Submission in opposition to the proposed re-opening of the Redbank Power Station (SSD-56284960)

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This is a submission in opposition to the proposed re-opening of the Redbank Power Station (SSD-56284960). In this submission I firstly review some discourse on forest bioenergy and why in general its proposal is often dubious. I then consider sustainable forest management which is often relied on as a foundation for using forest bioenergy. Then I consider one example of proposed environmental benefit from using bioenergy. Two appraisals which I examine in a little detail have a common co-author, namely Professor A. Cowie. I need to state that years ago I worked with Professor Cowie and I have a high regard for her personally and for her work, so these appraisals here are in no way intended as a slight on A. Cowie or on her work, as indeed goes for authors of other papers mentioned here too, instead I just offer an alternative technical appraisal for consideration.

Bioenergy and sustainability

Bioenergy is one of the few topics in the forestry realm where there could be said to be a true debate, because there is an ample amount of scientific literature representing the for and against arguments, and the topic is discussed between politicians (Johnson and Roman, 2008; Aguilar et al., 2020; Mai-Moulin, 2020). Nevertheless, regardless of the against arguments, the trade in forest carbon for bioenergy is already well underway in many jurisdictions.

The claim of sustainability when burning forests for energy relies on timber regrowing and reabsorbing emitted greenhouse gasses (Laurijssen et al., 2010), whereas burnt fossil fuels don't become fossil fuels again as readily. However, Ter-Mikaelian et al. (2015) explains how the claim that this generally produces climate-change-mitigation, is an oversimplification. Some obvious contraindications are:

(1) Any substitution for fossil fuels may, at least in part, instead be substituting for renewable energy such as solar, wind-power or hydroelectricity. (Which is a point often ignored, e.g. Gustavsson et al. (2021).)

(2) The effect of logging primary forest on soil carbon stock has often been discounted, though it is sometimes acknowledged that primary forests should not be used for bioenergy production (e.g. Giuntoli et al., 2022).

(3) The time required for forest regrowth is too long compared with the urgency of climate change mitigation. Instead, algae have a growth duration (hours to days) that is more relevant to climate change mitigation than is that of trees (years to decades, to centuries) (Benemann, 1997).

(4) Substitution of bioenergy for fossil fuel energy is not one-to-one, as portrayed in many timber industry simulations of forest carbon dynamics; without legislation on the actual GHG emissions

then extra energy sources (such as deploying bioenergy) increase average energy usage per capita (York, 2012; York and Bell, 2019) (which is similar to market-place forces for other products).

(5) Sustained yield from conversion of primary forest to secondary logging cycles, cannot occur. For example, for clearfell logging in Tasmania:

> 'Since the growing stock is dominated by a large quantity of overmature timber, the sustainable yield which could be cut from a "normal" succession of age classes on all sites has little relevance in determining the allowable cut for the present level of industry.' (ANM, 1979).

This is straightforward logic where clearfelling is used, but in some other situations sustained yield is still claimed but redefined: the 'primary forest premium' referring to an accepted loss for secondary forest logging, such as 50% compared with the primary forest (Putz et al., 2022). Using old-growth forests for timber, with no intention of regrowing them to the same carbon stock (e.g. harvesting after only 90 years), is similar to using coal for energy, in that both rely on past photosynthesis rather than on future photosynthesis (*cf*. Catton, 1980, p135): both are counter to the concept of sustainability. Similarly therefore, most of the burnt biomass from primary forests is not recoverable.

(6) Product substitution that provides avoided emissions is sometimes mistakenly treated as carbon removal from the atmosphere (Terlouw et al., 2021).

If the balance being considered is only that between the emissions from burning fossil fuels and those from burning forest biomass, the review by Giuntoli et al. (2020) found that the balance depends on details, such as the market response to increasing wood price. The replacement ratio may not be 1:1 for various reasons (Giuntoli et al., 2020). There are also other industrially driven factors such as increased logging due to bioenergy profits, logging intensification, average stand-age reduction, increased logging frequency, change in lumber use towards fuelwood, and change in species planted (Giuntoli et al., 2020). Regarding 'change in lumber use' for example, Giuntoli et al. (2020) noted that logging residues such as bark and stumps, may contain impurities and therefore not be of suitable quality for fuel pellets, and so pulpwood will be burnt instead. The authors of that review also found that the support for pro-bioenergy from forests relied on better use of forests and increasing forest area, but the evidence for these is weak. 'In general, our review finds that all studies that project a large role of forest bioenergy in climate change mitigation rely on too optimistic assumptions, at times even unrealistic.'

In paper mills, ventures to increase wood particle recovery, decrease toxic effluent, and increase fossil-fuel substitution, have often led to either equivalent or increased GHG emissions (e.g. Menzes et al., 2011). Notably, from a climate-change-mitigation perspective, Mathieu et al. (2012) found that it was better to burn waste paper than to place it in landfill, though that burning was used to substitute for fossil fuels, and substitution using cleaner energy was not assessed.

Stewart (1978) discussed the pros and cons of bioenergy from forests in terms of fossil fuel substitution but renewable energy such as wind or solar was not as popular in the 1970s so he may not have been aware that bioenergy might inadvertently be substituting for those too. He recommended that the bioenergy feedstock come from used rather than fresh, timber and paper. If the recommendations of Stewart (1978) had been implemented or empirically investigated, then the forest industry would have been able to mitigate climate change more successfully.

Since the short-cycle eucalyptus pulpwood output from tropical countries began to dominate the global pulpwood market, the demand for pulpwood from Australia has declined, and in its place, proponents of the forest industries and the Australian government have considered using native forest residues for bioenergy, and have even referred to it as 'green' hydrogen (Aalde et al., 2006; AECOM and ARNEA, 2014; Milani et al., 2020; Bioenergy Australia, 2022; SFM, 2022). Whereas actual 'green' hydrogen can be produced by desalination of seawater using solar or wind power (e.g. Wang et al., 2023).

The greenness of green hydrogen depends on the carbon footprint of its production, and if derived from biomass then it depends on either: (a) pyrolysis or gasification of the biomass (Balat and Kırtay, 2010; Brown et al., 2014; Nurdiawati and Urban, 2022) which may release CO_2 as a byproduct, or (b) the electricity derived from biomass burnt to hydrolyse water to make the hydrogen. Forest residues from native forests in Australia include non-sawlog biomass, such as non-target tree species in clearfell logging sites (such as rainforest species), pulpwood, sawmill offcuts, sawdust and pulp-mill residues.

The Australian government recently announced that burning native forest residues for bioenergy will not be considered renewable energy, but such a curtailing of emissions could be reversed by an alternative government, or by direct gasification of forest residues (Australian Government, 2022). Diverse opportunities exist for energy production for humans without having to burn trees or fossil fuels, such as hydrogen production by solar-powered catalysis of water splitting, or with more efficient energy transduction: from genetically modified micro-algae (Ardo et al., 2022; Gupta et al., 2022; Rosero-Chasoy et al., 2023).

Advocates of bioenergy also appear to rely on the claim that forests are 'sustainably managed'. However, that characteristic is usually assumed rather than proven, for example:

> 'Holistic assessments show that forests managed according to sustainable forest management principles and practices (around one billion hectares globally, of which over 420 million hectares are certified; UNECE FAO, 2019) can contribute to climate change mitigation by providing bioenergy and other forest products that replace GHG-intensive materials and fossil fuels, and by storing carbon in the forest and in long-lived forest products.' (Cowie et al., 2021)

In that review of approaches to bioenergy assessment, entitled 'Applying a science-based systems perspective…', Cowie et al. (2021) set out to clarify the 'significant role that bioenergy can play in displacing fossil fuels'. They cited a review by Achat et al. (2015). That review found that forest soil carbon declines when removing harvest residues for bioenergy. However, Cowie et al. (2021) did not refer to that mention of reduced soil carbon, but mentioned the potential drop in forest productivity with excessive residue removal.

Examination of UNECE (2019), which was cited in Cowie et al. (2021) for the >420 million hectares 'certified' as sustainably managed, showed that the certification of 424 Mha is by the Forest Stewardship Council (FSC) and the Programme for Endorsement of Forest Certification (PEFC). Such certification schemes recommend conservation of general soil attributes (e.g. by avoiding erosion and compaction) but do not require maintenance of soil carbon stocks (Forest Stewardship Council, 2021). Soil carbon stocks do drop notably after several logging cycles (e.g. Dean et al., 2017).Therefore in the review by Cowie et al. (2021) there was no evidence of sustainability of soil carbon stocks, although they claimed general sustainability over very large areas, and therefore in their logic, they also claimed that climate change mitigation via bioenergy was practicable from those areas.

The reliance on certification schemes is echoed in Aguilar et al. (2020) where the Sustainable Biomass Program is mentioned as a certification system relying in turn on systems such as FSC and PEFC. They studied sustainability but over only 12 years. Prudently, they emphasised this empirical limitation of only a 12-year condition analysis (i.e. too short a duration for representative and measurable ΔSOC).

It was difficult to trace the one billion sustainably managed hectares mentioned in Cowie et al. (2021)'s, in UNECE (2019) but there was a 1.7 billion hectares. This was forests in the 'UNECE region' that is part of the UN's Sustainable Development Goal for 2030, which is designed to be part of the intended 'circular economy' and part of the UN's aims to address climate change and to 'regenerate and sustainably manage natural resources'. This area increased from 1.7 billion hectares in 2020 to 2.1 billion hectares in 2020 (i.e. 43 and 54% of the world's forests respectively) (Siry et al., 2005; FAO and UNEP, 2020). However, Siry et al. (2005), in reference to the original 1.7 billion hectares, refer to the management intensity and protection as 'moot' (i.e. questionable) because there wasn't enough data to suggest good management. The mere existence of forestry plans does not mean sustainability, and indeed the area of actual sustainable management globally (a subset of the area with management plans) could not be assessed in 2010 as there was insufficient data on definitions, criteria and assessment methods (FAO, 2010). The management of the 2.1 billion hectares simply refers to land under nationally- or community-approved forest management plans that last for at least 5 years (FAO, 2001). It's likely that the sustainability part of those plans depends on the blank slate (benchmark of 0 Mg ha^{-1}) concept for SOC, in which the legacy soil carbon from the primary forest is not acknowledged (Dean, 2017, and section 5.1 in the draft preprint), or that they don't consider SOC. But the initial starting conditions must be considered when assessing the carbon balance of forest management (Krankina and Harmon, 1994). Thus the large area of sustainably managed forest, in Cowie et al. (2021), does not exist. That removes one of the bases for their logic in claiming that sustainable forest use exists, from which bioenergy can be extracted.

The emphasis on sustainable management is echoed in UNECE (2019):

> 'The EU's revised Renewable Energy Directive (RED II, 2018/2001/EU) entered into force in December 2018 (European Commission, 2019). …Specific to forest biomass, RED II notes that biofuels, bioliquids and biomass fuels produced from forest biomass should minimize the risk of unsustainable practices. …To ensure the sustainable harvesting of biomass, RED II requires the regeneration of harvested areas, special attention for areas designated for protective purposes, the conservation of biodiversity, and the tracking of carbon stocks. Thus, primary-sourced forest biomass should be harvested following sustainable forest management principles implemented through national laws or best management practices at the level of sourcing areas. Operators should take appropriate steps to minimize the risk of using unsustainable forest biomass for the production of bioenergy. … Wood is a cost effective and potentially renewable source of energy, which can supply a big share of global heat if the natural resource base is sustainably managed, including the environmental and social dimensions.' (UNECE, 2019)

The references to claims of actual sustainability appear to be circular in that the UNECE cite Cowie et al. (2021) and vice-versa:

> 'The sustainability of wood-pellet production in the United States southeast destined for the EU and the United Kingdom continues to be debated in public media and other forums (e.g. Popkin, 2021; Hodgson, 2021). Science-based reports assessing the integrity of carbon pools from forests used to procure fibre for pelletization suggest that carbon stocks are not being negatively affected, and new demand could contribute to the growth and regrowth of wood fibres (Aguilar et al., 2020; Cowie et al., 2021).' (UNECE, 2021)

Thus the concept of sustainability in Cowie et al. (2021) appears similar to that in Raison (2024): incorporeal, but a vital ingredient to the foundation of proposed policy for forest industrial usage.

The UNECE reflects on different regional criteria regarding sustainability of forest management and lists different criteria for inspiration (Linser and O'Hara, 2019). Among them are the Montréal Process and the Forest Europe criteria. The 2015 version of the Montréal Process indicators separate soil conservation ('resource protection') into Criterion 4, and carbon conservation (MPWG, 2015) into Criterion 5, both of which are qualitative. Criterion 5 merely reiterates the forest industry initiatives, though more mildly by using the word 'may', that wood products may be more sustainable than 'manufacturing products that have significant carbon footprints' and that forest biomass may 'offset the need to burn fossil fuels' (MPWG, 2015). The demand is that the contribution to global carbon cycles is retained (MPWG, 2014). It does however, state that the criteria will be periodically reviewed to reflect advances in knowledge.

The Montréal Process Technical notes provide more detail. For soil in Criterion 4 each country's report is merely obliged to summarise how they met best management practices and their efforts to monitor compliance (MPWG, 2014). For carbon in Criterion 5 forest managers are referred to the IPCC and UNFCCC for guidance on assessment (MPWG, 2014). For both criteria countries are told that 'Useful data may be obtained from government, university, industry, and research organisation sources.'. This again seems circular for assessing industry's carbon footprint. It fundamentally relies on accepted standards of practice and in these there is no indication of a requirement to measure or model soil carbon over a timescale appropriate to its half-life or its depth distribution. Likewise, the Forest Europe criteria reflect the requirement that the contribution to the carbon cycle be maintained:

> ‘Criterion 1: Maintenance and Appropriate Enhancement of Forest Resources and their Contribution to Global Carbon Cycles… 1.4 Forest Carbon. Carbon stocks and carbon stock changes in forest biomass, forest soils and in harvested wood products. …
>
> Criterion 2: Maintenance of Forest Ecosystem Health and Vitality… 2.2 Soil condition. Chemical soil properties (pH, CEC, C/N, organic C, base saturation) on forest and other wooded land related to soil acidity and eutrophication, classified by main soil types’ (Linser and O'Hara, 2019)

The paucity of ΔSOC measurement in relation to forestry and bioenergy, and the consequent absence of a thorough check on SOC sustainability, has had a major effect on outcomes. There is hope for a check on soil carbon sustainability, if the Forest Europe criteria are enforced over long-term effects: measurement or modelling of soil carbon stocks over appropriate time scales may then be undertaken.

Carbon modelling example of a power station in NSW

One of the few models of the bioenergy carbon footprint that includes soil organic carbon and decomposition of root and aboveground biomass was in an assessment for a power station in New South Wales (NSW) in Australia (Cowie, 2021). The question was whether biomass should be sourced from native forests for bioenergy. The author submitted the report as an independent expert witness while working for the Department of Primary Industries (NSW Parliament, 2021). That submission formed a counterbalance to those from the government’s Environmental Protection Authority and the local Council. Cowie (2021) claims that the burning of forest biomass produces less greenhouse gasses compared with burning fossil fuels and will cause net carbon sequestration over 80 years. The claim is stated to rely on ‘sustainably managed forests’ and science:

‘Switching from coal to sustainably-harvested woody biomass as an energy source reduces atmospheric CO_2 over time scales relevant to climate stabilisation. … Sustainable forest management ensures that annual biomass removals do not exceed annual forest growth. The forest carbon stock is therefore stable; the same quantity of CO_2 is released as is sequestered by the forest each year, so there is no net transfer of carbon from the forest to the atmosphere.’ Cowie (2021)

The majority of the biomass (70%) is to come from ‘plantation and native forest harvest residues’ (Cowie, 2021). That native forest biomass is from two sources: wood that normally would be pulpwood from native forests, and trees from ‘land clearing and other approved activities’, 44% and 56% by weight, respectively (HRL Technology Group, 2021). The single largest component (56%), from land clearing, is usually deforestation for livestock farming. The second largest component (44%) is from native forest logging (public and private forests, 60% and 40% respectively, HRL Technology Group (2021)). Cowie (2021) modelled the carbon accounts for one logging cycle of tall open native forest from 2020 to 2100 using the computer software, FullCAM (Richards, 2001; Paul and Roxburgh, 2017).

In the modelling by Cowie (2021) her Fig. 2, shows the soil carbon drop by a net 20% during the 100 year logging cycle (from 45 Mg ha^{-1} to 36 Mg ha^{-1}), and it does not recover, regardless of whether or not biomass is extracted for bioenergy. Therefore, although not shown in her report, after two rotations it would be lowered further, and so on. Considering the timescales taken to recover SOC (Figure 4-4), the proposed logging and burning, according to the modelling of Cowie (2021), will create a long-term carbon debt. However Cowie (2021) overtly states that the only requirement for sustainability is that biomass is replenished. Thus, the SOC loss appears to be ignored.

The biomass stock, as modelled in Cowie (2021), recovers after about 75 to 80 years, but that is greater than the usual logging-cycle-length for that region of 50 to 60 years (Ximenes et al., 2017). In the normal scenario of integrated harvesting ‘the crown, stump, bark, leaves, small branches etc. are left in forest for biodiversity and forest health’ (HRL Technology Group, 2021). This would not occur under bioenergy extraction and therefore, ‘forest health’ may suffer too, which would be a second reduction in sustainability.

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