sustainability benefits.

How do we ensure that the significant potential offered by the use of biomass for electricity, heat and liquid fuels is tapped in a way which significantly improves sustainability outcomes? How can emerging industries which provide more sustainable solutions have an opportunity to expand by developing new value chains linking the incumbent agricultural, forestry and fossil fuel industries? There are some building blocks in place in terms of the scientific approaches to assess sustainability, and current institutional systems (including international, national and local environmental, social and economic policies, laws, regulations and social norms) to achieve sustainable outcomes for bioelectricity and biofuel industries. We have in this report proposed a few of the ways in which they might be built on to develop a sustainability assessment system. There are, however, many gaps and challenges remaining.

7.2 Implications and challenges…

7.2.1 For industry

It is recognised in the international arena that quantitative, robust and independently verified (or certified) sustainability assessments are necessary for the bioenergy industry to gain a long-term ‘license to operate’ from society. This translates into government policies in some regions of the world (e.g. EU), which will limit market access and government support to biomass or biofuels which can be independently certified as meeting a specified standard for sustainability. It also translates to broad consumer support.

Economic viability is an immediate imperative for the biofuel industry. Second-generation technologies for biofuels are not yet commercially competitive in any country, especially in the absence of government support. Currently the very small first-generation biofuel industry in Australia is struggling for survival and a second-generation industry does not yet exist. There has been significant and ongoing change in bioenergy and biofuels policy, regulation and funding arrangements over the last ten years and this has created considerable uncertainty for biofuel producers and investors. Transitioning from first- to second-generation technologies; gaining investment given the uncertain policy environment; and gaining the significant research and development investment required to provide the underpinnings for a financially viable and demonstrably sustainable industry are all enormous challenges for the biofuels industry.

Internationally, sustainability targets are sometimes being expressed in terms of improvements relative to reference systems, especially for transport fuels. However, there has been less pressure brought to bear on the incumbent industries of agriculture or energy (against which biofuels must achieve significant improvements) to have robust sustainability targets themselves. This is a challenging situation for the bioenergy industry. Demonstration or certification of sustainability credentials will be a key market advantage and industry enabler for the bioenergy industry in Australia especially if participating in international trade, and there are many international initiatives which can be built on and adapted in order to achieve this. It is likely that the first-generation biofuels industry based on grains or other feedstocks currently used for human food or animal feed will be unable to meet targets specified by some countries (for example, the EU). This will provide impetus to the second-generation biofuel industry internationally, although it is not possible currently to gauge the effect on the Australian industry. Placing the burden of a) meeting significant sustainability targets over incumbent industries used as a reference and b) bearing the cost of demonstrating that they have indeed done so is a significant challenge for any new or emerging industry.

There will be extra effort required to design and/or adapt and implement a sustainability assessment system in Australia that complies with international standards, despite the existence of some relevant policy mechanisms as building blocks. For biomass producers, there may be additional requirements to meet sustainability requirements across a value chain, which do not apply if selling the biomass into traditional markets. The biofuel sustainability systems under development internationally will have to meet a broad set of C&I across the value chain. There are established systems in place for assessing forestry, although a new system will expand the set of C&I that must be assessed to account for GHG emissions through the whole value chain, including the biomass production system. So, for example, a forest biomass exporter will have to comply with these additional requirements if selling wood to an energy market rather than the traditional wood product market. Conversely, for a biofuel producer it will be easier to demonstrate sustainability from forestry or waste feedstocks where there is already a strong sustainability framework, compared to sourcing biomass from agriculture where there is little of that in place.

There are implications and challenges for related industries. The vehicle industry has only very recently, in Australia and in the US, had pressure to meet sustainability targets and there has not been a major impetus for fuel efficiency or alternative low-emission fuels. Major fuel-use industries (especially those which are more dependent on liquid fuels, such as aviation, agriculture, mining and freight (CSIRO, 2008) will find pressure to meet sustainability targets using 'green' fuels. There is already substantial activity in the aviation sector in this regard, and there is a clear need to establish the credentials for a 'green' fuel. These challenges for the fuel use industries represent major opportunities for second-generation biomass and biofuel producers.

7.2.2 For science

Sustainability is a complex and evolving concept that has a major human values component. There are many interpretations of how sustainability could be implemented, measured, monitored and demonstrated. The approaches each have their own epistemologies, cultures, languages and methodologies – and yet the overarching challenge is to integrate across disciplines, sectors, time horizons, and policy interfaces in order to address sustainability.

There are challenges specific to the scientific assessment of the sustainability of bioenergy and biofuels value chains. Within the construct of outcomes based criteria and indicator methods, these include defining C&I relevant to local contexts; addressing scale issues, especially moving from assessing the effects of single projects to assessing the often non-linear effects of scaling-up on landscapes; quantifying trade-offs between different dimensions of sustainability; identifying and quantifying natural and irreversible thresholds or 'tipping points' in natural systems, so that they can be avoided; and using C&I in designing sustainable solutions across sectors, where the data are sparse and several driving variables (climate, population) are outside of previous known ranges.

The current quantum of R&D funding for development of bioenergy is orders of magnitude lower than, for example, the annual oil and gas exploration expenditure in Australia – which in 2006/7 was 2,225.5 million dollars (Australian Bureau of Statistics, 2008). The low levels and largely sectoral nature of research funding delivery in Australia is insufficient to deal with the issues described in this report. In particular, greater resourcing is needed for developing both the science content, and the social process for moving beyond the analysis of a particular industry (as is the focus of this report) to an integrated view of sustainability at whole-of-system level.

7.2.3 For policy

The overarching policy challenge is how to deal in a systematic and rigorous manner with the rapidly emerging sustainability issues around climate, water, energy, transport, biodiversity, land use and regional development – while simultaneously dealing with inertia of incumbent industries, and the broader community. The bioenergy value chain – from biomass production through conversion to distribution to export and import markets – crosses a broad range of other sectoral, environmental, social and economic policies. We have shown in this report that in Australia there are national and state policies and regulations and voluntary mechanisms that can deal with individual parts of the value chain, but little that deals with the direct and indirect effects of the whole value chain, or the interactions with other value chains. In addition, governments must be cognisant of trends and events at international, national and sub-national scales. Designing and implementing policy to achieve multiple objectives across this range of scales is a fiercely challenging task, especially given the underlying scientific challenges described above.

The biomass production part of the value chain is very heterogeneous and most likely to be contentious. There is a continuum of policy and regulation related to the perceived value of the resource – for example, native forests are often considered more scarce and able to deliver a wide range of non-market values, whereas waste is perceived as having no or little value. The sustainability of forestry-derived biomass is generally well regulated in Australia, and sustainability assessment systems (and certification) are well developed for most production forests. Native forests have relatively comprehensive, robust and mature policy, but plantations (especially on private land) are not as well covered. There is an internationally accepted certification scheme for forestry.

Any major expansion of bioenergy in Australia is likely to be on agricultural land, since existing forest resources are limited and have strong legislative protection. There are opportunities to develop biomass production systems that are complementary to existing farming systems. There is as-yet untested potential to develop the low-productivity and under-utilised agricultural landscapes by establishing perennial energy crops that are adapted to increasing climatic variability and climate change. There is also potential, however, under certain policy and economic settings for bioenergy (or even carbon sequestration), to displace food production in medium- to high-productivity agricultural landscapes. In addition, the biosecurity risks arising from the weedy potential of energy crops must be considered.

Achievement of 'sustainability' ultimately requires goals and activities that are applicable at a whole-of-system level. It is, however, possible to assess and 'certify' the sustainability of components (biofuels and bioenergy) of the system in terms of their contribution to broader sustainability goals. In this report we have taken the pragmatic view that a sustainable whole will be made up of a set of well-managed components, each making varying contributions to overall sustainability. Ideally, any sustainability framework for bioenergy would be nested within a more holistic and cohesive approach to sustainability in the energy and land use sectors, and across all other sectors. In practice, this is a challenging task. Campbell (2009) has developed a range of policy propositions for Victoria which would strengthen the sustainability of food and farming systems as well as improving health outcomes through provision of more nutritious food. This type of policy approach which seeks to integrate outcomes across multiple domains will be the way to a more sustainable future.

7.2.4 For society

Because food is a fundamental and irreplaceable human need, the 'food v fuels' debate has vociferously and uncritically regarded food production as a higher order priority for use of land and water resources. The UN-Energy (2007) frames food security in 4 dimensions:

- availability (related to food production) – the amount of food produced and where
- access – who are the hungry and what are the barriers to them being able to access food, including the cost of the food?
- stability – the time dimension of food production which could be affected if productive land were diverted to biofuels, but will also be affected by changes in rainfall patterns and water available for irrigation based on glacier melt and changed patterns of events like cyclones
- utilisation – the nutritional value of the food, and the ability of people to absorb the nutrients in the food which is in turn related to health and nutrition factors such as access to clean water and medical services.

Society accords food production a very high priority – and with the global population increases converging with climate change impacts the land and water resources required to provide food for the world are going to be under more pressure than they are currently. The use of good quality land and water for increasing food production would not, however, on its own redress global food security issues across the four dimensions described by UN-Energy (2007). There must be broader consideration of multiple objectives for landscapes AND simultaneously tackling the other dimensions of food security – and this is a global policy and political challenge. For example, legumes provide the nutritional requirement for protein with a significantly lower greenhouse gas and water requirements than meat, but would require a shift in the values currently held by many parts of society.

There is a substantial effort required in science, economics and policy to guide the most efficient allocation and use of resources. A shift away from fossil energy to bioenergy represents an increase in efficiency if it results in a decrease in the external costs (or externalities), such as GHG emissions. However, the Jevons paradox contends that an increase in the efficiency with which a fuel (or any other resource) is used does not equate to less use (Tainter, 2008). In fact, consumption may increase. For example, a survey in Sweden showed that if Swedes ate less meat in their diet, they would spend the money saved on travel – which would, in turn, increase GHG emissions rather than reduce them (Tainter, 2008).

It is clearly going to take some major revisions of the world economy and resource use across countries and sectors, as well as major change in societal attitudes and behaviours to achieve a sustainable future. To the extent that sustainability assessment systems can be designed and implemented in the bioenergy industry, they will be able to claim a contribution from this sector in moving towards a sustainable future.

7.3 Sustainable bioenergy for Australia – where to next?

Australia lacks a cohesive and comprehensive bioenergy sustainability framework – in terms of institutional systems or sustainability assessment systems. What would be required to support the sustainability of biomass, bioelectricity or biofuels either produced in or imported into Australia?

There is already a complex policy and regulatory environment, and the development and application of any additional assessment or reporting processes need to be well justified. Sustainability assessment systems will ideally build on existing activities and processes wherever possible; involve stakeholders and communities of concern; and require well defined governance and responsibilities. It is important that new systems are, as far as possible, compatible with other systems to assist mutual recognition, and thus facilitate international trade in biofuels or renewable energy certificates.

We contend that the lack of robust evaluation of:

- potential for the growth of the bioenergy industry and contribution to the future energy mix
- different pathways for industry growth and the sustainability impacts that might occur
- the efficacy of existing policy settings at Australian and State Government levels to ensure sustainable outcomes in the case of rapid industry growth
- a formal scheme to assess and demonstrate sustainability.

are all barriers to consumer and broader government confidence, and therefore to industry expansion.

A clear demonstration of the ability of the bioenergy sector to produce sustainable energy products, as well as make a significant contribution to the broader sustainability goals of Australia, would be a strong industry enabler. It would provide consumer confidence in bioenergy products, as well as the confidence for governments to invest in bioenergy as a plausible energy alternative.

A dialogue about the implications and prospects for bioenergy sustainability in Australia – involving industry stakeholders along the value chain, government, stakeholders and representatives of communities of concern – would be a useful first step. Exploration of scenarios for bioenergy development as part of a transition to a future energy mix would help to underpin a clear understanding of the sustainability implications of industry development along different pathways. For example, a future industry based on algae compared to complementary food/energy farming in lower productivity landscapes, or short rotation forestry provide different benefits and risks. An assessment of the risks, costs and benefits, and the distribution of these across public and private interests would also be useful to support decisions on the options and development and implementation pathways for bioenergy sustainability assessment. Engagement with international developments by Australian and State Governments, non-government organisations and industry is critical in moving forward.

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Appendix 1 Roundtable of Sustainable Biofuels (RSB) *Version Zero, Standard for Sustainable Biofuels,* August 2008

Principle 1. Legality	
Criteria	***Key Guidance***
1. Biofuel production shall follow all applicable laws of the country in which they occur, and shall endeavour to follow all international treaties relevant to biofuels' production to which the relevant country is a party.	*Includes laws and treaties relating to air quality, water resources, soil conservation, protected areas, biodiversity, labour conditions, agricultural practices, and land rights, including for instance ILO, CBD, UNFCCC, and the Universal Declaration of Human Rights. This standard can go beyond national law, but cannot contradict or contravene national law.*
Principle 2. Consultation, planning, and monitoring	
2. Biofuels projects shall be designed and operated under appropriate, comprehensive, transparent, consultative, and participatory processes that involve all relevant stakeholders. **2.a** For new large-scale projects, an environmental and social impact assessment, strategy, and impact mitigation plan (ESIA) covering the full lifespan of the project shall arise through a consultative process to establish rights and obligations and ensure implementation of a long-term plan that results in sustainability for all partners and interested communities. The ESIA shall cover all of the social, environmental, and economic principles outlined in this standard. **2.b** For existing projects, periodic monitoring of environmental and social impacts outlined in this standard is required. **2.c** The scope, length, participation and extent of the consultation and monitoring shall be reasonable and proportionate to the scale, intensity, and stage of the project and the interests at stake. **2.d** Stakeholder engagement shall be active, engaging and participatory, enabling local, indigenous, and tribal peoples and other stakeholders to engage meaningfully. **2.e** Stakeholder consultation shall demonstrate	*'Biofuel projects' refers to farms and factories producing biofuels. The intent of this principle is to diffuse conflict situations through an open, transparent process of stakeholder consultation and acceptance, with the scale of consultation proportionate to the scale, scope, and stage of the project, and any potential conflicts. The RSB will develop a scoping process to help determine the extent of the stakeholder consultation based on key criteria. Where many farmers are engaging in the same activity in the same area, there should be flexibility for a group of farmers to combine their work.* *The ESIA shall include the identification of High Conservation Value areas, biodiversity corridors, buffer zones, and ecosystem services; shall evaluate soil health; shall identify potential sources of air, water and soil pollution; shall evaluate potential impacts on water availability; shall cover a baseline social indicator assessment; shall include an economic feasibility study for all key stakeholders; shall identify potential positive and negative social impacts including job creation and potential loss of livelihoods; shall establish any existing water and land rights. Small-scale producers or cooperatives unable to perform ESIAs will need support*

best efforts to reach consensus through free prior and informed consent. The outcome of such consensus-seeking must have an overall benefit to all parties, and shall not violate other principles in this standard. **2.f** Processes linked to this principle shall be open and transparent and all information required for input and decision-making shall be readily available to stakeholders.	*and/or modified ESIAs. 'Large-scale producers' and 'relevant stakeholders' will be defined in the indicators.* *The focus of this principle shall be on mitigating any potential negative impacts of large-scale projects in regions where stakeholder conflict is potentially high.* *'Free prior and informed consent' and 'consensus' will be carefully defined. Consensus-seeking will be used to find the best solutions and iron out any potential problems that may arise over the lifetime of the project. Consensus can be sought from a group selected from stakeholders, to prevent decision-blocking by any one group or individual.* *Good practices for stakeholder consultation will be developed. Smallholders will need support for complying.*
Principle 3. Greenhouse gas emissions	
3. Biofuels shall contribute to climate change mitigation by significantly reducing GHG emissions as compared to fossil fuels. **3.a** Producers and processors shall reduce GHG emissions from biofuel production over time. **3.b** Emissions shall be estimated via a consistent approach to life cycle assessment, with system boundaries from land to tank. **3.c** At the point of verification, measured or default values shall be provided for the major steps in the biofuel production chain. **3.d** GHG emissions from **direct land use change** shall be estimated using IPCC Tier 1 methodology and values. Better performance than IPCC default values can be proven through models or field experiments. **3.e** GHG emissions from **indirect land use change**, i.e. that arise through macroeconomic effects of biofuels production, shall be minimized. There is no broadly-accepted methodology to determine them. Practical steps that shall be taken to minimize these indirect effects will include: • Maximising use of waste and residues as feedstocks; marginal, degraded or	*The aim of this principle is to establish an acceptable standard methodology for comparing the GHG benefits of different biofuels in a way that can be written into regulations and enforced in standards. The overriding requirement is therefore a methodology that is not susceptible to subjective assumptions or manipulation. The fossil fuel reference shall be global, based on IEA projections of fossil fuel mixes.* *The RSB shall investigate incentive mechanisms to promote those biofuels with significantly higher reductions than others, for instance by introducing performance categories based on percentage reductions as compared to fossil fuels.* *The scope shall include carbon embedded in the fuel but exclude vehicle technology. Carbon sequestered in the soil and plant matter and carbon emissions from direct and indirect land use change shall all be accounted for whenever accepted methodologies are available – per 3d and 3e. Life cycle assessment tools that go beyond this scope (for instance that include vehicle technology) shall be recognized as long*

previously cleared land; improvements to yields; and efficient crops; • International collaboration to prevent detrimental land use changes; and • Avoiding the use of land or crops that are likely to induce land conversions resulting in emissions of stored carbon. **3.f** The preferred methodology for GHG life cycle assessment is as such: • The functional unit shall be CO2 equivalent (in kg) per Giga Joule [kgCO2equ/GJ]. • The greenhouse gases covered shall include CO2, N2O and CH4. The most recent 100-year time horizon Global Warming Potential values and lifetimes from the IPCC shall be used.	*as any extra elements can be isolated to facilitate comparisons.* *The RSB will develop criteria for the quality of acceptable default values and measurements, and work with other institutions to develop default values for typical supply chains in different regions to help small producers comply with this criterion.* *The use of residues and waste shall not violate Principle 8 on Soil. Careful definitions and guidelines for identifying preferred land (marginal, degraded, underutilized, etc.) will be needed. The RSB will work with key international and national agencies and experts to try to provide a methodology to measure the indirect impacts of biofuels production for inclusion in the assessment of compliance with this standard, and to give guidance to producers.* *The RSB will develop guidelines for how substitution, allocation by energy content, and allocation by market value should be used, as there is a risk of mistakes and variability in results. Waste products (defined by the IPCC as having no economic value) will have zero allocation of historical emissions. It is possible that the definition of 'waste' will be expanded beyond the IPCC definition.*
Principle 4. Human and labour rights	
4. Biofuel production shall not violate human rights or labour rights, and shall ensure decent work and the well-being of workers. **4.a** Workers will enjoy freedom of association, the right to organise, and the right to collectively bargain. **4.b** No slave labour or forced labour shall occur. **4.c** No child labour shall occur, except on family farms and then only when work does not interfere with the child's schooling. **4.d** Workers shall be free of discrimination of any kind, whether in employment or opportunity, with respect to wages, working conditions, and social benefits. **4.e** Workers' wages and working conditions shall	*Key international conventions such as the ILO's core labour conventions and the UN Declaration on Human Rights shall form the basis for this principle. Employees, contracted labour, small outgrowers, and employees of outgrowers shall all be accorded the rights described below. 'Decent work', as defined by the ILO, will be the aspirational goal for this principle.* *In countries where the law prevents collective bargaining or unionisation, special measures must be developed within the framework of the project implementation plan to ensure that workers can engage with the project owners or partners while being protected from breaking the law.*

respect all applicable laws and international conventions, as well as all relevant collective agreements. They shall also be determined by reference to, at a minimum, the conditions established for work of the same character or offered by comparable employers in the country concerned. **4.f** Conditions of occupational safety and health for workers and communities shall follow internationally-recognised standards.	*Applicable standards will be referenced by the RSB in the full guidance.*
Principle 5. Rural and social development	
5. Biofuel production shall contribute to the social and economic development of local, rural and indigenous peoples and communities. **5.a** The ESIA carried out under 2a and monitoring required under 2b shall result in a baseline social assessment of existing social and economic conditions and a business plan that shall ensure sustainability, local economic development, equity for partners, and social and rural upliftment through all aspects of the value chain. **5.b** Special measures that benefit women, youth, indigenous communities and the vulnerable in the affected and interested communities shall be designed and implemented, where applicable.	*Small producers will need support or reduced requirements for this criterion. Large producers and processors shall work with local governmental and non-governmental agencies to ensure the proper application of this criterion. There should be measured improvements in the social and economic indicators as set against the baseline and targets, in proportion to the scale and extent of the project and the region in which it is located. The ILO's Decent Work Agenda is a recommended tool for assessing local impacts. The following best practices should be aimed for in the projects: Local ownership, local employment and livelihood opportunities, opportunities for the labour force in the off-season to ensure stable local communities, diversification of crops if shown to improve local economic conditions of communities, training, value added products, credit facilities for local communities and small outgrowers (e.g. through micro credit schemes supported by buyers and/or financial institutions), and/or provision of biofuel or bioenergy to local communities to promote energy security. Appropriate institutional structures should be developed, such as co-operatives that encourage and maximize local involvement and management.* *Large producers and processors shall work with local governmental and non-governmental agencies to ensure the proper application of this criterion in proportion to the scale of the project.*
Principle 6. Food security	
6. Biofuel production shall not impair food security.	*Clear definitions are needed for waste, residues, and degraded or marginal or*

6.a Biofuel production shall minimize negative impacts on food security by giving particular preference to waste and residues as input (once economically viable), to degraded/marginal/underutilized lands as sources, and to yield improvements that maintain existing food supplies. **6.b** Biofuel producers implementing new large-scale projects shall assess the status of local food security and shall not replace staple crops if there are indications of local food insecurity.	*underutilized land. ESIA should ensure that these lands were not used for livelihoods support, or that benefits of use for biofuels outweigh any loss of livelihoods. All of these definitions are time-dependent; unused land might come into production anyway given climate change as well as population and wealth growth. These criteria and definitions should be periodically re-assessed. The RSB will examine different tools for incenting the use of these preferred sources of biofuels.* *The RSB will work with other actors to develop tools for assessing local food insecurity. To mitigate local food security impacts, the biofuel project could, for instance: take the maximum food value from the crop and use the remainder as an energy stock, offset impacts via economic instruments, and/or intercrop food and fuel.*
Principle 7. Conservation	
7. Biofuel production shall avoid negative impacts on biodiversity, ecosystems, and areas of High Conservation Value. **7.a** High Conservation Value areas, native ecosystems, ecological corridors and other public and private biological conservation areas shall be identified and protected. **7.b** Ecosystem functions and services shall be preserved. **7.c** Buffer zones shall be protected or created. **7.d** Ecological corridors shall be protected or restored.	*HCV areas, native ecosystems, ecological corridors and public and private biological conservation areas can only be exploited as far as conservation values are left intact and can in no case be converted. Definitions of these terms and an appropriate cut-off date will be developed by the RSB.* *Identification and mapping of HCV areas should be undertaken by governmental, inter-governmental, and conservation organizations, as part of larger processes involving non-biofuel sectors. Where such mapping is occurring, the results shall be respected by producers. Where such maps do not exist, large-scale producers shall use existing recognized toolkits such as the HCV toolkit or the IBAT. Producers or cooperatives unable to perform an environmental impact assessment and/or a land management plan will need support. The use of native crops shall be preferred. Hunting, fishing, ensnaring, poisoning and exploitation of endangered and legally protected species are prohibited on the production site.* *Ecosystem (ecological) functions are*

	described in other systems, for instance FSC criterion 6.3. Ecosystem services are provisioning, regulating, cultural and supporting services obtained by people from ecosystems, as described in the Millennium Ecosystem Assessment. Specific ecosystem functions and services relevant to an area of production shall be locally defined.
Principle 8. Soil	
8. Biofuel production shall promote practices that seek to improve soil health and minimize degradation. **8.a** Soil organic matter content shall be maintained at or enhanced to its optimal level under local conditions. **8.b** The physical, chemical, and biological health of the soil shall be maintained at or enhanced to its optimal level under local conditions. **8.c** Wastes and byproducts from processing units shall be managed such that soil health is not damaged.	*The optimal level of organic matter is to be defined through the consultation of local experts, communities and producers, taking into account local climatic, geologic and ecologic conditions. Realistic targets should be set, in accordance with the producers' capacities and on a reasonable timeline. Follow-up indicators should focus on the implementation of recognized good practices. The use of agrarian residual products, including lignocellulosic material, must not be at the expense of other essential functions for the maintenance of soil organic matter (e.g. compost, mulch).* *Soil erosion must be minimized through the design of the plantation or production site and use of sustainable practices (where possible: use of perennial crops, no till, vegetative ground cover, side-hedges of trees, etc.) in order to enhance soil physical health on a watershed scale. WHO class Ia and Ib pesticides are prohibited. Risks to health related to the application of pesticides are covered under 4.f.*
Principle 9. Water	
9. Biofuel production shall optimize surface and groundwater resource use, including minimizing contamination or depletion of these resources, and shall not violate existing formal and customary water rights. **9.a** The ESIA outlined in 2a shall identify existing water rights, both formal and customary, as potential impacts of the project on water availability within the watershed where the project occurs. **9.b** Biofuel production shall include a water management plan appropriate to the scale and intensity of production.	*The use of water for biofuel production must not be at the expense of the daily basic water needs of local communities. Water-intensive biofuel crops and biofuel production systems must not be established in water-stressed areas. The most efficient use of water must be sought through the use of crops that fit the local conditions.* *Adequate precautions must be taken to avoid run-off and contamination of surface and ground water resources, in particular from chemicals. Waste water*

9.c Biofuel production shall not deplete surface or groundwater resources. **9.d** The quality of surface and groundwater resources shall be maintained at or enhanced to their optimal level under local conditions.	*must be adequately managed.*
Principle 10. Air	
10. Air pollution from biofuel production and processing shall be minimized along the supply chain. **10.a** Air pollution from agrochemicals, biofuel processing units, and machinery shall be minimized. **10.b** Open-air burning shall be avoided in biofuel production.	*the use of ground or aerial pesticides must comply with the FAO's codes of conduct.* *Open-air burning of leaves, straw and other agricultural residues must be minimized, with the aim of ultimately eliminating burning practices. In specific situations such as those described in the ASEAN guidelines and other appropriate policies, or if workers' health and safety is at stake, limited open-air burning practices may occur.*
Principle 11. Economic efficiency, technology, and continuous improvement	
11. Biofuels shall be produced in the most cost-effective way. The use of technology must improve production efficiency and social and environmental performance in all stages of the biofuel value chain. **11.a** Biofuel projects shall implement a business plan that reflects a commitment to economic viability. **11.b** Biofuel projects shall demonstrate a commitment to continuous improvement in energy balance, productivity per hectare, and input use. **11.c** Information on the use of technologies along the biofuel value chain must be fully available, unless limited by national law or international agreements on intellectual property.	*Biofuel projects should seek to be economically viable without distortive public support (for instance, tariffs and production subsidies).* *The focus shall be on technologies that might pose a hazard to people or the environment.*
Land rights	
12. Biofuel production shall not violate land rights. **12.a** Under the ESIA described under criterion 2a, land use rights for the land earmarked for the biofuel project shall be clearly defined and established, and not be legitimately contested by local communities with demonstrable rights, whether formal or customary. **12.b** Local people shall be fairly and equitably compensated for any agreed land acquisitions and relinquishments of rights. Free prior and	*The term 'land use' means any land use, whether it be for commercial, industrial, agricultural, customary, leisure use, right of way, or any land rights. Methods for establishing ownership and land use should include advertising, communication with local leaders, and locally-established methods of data collection. Lack of a legal deed shall not hinder the inclusion of local communities in biofuel projects.*

informed consent and negotiated agreements shall always be applied in such cases. **12.c** Appropriate mechanisms shall be developed as part of the ESIA to resolve disputes over tenure claims and use rights.	*Coercion by investors or authorities to change or adapt land use is not allowed. Compensation should be at the value of the land for the community or household, based on existing land uses and livelihood needs.*

Sustainable Production of Bioenergy

A review of global bioenergy sustainability frameworks and assessment systems

by D. O'Connell, A. Braid, J. Raison, K. Handberg, A. Cowie, L. Rodriguez and B. George

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Sustainability is a critical issue for the bioenergy industry internationally and in Australia. Many governments and market segments now consider that quantitative, robust and independently verified (or certified) sustainability credentials are vital in order for the bioenergy industry to expand globally. This is already translating to government policies in some countries. These policies will limit market access and government support to only those biofuels which meet specified sustainability criteria.

This report discusses the theory behind sustainability assessment and the design of sustainable solutions and how a bioenergy sustainability framework might be applied.

Sustainability issues that have arisen through rapid international expansion of the biofuels industry and report on the international response to these issues in terms of both institutional systems, and sustainability assessment systems are reviewed.

This report is for those who may have an interest, in the development of a bioenergy industry. This includes industry and policy makers from the agriculture, forestry, waste management, biofuel, investment, transport, energy and large fuel use sectors.

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