



Biomass Fuels from Sustainable Land Use: A permaculture perspective

by David Holmgren
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The increasing interest, research and promotion of renewable energy, driven by the Greenhouse imperative has included a vigorous debate over the role of biomass fuels in a more sustainable future. Imminent global oil peak and consequent rises in global energy prices are likely to accelerate the action and the debate on biomass options.

Biomass energy sources include industrial use of wood and charcoal fuels, methanol production from wood and ethanol production from agricultural crops such as sugar cane as well as oil seed crops such as canola for "biodiesel".

The permaculture concept lends substantial support to the concept of plants as sources of sustainable energy. In many ways nature has already optimised the harvesting of solar energy, we just need to develop the most productive land use systems to use that abundance within nature's limits. However, many of the proposals and projects to produce biomass fuels have had less than ideal environmental consequences.

Twenty years ago, the Solar Energy Council of Victoria (predecessor to SEAV) produced a plan for 20% of Victoria's liquid fuel needs from biomass by 2000. The centre piece of the plan was a root crop Jerusalem artichoke to be grown in the northern Victorian irrigation district for ethanol production from industrial scale regional plants. In a detailed submission to the draft plan I commended the choice of Jerusalem artichoke as probably superior to Sugar beet but questioned the sustainability of the scheme, and the claimed net energy yield ratio of 10:1. The proposed irrigation districts already suffered from salinity and compaction under dairy farming. A shift to broadacre root cropping would have been disastrous. Because the mash by product of ethanol is potential animal feed, dairy production in the region could have been maintained but it would have required cows in large feedlots clustered around the ethanol plants as well as longer distance transport of manure back to the artichoke crops. This suit of adverse environmental impacts was capped by doubts about the net energy yield figures. A similar proposal in NZ (using Sugar beet) had been evaluated in 1979¹ to have an embodied energy yield ratio of 0.9:1 (in other word a marginal net loss). The Solar Energy Council never replied to my questions and 20 years of cheap oil has made sure the scheme never came to fruition.

While current proposals may not be quite as environmentally naïve, the latest crop of grand proposals include optimistic claims on both energy productivity and environmental sustainability for energy crop monocultures. Like all renewable energies, the real sustainable yields are modest.

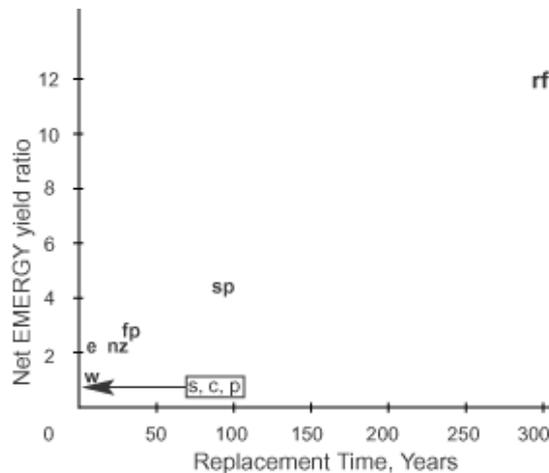
¹ By Howard Odum, American system ecology and EMerger accounting guru. Emergy is short for (embodied energy) but the methodology is significantly different from more conventional methods. The main difference is that Emergy includes evaluation of the free services of nature and the human service inputs to a product or system rather than just the energy used in the economic inputs



Reflecting the extensive work by Odum and colleagues over several decades, permaculture design principles² suggest the following rules of thumb in thinking about sustainability and productivity of biomass crops.

- Annual agricultural crops and short rotation perennials tend to give the greatest productivity per hectare per annum but have marginal or even negative returns on EMERGY due to inputs for soil preparation, fertilising and harvesting.
- The challenges of making these systems sustainable are great while the land required has the greatest potential for human food production.
- Long rotation and low input plantation and natural forestry have lower productivity per hectare per annum but can more easily be managed sustainably and can be grown on land too poor for food production. These advantages show up in high EMERGY yield ratios.

Figure 1 shows the results of several Emergy studies of biomass crops around the world.



	Biomass fuel	Replacement time (yrs)	EMERGY yield ratio
rf	Rainforest timber, Brazil	300	12.00
sp	Spruce	90	4.10
fp	Slash pine, Florida	25	2.40
e	Eucalypts, Brazil	7	2.20
nz	Radiata pine, New Zealand	24	2.10
w	Willow, Sweden	6	1.34
s	Sugar Cane Alcohol	1	1.10
c	Corn	1	1.10
p	Palm Oil	1	1.06

Figure 11: EMERGY yield ratios of biomass fuels as a function of frequency of harvest (after Odum 1996)
From *Permaculture Principles & Pathways Beyond Sustainability* by David Holmgren
Principle 3: Obtain a Yield

² See David Holmgren *Permaculture: Principles & Pathways Beyond Sustainability* 2002 Holmgren Design Services



For example, waste wood from logging operations in natural but managed Swedish conifer forests, have, for decades fuelled district heating plants. This makes energetic and environmental sense. On the other hand, more recent, short rotation willow biomass plantations on prime agricultural land feeding the same furnaces should be thought of as caretaker crops to help reduce Europe's food production surpluses rather than a net source of energy.

In Australia, common sense should tell us that schemes to use wheat, sugar cane and oil seeds for biomass fuels are like burning books to keep warm. The existing unsustainability of these broadacre agricultural cropping systems compound the problems.

Much of the groundwork to seriously address the environmental, economic and social problems of rural Australia with multi functional reforestation has been done over the last 20 years. Biomass production is increasing being recognised as part of the solution. For example, proposals to rehabilitate the salinity affected wheat belt in WA by growing mallee eucalypts for essential oil with wood biomass residue as a feedstock for renewable power³, more closely reflect permaculture design principles, albeit at an industrial scale. However such plantations need to include soil improving legumes, such as wattles, if they are to heal the very substantial soil degradation problems of this region.

On the other hand, schemes to harvest native forest waste in higher rainfall regions for renewable power production or methanol transport fuel have been the target of strong opposition from environmental groups⁴. The continuing failure to fundamentally reform public forest management in Australia gives good reason to believe biomass harvesting of native forests would follow the "maximum waste, minimum care" legacy of harvesting native forests for paper pulp over the last 30 years.

Without ignoring this terrible legacy, both native forests and mixed species plantations have huge potential to sustainably yield greenhouse gas neutral biomass fuels as a by product of management for high value timber and ecosystem services. Many small, but mostly undocumented examples of private management of regrowth forests exist⁵. From a permaculture perspective, these provide potential models for how we might fast track the nature based forestry practices and products which will necessary to integrate sustainable biomass production as a normal part of our rural landscapes. If our grandchildren are not to curse us for consuming the fossil fuels while growing nothing to give them a modicum of the mobility we take for granted, then the potential of forestry to lead the way in broadacre sustainable landuse must be realised.

A century after the peaking of oil and Greenhouse, the tree rather than the PV panel may be the dominant symbol of the Solar Age.

³ See various press releases by the Oil Mallee Ass of WA <http://www.oilmallee.com.au/>

⁴ For example see campaign by Nature Conservation Council of New South Wales <http://www.nccnsw.org.au/forests/projects/Newsletters/biomassn1.html>

⁵ For example Fryers Forest eco-village in central Victoria <http://www.holmgren.com.au/fryerstimber.html>



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