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Comments on draft State Sustainability Strategy

These comments are in several sections (attached):

1. Discussion of the potential for woody crops to contribute to many facets of sustainability in Western Australia,
2. A brief description of current initiatives in woody crop development,
3. Comments on a background paper that deals with the potential salinity benefits of tree planting (Bennett 2002),
4. The "hydrogen economy", and risks facing alternative fuels,
5. Some general comments on the draft Strategy.

Summary

Woody crop development could be one of the focal points of this strategy. However, the potential for development of new woody crops for Western Australia's agricultural areas, and the range of sustainability targets they could assist, is not clearly articulated. Further, one of the background papers gives an inaccurate and pessimistic view of the potential role of woody crops in salinity management.

The draft Strategy would be improved if it discussed in greater detail the opportunities for biomass fuels, clarified some of the misconceptions held about this class of fuels, and if found to be justified, argued for changes to the Commonwealth Renewable Energy Act to allow woody bioenergy crops to earn renewable energy receipts.

The draft Strategy has a number of systemic weaknesses that limit its usefulness to the community as a source of information and discussion, and limit its usefulness to government for policy development.

Yours sincerely

Graeme Olsen

Declaration of interest

Graeme Olsen is a private consultant within the partnership Olsen & Vickery, currently contracted to the Search project (an NHT project managed by CALM) as coordinator.

A brief description of the Search project is contained in Section 2.

All views expressed here are personal views.

Section 1 - Opportunity for woody crops

Benefits from woody crops

There is an outstanding opportunity for new perennial crops in Western Australia's agricultural area to make major contributions to a number of sustainability issues addressed in the draft State Sustainability Strategy. Woody crops in particular could provide large benefits in many areas of sustainability, including improved land management, biodiversity enhancement and protection, regional employment and community support, and production of new products including renewable fuels. However, the draft Strategy fails to:

- highlight this opportunity,
- present a coherent picture of the integrated benefits that new woody crops could provide, or
- recommend a development pathway.

Some issues related to woody crops were discussed in the background paper by Bell and Bennett (2002), specifically in relation to oil mallees, but there is little evidence in the draft Strategy that woody crop development is seen as a priority, or that there is an appreciation of the scale and urgency of the task, or that the potential role of State government agencies is understood.

Few new industries based on woody crops are being developed. The only one of any size is the oil mallee industry. Although this is an exciting initiative, it is just a small start. A number of much larger industries, supplying raw materials to large markets for products such as pulp and paper, panel boards and bioenergy are needed if Western Australia's agriculture is to be developed into a more sustainable industry.

Some potential misconceptions that could arise from the background paper by Bennett (2002)also require comment (see Section 3).

Some of the elements of sustainability that would be strongly supported and enhanced by the large-scale development and deployment of woody crops within agriculture are discussed below.

Improved land management

Perennial crops can ameliorate many aspects of land degradation, including erosion, waterlogging, decline of soil structure and loss of organic matter, but the most important function they could perform is to alter the water balance to reduce the impact of salinity, one of this State's most devastating and intractable environmental problems.

Although salinity is described in the draft Strategy as "the greatest environmental threat to Western Australia" (page 97), its treatment is cursory, no clear pathway for dealing with the problem is articulated, and focus is lost among many other issues of lesser importance.

It has become clear that the primary impediment to managing dryland salinity is a lack of effective, affordable and environmentally sound treatments, yet little of the public money allocated to salinity is earmarked for developing new treatments, farming enterprises and farming systems that meet these criteria. Most is devoted to problem definition, and facilitation, communication and implementation in programs such as Landcare.

As correctly identified in the draft Strategy, Landcare has largely been a failure as a mechanism to change land management on farms(page 96), despite the generous resources applied to it. The reasons were always clear and the result quite predictable– it does not have a strong focus on the survival and development of the farm business, and it does not contain a mechanism for developing new sustainable enterprises on the scale needed to deal effectively with challenges such as salinity. Instead it provides generous support through participatory processes for farm and catchment planning, and for implementation of largely ineffective non-commercial treatments. In short, it has been insufficiently businesslike to deal with a problem as intractable as salinity, and has lacked the tools to develop more sustainable agricultural systems. This need is reflected in the submission from the Department of Agriculture, which calls for targeted research and development that leads to changes in farming businesses at the system level (DoA submission, p7).

There has been much written about the effectiveness or otherwise of “trees” in the management of salinity, much of it poorly informed, or lacking an understanding of the biophysical and commercial conditions that need to be satisfied for trees to “work”. These conditions include:

- Rapid growth of healthy plants, on good sites (not severely salt affected sites).
- An appropriate crop configuration for each soil type and landscape position, to maximise productivity, and uptake of surplus water.
- Efficient, integrated production systems that enable woody crops to be grown and harvested at low cost per tonne, while minimising adverse cost or production penalties on other agricultural enterprises.

For new woody crops to be adopted by farmers, it is imperative that they pay their way, make a positive contribution to salinity control, and cause minimum disruption to other enterprises.

Improved biodiversity

Woody crops could provide direct biodiversity benefits in agricultural areas by partly replacing structural elements of the vegetation that were removed by clearing. The benefits are likely to be enhanced further if the woody crops are developed from native species, and if a number of different species prove to be suitable for commercial development. The emerging oil mallee industry is one example of the possibilities – a number of different species, each with attributes that suit particular sites or conditions, are likely to be grown within that single industry.

Although the potential *direct* biodiversity benefits of woody crops are considerable, a much greater potential benefit stems from the *indirect* effect of controlling groundwater, to help prevent the catastrophic destruction of remnant native vegetation currently occurring. Some 450 species of vascular plants are thought to be at risk from salinity spread on valley floors in the WA wheatbelt (State Salinity Council 2000). A significant slice of the State's investment in salinity control is focussed on local protection of a few small areas of high biodiversity or other conservation value, such as Lake Toolibin. But many small, dispersed remnants of native vegetation remain unprotected and are at risk of destruction if regional water balances are not stabilised. This indirect aspect of biodiversity protection is often overlooked.

The draft Strategy emphasises the importance of biodiversity protection, but misses the main target! Halting logging in old-growth forest, and establishing corridors of bush between nature reserves are quoted as examples of biodiversity conservation (page 81), yet the effect of the first on biodiversity is trivial, and the second is only minor compared to the catastrophic assault on biodiversity unfolding due to salinity in agricultural areas. The draft Strategy does biodiversity conservation no favours by getting these issues so badly out of perspective.

Enhancement of rural employment opportunities

New woody crops could stimulate the rural economy in many positive ways. The first and most obvious benefit would be employment opportunities provided by local processing of woody materials. Unlike grains and other high value products, wood and associated biomass has a low value per tonne. As a result, it must be processed locally into higher value products before it can be transported large distances. The number of jobs provided directly in harvesting, transport and processing could be large. For example, industries that may be attracted by cheap woody materials produced on WA farms include pulp and paper manufacture, and panel board manufacture (particleboard or medium density fibreboard). Industries of this size consume large tonnages of raw material per year, operate continuously, and offer a variety of employment opportunities.

Other regional benefits of local processing of woody materials include diversification of farm and regional income, and more uniform distribution of income through the year, with benefits for both farm and regional cash flows.

Supply of renewable solid and liquid fuels

Biofuels are mentioned very briefly in the sections on oil vulnerability (page 89), sustainable agriculture (page 95) and sustainable energy (page 154), but the potential importance of this industry is not adequately explored in the draft Strategy, nor in any of the background papers. The background paper by Hawkes (2002) considers biodiesel, and correctly recognises that it is likely to remain a niche fuel, due to the limited availability of cheap feedstocks such as waste cooking oil and tallow, while other potential feedstocks such as canola are likely to remain too expensive for conversion to transport fuels.

However, the potential large-scale production and use of fuel alcohols, and the contribution woody crop residues could make to electricity generation are not considered. In particular, the section on oil vulnerability paints a dire picture of impending oil shortage, yet pays little attention to biofuels, selecting natural gas followed by hydrogen (manufactured using renewable sources such as wind and solar), as the most likely development pathway for transport fuels. This development pathway is much more speculative than the draft Strategy makes clear, and may turn out not to be an incorrect forecast. To be fully rounded and less risky, the draft Strategy should adopt a wider view of possible future energy sources and technologies. Further, the proposed "Taskforce to examine issues to do with oil vulnerability, the gas transition and the Hydrogen economy" (page 91) should not be restricted to the narrow path that its name suggests.

Why should biomass be given greater consideration?

Biomass could supply a large part of Australia's energy needs and achieve several sustainability objectives – it is a greenhouse neutral, renewable energy source, that could help Australia be self-sufficient in energy. Biomass can be used as solid fuel, or it can be transformed into liquid or gaseous fuels, including hydrogen. Biomass crops can be dispersed throughout agricultural areas (to achieve land management and community sustainability objectives), but still be grown within reasonable transport distances of Australia's population centres.

Why is biomass so frequently overlooked?

The potential of bioenergy is frequently dismissed on the basis of negative issues such as:

- large area required,
- diversion of land from food production, and
- negative energy balance of liquid fuels on a life cycle basis.

However, while these issues may be relevant in Europe or North America, where they are most frequently raised, they have little relevance to Australia. To examine each of the issues listed above:

- *Large area.* Australia has a small energy requirement, due to its small population, but a large area suitable for growing woody crops for energy production. It is estimated that *all* of Australia's liquid fuels could be supplied from plantings of 12 to 39 million hectares, depending on site productivity and growing rates (Foran and Mardon 1999) This area is in approximate agreement with the scale of revegetation needed to radically transform Australian agriculture into a sustainable industry. For comparison, the area cleared for agriculture in southern Western Australia alone is about 18 million hectares (State Salinity Council 2000), while the total area of crop and managed pasture in Australia is about 93 million hectares(derived from data in Foran and Mardon 1999).
- *Diversion of land from food production.* Diversion of 20% of agricultural land to biomass crops would not require a similar reduction in grain production. Some land that is suitable for woody crops is not suitable for annual cropping (such as acid sands and some land currently devoted to grazing), and integration of woody crops into farming systems in belt layouts or phase farming arrangements may provide some synergies for annual crops and pastures. Australia produces less than 2% of the world's grain (ABARE 2001), and produces about three times the amount of grain that it consumes. Therefore, considerable areas of crop land could be diverted to other purposes without affecting Australia's food availability, and without having a significant effect on global grain production, which in the most recent decade has been frequently oversupplied. Note that both North America and Europe have large areas of land which are deliberately withdrawn from agricultural production (usually

with an associated compensation payment to the land-owner), to reduce the over-production of food.

- *Negative energy balance.* Analyses that show biofuels to have low or even negative net energy yields are usually based on production systems that bear little resemblance to those likely to be developed in southern Australia. For example, negative net energy yields have been calculated for ethanol made from corn in the USA. In this case, production is based on corn, a high input agricultural crop, with only the kernels being used for ethanol production, and all power for processing being provided by fossil fuels. The subsidy paid to corn ethanol producers in the USA makes this system commercially attractive, although it is inefficient in energy terms. Ethanol production systems in rural Australia would be quite different – they would be low input, large-scale and extensive, be based on woody crops (100% of above-ground biomass harvested), require efficient harvest and handling technology (under development for the oil mallee industry) and have short transport distances to processing facilities. The plant material used for ethanol production would most likely be residue from some higher value manufacturing industry. Ethanol plants would be designed to be self-sufficient for process energy, by combustion of waste biomass such as the lignin fraction of woody plants. Ethanol production under these conditions is expected to be energy positive (Klass 1998 pages 580 - 589; General Motors Corporation et al. 2001). Further, the final distillation step to convert azeotropic ethanol to anhydrous ethanol is only necessary if the ethanol is blended with petrol or diesel, in order to prevent phase separation between the two fuels. If ethanol is used as a transport fuel without blending it with petroleum fuels, then azeotropic ethanol is adequate, and the energy required for the final distillation step is saved.

Other misconceptions that have contributed to the poor image of biomass fuels include:

- Confusion in the public mind between biomass grown in native forests, and biomass grown on farm land.
- Lack of appreciation of the renewable nature of trees and shrubs.
- An assumption by many in the community that wood combustion is undesirable. Wood is often portrayed as a fuel of the past, and is associated with images of inefficient combustion, low heat yield, smoke, soot and ash. This image is no longer relevant. Modern combustion and gasification facilities can operate at high efficiency and meet stringent emissions requirements. Further, the conversion of biomass to liquid fuels or hydrogen involves industrial processes, not combustion.
- A common misunderstanding that combustion of farm-grown biomass (or processed biofuels) contributes to greenhouse gas levels in the atmosphere, when in fact it is greenhouse neutral. There is no need to decouple energy production from carbon emission if the carbon has been recently removed from the atmosphere by planted trees and shrubs.
- Most important from an investment viewpoint, is that purpose-grown, woody bioenergy crops have been excluded from earning renewable energy credits under the Commonwealth Renewable Energy Act, placing them at a severe disadvantage to other forms of renewable energy.

Given the contribution that bioenergy could make to many facets of sustainability, it is incumbent on this draft Strategy to include measures to improve the perception of biomass as an energy crop, and to seek amendments to the Renewable Energy Act to remove the unwarranted discrimination against this class of renewable fuels.

Energy strategy for Australia

It may be a strategic error for Western Australia to place too much faith in energy delivery systems based on solar power, wind power, fuel cells and hydrogen, when the transitional arrangements that will be required in the interim may persist for a long time. Further comment on the "hydrogen economy" is contained in a separate section below.

If the prediction made in the draft Sustainability Strategy that petroleum supply will become constrained this decade turns out to be correct, then liquid fuel prices will rise, changing the competitive position of alternative fuels, including alcohol fuels. Alcohol fuels are currently more expensive than the pre-tax price of petrol, making them uncompetitive unless subsidised (Enecon Pty Ltd 2002). However, they are likely to be cheaper (on an energy basis) than hydrogen for some time (or perhaps, for ever), and could become important transport fuels in Australia in the medium and longer term.

Alcohol fuels made from woody biomass would have a number of strengths in the Australian context:

- They could be produced relatively cheaply and reliably, free of disruption by global political events.
- Alcohols can be blended with petrol or diesel without engine modification (at low percentage mixtures). With some engine modifications they can be used in higher ratios, or as pure fuels.
- They have higher energy density and are easier to transport and handle than gases.
- Alcohols can be used directly in fuel cells (with integrated reformers), or can be used as feedstocks for hydrogen gas manufacture for direct use in fuel cells.

The option of making these fuels from locally-grown biomass is too good to pass up without thorough consideration.

The position with solid fuels for electricity generation is somewhat different. Australian coal fired power stations produce very cheap electricity, Australia has sufficient proven coal reserves for at least 200 years (at current rates of consumption), and new developments in coal technology could significantly improve its combustion efficiency and its environmental performance. Woody biomass cannot compete with coal for large-scale base load electricity production unless subsidised, but it can be economic in certain circumstances, such as:

- at points on the grid where transmission costs are high, or where additional generating capacity is needed to level loads,
- at places where large amounts of biomass are available as low-cost residue from other industries, such as pulp and paper or panel board manufacturing
- in circumstances where biomass residue meets the quirky requirements of the Renewable Energy Act, and can therefore be counted as part of the Mandated Renewable Energy Target (MRET).

Section 2 – woody crop development initiatives

Some Federal and State funded initiatives in this area are described below. Each of these research initiatives owes its genesis to support for new perennial crop development from within WA educational and State government institutions, starting over a decade ago with investment in the development of an oil mallee industry. Western Australia has been a national leader in this field, and has much to gain from the successful development of new woody crops.

Search project (WA based) and Florasearch project (national focus)

The Search and Florasearch projects' aim to systematically assess woody plant species with the potential to be developed as new large-scale perennial crops in Australian agriculture, for low and medium rainfall areas in southern Australia. The process involves a number of steps including:

- identification of suitable products with large-scale markets,
- selection of plant species with desirable attributes,
- testing these species for their suitability as feedstocks for the target products,
- selection of the most promising combinations of species and products for further evaluation and development.

Both these projects have a strong emphasis on native Australian species, for a range of commercial, practical, and environmental reasons.

The Search project is managed by the WA Department of CALM, with financial support from the Commonwealth's Natural Heritage Trust, while Florasearch is managed by the SA Department of Water, Land and Biodiversity, in collaboration with State agencies in WA, Victoria and NSW. Additional funding is provided to Florasearch by the Rural Industries Research and Development Commission and the Murray-Darling Basin Commission.

As of January 2003, both these projects have selected a range of promising native species for further testing, and have delivered material to commercial laboratories for assessment. Results are expected to be published in the first half of 2003.

Cooperative Research Centre for Plant Based Management of Salinity

This CRC, which has its headquarters in the University of Western Australia, has collaborative links with educational institutions, land management agencies and research bodies across southern Australia. In its first year of operation, it has developed a series of programs dealing with many aspects of perennial crop development – social, economic, botanical, ecological and industrial. Plants under consideration include both herbaceous perennials such as lucerne and native herbs, and woody perennials such as trees and shrubs. The CRC will build on the results from Search and the first stage of Florasearch to focus on the development of the most promising species and products. Florasearch has been integrated into the CRC as an independent program, to maximise collaboration and coordination of activities.

It is important to understand that the CRC budget is limited, that it has a variety of different program objectives, and that new industry development is a long and complex task. Therefore the pace of woody crop development it is able to sustain will be modest. Partnerships with other bodies will however add leverage to the CRC's budget.

Section 3 – Comments on Bennett (2002) background paper

This paper gives an inaccurate assessment of the potential usefulness of woody crops in agricultural systems. There are many aspects of this paper that require comment, some of which are listed below:

Comment 1 - From the specific to the general

The paper makes a number of sweeping generalisations about the role of commercial trees in agricultural systems, based on a few very specific examples, some of which are not representative of the potential role of trees in land management.

Comment 2 – Modelling results

Any short term role for trees is dismissed because of their inability to provide instant fixes to urgent problems, or to fix problems that are not caused by recharge in the catchment (for example, rising groundwater in some rural towns). The long term role of trees is dismissed on the basis of a modelling study ((George et al. 1999)cited in (Bennett 2002), now published in modified form (George et al. 2001)). This study found that partial revegetation with perennial plants of relatively flat catchments in the low to medium rainfall areas (representing over 60% of the region at risk from salinity) makes no difference to the final salinity outcome after 300 years. This is because the reduced rate of recharge still exceeds the catchment discharge rate – an inevitable result given that none of the modelled treatments were permitted to reduce recharge to less than 10% of its original value.

However, over shorter periods, trees can play an important role in salinity management at the farm and catchment level. For example, the same modelling study showed that at 100 years, medium levels of coverage with trees or other perennial plants achieved between 50 and 70 per cent reduction in recharge (over the whole catchment) and 35 to 43 per cent reduction in the length of flow path affected by salinity. When coupled with other treatments such as drainage, the task of managing salinity on a broad scale becomes more feasible.

A brief comment is required about modelling periods as long as 300 years. First, the longer term results are likely to be unreliable, since small errors in the value of one or more parameters will cause large errors over that length of time, and second, human society in 300 years time will have different technology, and perhaps different land management needs from those of today.

Comment 3 – No measurable economic benefits

The summary contains the statement: “It is concluded that the planting of trees in catchments is unlikely to produce measurable economic benefits.” It is not clear to what this statement applies – to the whole catchment, or to specific high value assets located within the catchment. Either way the conclusion is not supported by the contents of the paper, which contains no economic analysis. The only data presented that could be taken as support for this conclusion is Table 13, reproduced from a paper by (George et al. 1999). It includes a range of perennial plant options designed to provide different levels of recharge control in the catchment of Lake Toolibin. These treatments were reported to have negative net present values, becoming increasingly negative as the scale of intervention increased (but being increasingly effective in salinity control).

There are a number of reasons why this single example is not typical of the likely economic performance of trees. For example, the selection of species and layouts were not optimised for commercial returns - pines (10% of the area) are known to be uneconomic in this rainfall zone, and oil mallees do not perform at their best when grown in blocks.

There are other more sophisticated tools of economic analysis available (such as the new Imagine spreadsheet) that enable economic analysis of different spatial and temporal arrangements of tree crops in integrated agricultural systems. Farming systems incorporating oil mallees can de designed that have similar economic outcomes to annual crops and pastures alone (excluding intangible costs and benefits). A series of economic analyses using the Imagine spreadsheet to help identify potentially profitable tree crop options for wheatbelt farms will be published early in 2003 (Abadi et al. 2003 in press).

A similar outcome was reported in another background paper (Bell and Bennett 2002) where oil mallees were calculated to be profitable when grown in belts: "The NPV benefit of oil mallee hedges compared with the existing land use in the Toolibin Lake catchment would therefore be $133 per hectare."

It is possible that the conclusion that trees are "…unlikely to produce measurable economic benefits." was intended to apply only to the protection of high value assets in the catchment. However, this possibility is also poorly supported by the contents of the paper. For example, tree planting in the Collie catchment has been successful in halting and reversing the rise in salinity in Wellington Dam. More tree planting is planned to reduce the dam's salinity even further. This is a clear economic benefit. The paper also fails to mention that much of the Collie catchment is suitable for commercial tree farming – the trees need not be just a cost. Finally, it is unreasonable to criticise trees because 90% of the catchment needs to be revegetated to return river flow to a drinking quality target of 500 mg/L salt. A target of this difficulty will inevitably require intensive intervention. In this case, pumping of saline water is also a feasible option. The optimum economic solution will be a balance of pumping and trees, determined by the relative marginal cost of each per unit of improvement in water quality, and the marginal value of that improvement.

Comment 4 – Lake Toolibin

Another quote from the summary is: "…so far, Toolibin Lake has been saved by engineering works, with very little indication that tree planting will make a significant difference to salinity risk within economic time periods." It is not clear how this sentence relates to the rest of the paper, or the meaning of "economic time period". If changing land use in this catchment to include oil mallees is not a cost, but produces a net present benefit of $133 per hectare (Bell and Bennett 2002), it is hard to see the relevance of "economic time period", as the trees are revenue positive. It may be true that there is a long time lag before plantings in the catchment have an appreciable effect in the Lake. But it is also true that the net present value of pumping water from the lake bed forever is very high.

This is a situation where a balance between short term pumping and long term changes in the catchment are needed to optimise the outcome. If the net present benefit of growing oil mallees in this catchment is $133 per hectare, then any resulting benefit at the lake bed is provided free. The information quoted from George et al. (1999)

indicates that establishing tagasaste on the upper 10% of the catchment (sandplain) reduces the wet length of the flow tube to 66% of the base case, and that subsequent deployment of oil mallee belts at 50 metre spacing reduces it further to 35%. This would seem to be a "significant difference" attributable to the oil mallees.

Comment 5 – Percentage cover with trees

A quote from the Summary: "The information provided by hydrological models, which are themselves based on field measurements, indicates that, with few exceptions, to restore the salinity balance in time to prevent significant degradation of the asset, will require almost all the catchment above the asset to be planted." And another from the Conclusions: "Once catchments have been partly or wholly cleared establishing trees and shrubs to reduce salinity threats on downstream assets is going to need significant areas of the catchment, usually in the region of 80 percent or more."

These statements are not necessarily true. Water use is related to transpiring leaf area, and is not a simple function of percentage cover. Transpiration is a function of many factors including plant leaf area, leaf physiology (including stomatal control), plant growth rate, weather conditions, and the availability of water accessible to plant roots. Therefore a small area of rapidly growing (and transpiring) trees with large healthy canopies of foliage can consume the same quantity of water as a much larger area of slowly growing trees, if they have adequate access to water.

Since water availability is quite limited in the wheatbelt, options for using commercial trees are similarly limited. An important part of the water use equation is the availability of water to tree roots.

Growing large areas of low productivity trees is not an option, as they will be very unprofitable. Trees will only be profitable on wheatbelt farms if they are grown at high rates of production, which means they must be grown in belts or as phase crops.

Tree belts

In soils of low transmissivity, tree roots will be limited to water within their immediate reach. In this case, narrow belts of trees at wide spacing will have little or no effect on salinity beyond their immediate area. Also the trees will become water limited and will need to grow and survive on annual rainfall, lowering their productivity and profitability.

If however the soil is transmissive (as found in about 30% of the WA wheatbelt), or surface and shallow subsurface water can be directed into contour banks above belts of trees, then the trees' growth will be enhanced, and their contribution to salinity management will exceed their percentage cover of the land area.

Phase crops

For soils of low transmissivity unsuited to contour bank water collection, the best commercial solution is not to cover 80-90% of the area with permanent trees growing at low productivity (similar to the native vegetation). Instead, 100% of the area can be covered with rapidly growing, highly productive trees or shrubs for a short period – say 3 to 5 years – while they 'mine' the available soil water, after which they are removed (for a commercial use) and replaced by annual crops. The important factor here is not the percentage cover in area, but the percentage cover in time. The proportion of the time such phase crops will be required in any one paddock will depend on a number of factors – plant, soil and climate.

The figure of 80-90 per cent cover is predicated on achieving total control of recharge, and total resolution of salinity using trees. This is unlikely to be the most effective strategy. Rather, trees will be one component of new agricultural systems (probably including drainage), with the degree of deployment of each component depending on the relative costs and benefits of each. The least-cost system is likely to involve a combination of salinity treatments.

Comment 6 – the problem of adoption

The paper concludes that because of the low effectiveness of trees, the high percentage cover required to protect downstream assets, and the long lag before the benefits are manifested, there are two options – strict State control of land use to mandate revegetation, or total reliance on drainage.

A better solution would include a mixture of:

- intensive, near-term engineering works to give immediate protection of assets where urgently needed,
- establishment of profitable, freely adopted perennial crops, sited and arranged in ways that maximise their water use (and hence both their profitability and salinity benefit) to give long term benefits,
- long-term engineering works to deal with any surplus water not captured by the new modified farming systems in the catchment.

A mixed solution along these lines is more likely to give the best outcome at the lowest cost.

Comment 7 – conclusion

This background paper is focussed on the potential for trees to provide near-term protection for downstream assets from salinity, and finds them deficient. This is a reasonable conclusion, since any amelioration provided by tree crops at a catchment scale is likely to take place over a similar time scale to the development of the problem – decades. However, the failure of tree crops to fix near-term, urgent problems at specific locations should not be extrapolated into the medium and long term, where well-sited commercial trees could provide an important part of the lowest-cost, long-term strategy to contain and eventually reverse the spread of salinity throughout the agricultural landscape.

Section 4 – The "hydrogen economy" and risks for alternative fuels

Comments on the "hydrogen economy"

The so-called "hydrogen economy" may be a long term goal, but its realisation is unlikely to be smooth or swift. This area of development is characterised by large amounts of hope and hype that obscures rational analysis of the prospects for both fuel cells and hydrogen as a "fuel".

Despite the large research budgets allocated to fuel cells by the major US and Japanese car manufacturers, it is unlikely that fuel cell vehicles will make up a large percentage of the vehicle fleet much before 2020. It is also unlikely that car manufacturers are motivated by a desire to switch fuels. Rather, a large part of their enthusiasm for fuel cells can be ascribed to their need to meet stringent tail pipe emission standards, and the opportunity to develop a more efficient way of extracting energy from petroleum. The chemical efficiency of fuel cells is much higher than the efficiency limits imposed on internal combustion engines by the laws of thermodynamics. Therefore, the development of fuel cell vehicles will present an opportunity for existing petroleum and natural gas resources to be used more efficiently than is currently possible.

The very large problem of how to manufacture hydrogen efficiently, cheaply, and in very large volumes from renewable resources such as solar and wind power remains unresolved. When first commercialised, most fuel cells will almost certainly not use hydrogen generated from renewable sources such as wind or solar energy unless there are some remarkable improvements in technology in those areas. Even in the longer term, it is quite possible that hydrogen manufactured by solar and wind energy will fail to become competitive with other sources of fuels, even if large amounts of development funding are applied to them.

It seems most likely that the first commercial fuel cells will be powered by hydrogen gas produced from liquids or gases derived from fossil fuels. The hydrogen will be produced either at a processing facility, or in a reformer integrated into the fuel cell. Other more expensive options, such as hydrogen manufactured by electrolysis using electricity from coal-fired, gas-fired, biomass-fired, or nuclear power stations, are unlikely to be competitive until oil and gas become less plentiful and their prices rise.

A second major problem confronting hydrogen is the efficient storage and transport of this light, low energy density gas. Again, it is a fair bet that liquid fuels are going to be very hard to displace, due to their higher energy density, simpler storage, and the existence of infrastructure suited to liquid fuels. Advanced hydrogen storage techniques are under development (metal hydrides, carbon nanotubes etc), but even assuming that all technical difficulties with these new technologies can be resolved in the near to medium term, they are likely to find it hard to compete on price with liquid fuels stored in simple, cheap tanks. Liquid hydrogen is promoted as a solution by some researchers and car manufacturers (such as BMW), but the energy cost of liquefaction, and the cost and difficulty of maintaining the liquefied fuel below –253 degrees Celsius is likely to prevent its widespread use in individual vehicles, although it may have a role in bulk storage and commercial transport.

A third problem is the inefficiency of manufacturing hydrogen from electricity (General Motors Corporation et al. 2001). Hydrolysis of water to produce hydrogen is about 70% efficient, about the same energy efficiency as the direct manufacture of hydrogen from natural gas (without the need to make electricity first). Hydrogen compression uses about 10% of the gases energy, but if hydrogen is to be transported more than a short distance, then liquefaction is required to increase its energy density (energy loss 30%). Since fuel cells operate at about 70% efficiency, the maximum output of a fuel cell operating on compressed hydrogen is about 45% of the energy value of the electricity used to make it (70% x 90% x 70%). If operating on liquefied hydrogen, the efficiency falls to 35% (70% x 70% x 70%). The energy losses during transport and storage are ignored in this simplified example. On top of this, electricity production itself is not 100% efficient, but depends on the method used to make it – for example, coal-fired steam turbines are about 33% efficient, and transmission accounts for a further 8% loss (US average).

In summary, the high efficiency of hydrogen fuel cells is severely undermined by the inefficiency of hydrogen manufacture and handling. Other fuels may be better candidates for use in fuel cells, especially liquid fuels such as alcohols. These issues are discussed in detail in "Well-to-Wheel Energy Use and Greenhouse Gas Emissions of Advanced Fuel/Vehicle Systems" (General Motors Corporation et al. 2001), in which a comparative analysis is made of the energy and greenhouse gas efficiency of a number of future transport fuels and technologies.

What are the risks for alternative fuels?

The draft Sustainability Strategy assumes that transport fuels will pass through a transition from petroleum to natural gas to hydrogen. However, this clear line of succession may be disrupted by many factors, including those discussed below.

All alternative fuels have a number of risks that could prevent them from becoming mainstream fuels. In broad terms these risks are:

- research and development may fail to commercialise the fuel,
- engine and power generation technology, or changes in public policy may go in a direction that makes the fuel redundant or unusable,
- existing fossil fuels may remain dominant for far longer than expected due to further discoveries and increases in the efficiency with which they are used,
- other new fuels may have a more rapid and successful development path and steal the market, especially once the price of oil begins to rise, providing greater incentive for investment in alternatives.

These risks are generic for all new fuels, but they are discussed in a little more detail below using fuel alcohols as an example. Many of the same or similar risks apply to other alternative fuels that could be commercialised after oil and gas use declines.

Development may fail

The first risk is that manufacture of ethanol and methanol from woody material has not been proven (current commercial ethanol facilities produce ethanol from sugars or starches). Research in the USA and Europe has led to the successful construction and testing of pilot-scale wood-to-ethanol plants, but no investor has been prepared to build a full-scale plant while refined petroleum products can be produced much cheaper than ethanol. Note that corn to ethanol plants in the USA are profitable only because they are subsidised. Similarly, there are no full-scale biomass to methanol plants in existence, because at current prices it is cheaper to manufacture methanol from natural gas. However, there are no major technical hurdles preventing methanol synthesis from biomass.

Out on a limb

The second risk is that engines suited to fuel alcohols, or alcohol blends may not be available cheaply in mass produced cars of the future, because Australia is a small market, and motor vehicle technology will be determined elsewhere. Australia may have its personal transport choices determined by the domestic needs of US, European and Japanese interests.

Is oil a stayer?

The third risk is that oil prices will not rise in the short to medium term, ensuring that ethanol remains uncompetitive with petroleum in the foreseeable future, and investment in its development turns out to be premature. Petroleum is postulated in this draft Strategy to be in imminent decline (some background papers state that it is already in decline). However, there is a large and respectable body of opinion that holds a different view, proposing that petroleum products will be the dominant transport fuels for at least the next 50 years, due to improvements in efficiency of use, continued discoveries of new (mostly small) fields, continued upward revision of existing reserves, improved extraction techniques, some level of exploitation of non-conventional resources, and a partial switch to natural gas for transport fuels. As a result, oil prices may not rise for some time. For example, “Consensus forecasts collated by the Energy Information Administration in the US suggest prices between US$21 and $22 per barrel between 2010 and 2015” (Enecon Pty Ltd 2002). Similarly, the Renewable Energy Technology Roadmap (Department of Industry 2002) lists five drivers for renewable energy, but does not include rising fossil fuel prices.

Even if the claim that oil depletion is about to begin turn out to be correct, it will still take several decades for current reserves of conventional petroleum products to become scarce and expensive. Published proven oil reserves are higher than they have ever been (BP 2002). They were 55% greater in 2001 than in 1981 and stand at 40 times current annual consumption. John Browne, BP CEO expects oil and gas will remain the predominant fuels for some time: “The world has at least 40 years of oil supply and 60 years of gas, even before taking account of advances in technology which will increase the volumes we can recover” (Press release accompanying the release of the 51st edition of the BP Statistical Review of World Energy (BP 2002).

Other competitors

A fourth risk is that technology to make transport fuels from coal, the most abundant fossil fuel, will become economic and acceptable. Coal interests are unlikely to abandon their reserves without pursuing options to improve coal’s economic and environmental credentials. Proven global coal reserves stand at 216 times current annual consumption, while Australia has a ratio of reserves to annual production of 261 (BP 2002).

Section 5 - General comments

I have not had time to read all the document and supporting information, but have tried to cover the topics of agriculture, biodiversity, energy and greenhouse in some detail. The comments below relate solely to those areas, and the introductory pages.

Definition of sustainability

The acceptance of a political definition of sustainability (page 24) leads to a number of difficulties with subsequent application of the concept. It soon becomes apparent that there is little objectivity in the way the concept is applied, because it embodies two different concepts:

- the concept of continuing for a long time, and
- the concept of desirable outcome.

The difficulty with this intertwining of the two concepts is that it is not always clear which of the concepts is behind particular statements, and it is not clear whose concept of desirable outcome is being used. For topics where there may be differences of opinion on what constitutes a desirable outcome, there appears to be little or no discussion of the alternatives. This weakens the robustness of the document.

Resource use and sustainability

Box 5 "Resource use and sustainability" (page 29) is quite misleading. "Decoupling of resource use and wealth" perpetuates a myth now pervading our society that tertiary industry pursuits (including fashionable jargon such as the so-called "information age", and "knowledge economy") have become independent of primary and secondary industry, and that primary and secondary industry are no longer needed. Nothing could be further from the truth. The apparent independence of tertiary industry from primary and secondary industry is due solely to the extraordinary efficiency with which those two sectors now operate. As a result of their constant improvement in efficiency, they make up a constantly declining proportion of total economic activity and employment, and are becoming a less visible part of the total economy – but this doesn't mean they are no longer needed! It is their very efficiency that allows the rest of society to engage in tertiary pursuits.

Instead of describing this process as the "decoupling of resource use and wealth", it should more accurately be described as the "decoupling of *increasing* wealth from *increasing* resource use, due to continued increase in efficiency with which resources are used". This is demonstrated by a number of indices that show static or declining resource use per capita and per unit of GDP.

Comments on agriculture, biodiversity, and energy sections

The sections of the draft Strategy dealing with agriculture, biodiversity and energy are inadequate. They share a number of problems, to varying degrees, especially the biodiversity and energy sections:

- They are too short to offer more than a glimpse at each issue. Each of these large complex issues deserve better than the truncated treatments presented in the draft Strategy.
- Where a number of issues are discussed, they are often not placed in context, or their relative importance and applicability are not adequately explained. Major and minor issues are treated with equal gravity, and no attempt is made to set priorities.
- Many obvious strategic questions are ignored. For example, if oil and gas are as close to becoming constrained by production as the draft Strategy and background papers predict, why is there no discussion about the continued export of large volumes of natural gas to Japan and China? Are we exporting fossil fuels at a time when they are cheap, ensuring that we run out in future at a time when they will be expensive to import? Similarly, if the greatest threat to biodiversity in Western Australia is due to a combination of clearing for agriculture, and the resulting inexorable spread of salinity, how is this to be resolved? What is the appropriate strategy for dealing with a public asset such as biodiversity when the land management practices that are threatening it are controlled by private interests subject to a wide range of commercial, social and environmental pressures?

- In many areas there is a lack of analysis leading up to conclusions. Perhaps this analysis has been done elsewhere, but a summary of the logic behind each conclusion should be presented here.

Comments on greenhouse and energy sections

These sections lack breadth, failing to discuss a sufficiently wide range of options. The information presented generally follows a discernable “party line”, and does not recognise or discuss alternative viewpoints where these conflict with it. This is particularly strange when dealing with topics such as energy and greenhouse, where views different from those presented in the draft Strategy are held by a large number of diverse and credible people and organisations. These are easily accessible on the Internet and in published journals and reports. For example, a laypersons guide to the range of opinions on these issues is provided by Deloitte Research (2001). To ignore alternative views completely is a subversion of the process of developing a credible sustainability strategy.

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