Submission to the Draft Bioenergy Vision for Tasmania

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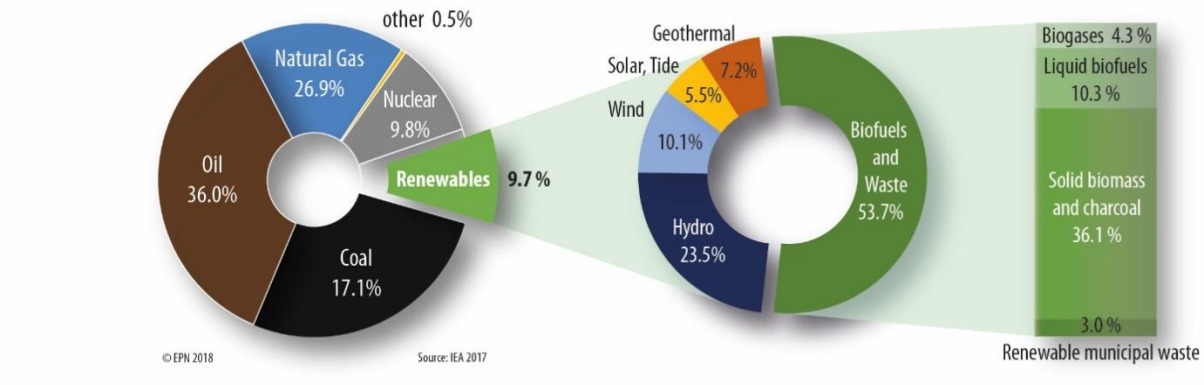
The Draft Bioenergy Vision Statement is claimed to have been informed by inclusion of an extensive range of stakeholders, but examination of the list of 'stakeholders' shows that the vision has been developed without consultation with civil society, in particular failing to include any environmental and conservation groups. This is an important and serious deficiency. The focus has been on consulting with a range of industry interests, and government. Renewables, Climate and Future Industries Tasmania (the author) views bioenergy advocacy groups such as Bioenergy Australia as experts, rather than recognising them as lobbyists advocating on behalf of expansion of bioenergy.

The result of this deficient and skewed consultation is a product that is missing many vital considerations and ignores important science and the increasing international controversy around some types of bioenergy – in particular the large scale production and subsidisation of wood-based bioenergy whose eligibility for renewable energy incentives is under question.

In describing bioenergy the claim is made that *"As biomass can be grown sustainably, bioenergy is globally recognised as a renewable energy. It can displace fossil fuels in almost every market and reduce greenhouse gas emissions."* (page 5) This claim is not interrogated nor explained. There is no nuancing around the various potential sources of biomass or their actual sustainability. The blanket statement that there will be greenhouse gas reductions ignores the need for differentiation of feedstock and the time frames for recovery of carbon from atmosphere that will be released by bioenergy combustion. Carbon accounting methodologies and their efficacy for truly representing the impacts of bioenergy on climate are not teased out. These deficiencies make the claim an unhelpful and inaccurate motherhood statement.

Nowhere is a picture painted of the relative size that each potential bioenergy type could be expected to attain. We simply see a wish list of various types of feedstock and end product (solid, gaseous or liquid fuel), yet international examples show that in the end it is solid biomass that dominates bioenergy production, and that woody biomass dominates that. Is this vision deliberately hiding this from Tasmanians, or is it actually ignorant of the details of development trends it claims to have researched? See below the breakdown of fuel shares in primary energy supply for the OECD, and note the large proportion of solid biomass contained within the biofuels and waste category. Familiarity with the industry enables a further understanding that the vast majority of solid biomass is wood. The pattern of development is that use of solid biomass matures from mixed feedstocks, including annual crop wastes, to solid wood for which quality control is more achievable.

Fuel shares in 2015 OECD total primary energy supply



The failure to tease out these important details downplays the extent to which a push for bioenergy development may actually centre on exploitation of forest biomass. That there is an assertion that *"the harvesting of native forests specifically for renewable energy production is not required or anticipated to be part of the Tasmanian Renewable Energy Target",* this does not alleviate concerns about the large scale use of forest biomass. Just as the native forest woodchip industry has been reliant on large volumes of lower grade logs, often described as 'waste' from logging operations that claim their purpose as production of higher quality sawlog, so we can expect that 'waste' or 'residues' destined for bioenergy feedstock will also fill this niche. This is how the industry has developed internationally, often followed by a gradual shortening of rotation lengths in the forest harvest cycle that reflects efforts to supply the high ongoing demand for forest biomass.

The vision document says (page 9) that without significant subsidies it is unlikely that bioenergy facilities could compete with higher value uses, but is this a guarantee that such subsidies will not be provided? Apparently not. Page 16 outlines that support could flow for those wishing to emulate case studies highlighted by government. On this subject of subsidies and other incentives it is important to note that they underpin forest derived bioenergy in most international examples, and that the viability of biomass burning at scale is dependent on their continuation[i].

Another concerning omission from the vision document is recognition that the Tasmanian government has invested in the removal of domestic wood heaters due to the serious health issues associated with particulate emissions, especially in places such as Launceston with its atmospheric inversion layer trapping the pollutants. The policy has also been applied to public housing. Surely the polluting nature of wood burning and the unacceptable health impacts on heart and lung disease routinely highlighted by the AMA deserve consideration? This ought to be a limiting factor on development of wood-fired power. Is the government suffering amnesia?

The circular economy gets a good run in the vision document, but much more important is to focus on cascading use of resources. Thereby a product would never end up as bioenergy (when it will inevitably end its life and go to atmosphere) if it can go to another use instead. This is important for wood products where there is a hierarchy of use from higher to lower value product, but also municipal waste. High temperature incineration forecloses reuse and recycling of wastes and demands ongoing feedstock, thereby working against waste reduction and efficient use of resources. The claim that in a circular economy a tree, or forest, may grow again apparently excuses failure to actually implement principles of cascading use.

Another possibility for application of large scale electricity production from forest biomass has gone unremarked. Whilst hydrogen production from 'green' sources is being pressed as a new industry, the fuel source for such energy is key to whether there is climate benefit. Use of woody biomass for hydrogen production has been flagged in Victoria to the horror of environmental groups , and it should be ruled out for Tasmania.

There is a paucity of references, and none that discuss the serious questions around the impacts of forest derived bioenergy. The author should at least read, absorb, and cite the European Academy of Sciences and Chatham House on the subject.

The next part of this submission focuses on issues specific to forest derived bioenergy.

Forest derived bioenergy is:

- more emissive than coal at the point of combustion
- not carbon neutral, (within time frames identified by the IPCC to reduce atmospheric carbon, if ever)
- not clean
- harmful to people and biodiversity.

Investment in forest derived bioenergy would directly undermine genuine low emissions, clean energy sources like wind and solar if it competes for limited government incentives.

Further, the best way to deploy native forests to tackle climate change is to protect and restore them so as to halt substantial, immediate emissions and increase removals of CO2 from the atmosphere. Existing plantations would be deployed for wood supply for industry.

We remind the authors of the draft vision of the following statement in which the Australian Government in 2013 explained their policy on native forest bioenergy in their published response to the Climate Change Authority's Renewable Energy Target (RET) Review:

"Wood waste from native forests was removed from the RET as an eligible renewable energy source in 2011. ***This amendment was made to ensure that the RET did not provide an incentive for the burning of native forest wood waste for bio-energy, which could lead to unintended outcomes for biodiversity and the destruction of intact carbon stores."*** (our emphasis)

These specific concerns have not been refuted despite a subsequent policy revision reversing that exclusion.

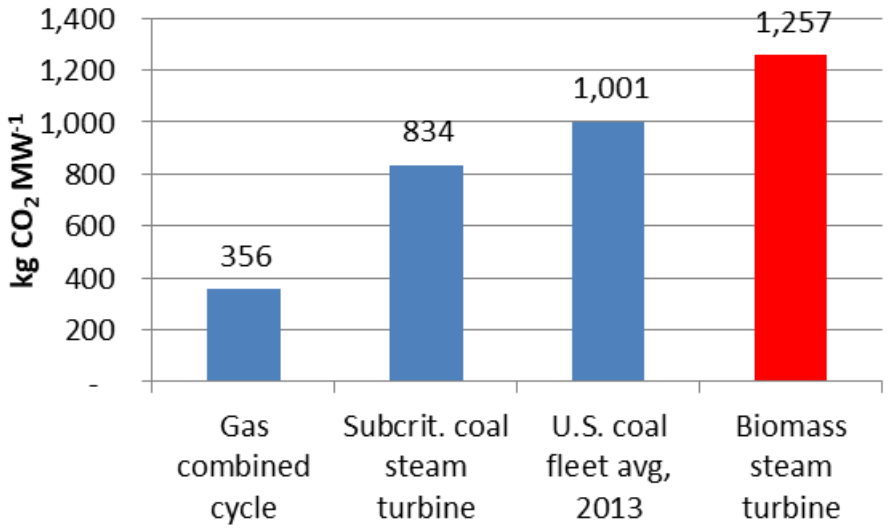
For these reasons we call for the Draft Bioenergy Vision for Tasmania to contribute to responsible action on the climate crisis by ruling out use of forest derived bioenergy (FDB) or biomass at scale as a credible or desirable energy source or route out of fossil fuel dependence.

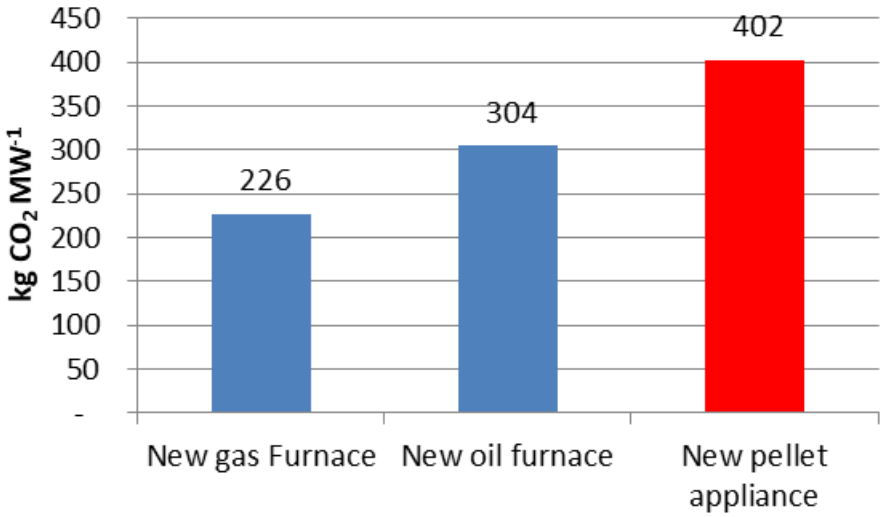
The Draft Bioenergy Vision for Tasmania should concentrate on genuine low emission and non harmful technologies.[ii]

1. Forest biomass is not zero emissions

Burning biomass emits CO_2 to the atmosphere, just as burning fossil fuels does. In fact, generating a unit of energy from wood emits between 3% and 50% more CO_2 than generating it from coal[iii]. The variation in emissions per unit energy relates to the type of woody biomass feedstock, and in particular whether it is wet (such as green woodchips) or dry (such as wood pellets).

Electricity Power Plants





Boilers for Heating

The two charts above are derived from data from various sources for units burning **green woodchips** for fuel, assembled by Mary S Booth, Partnership for Policy Integrity www.pfpi.net

Chart below: Data above from Drax biomass power station in the UK

This is stack emissions, only – does not include "lifecycle" fossil fuel emissions from harvesting, processing, and transporting pellets. The reason there is a smaller difference in CO2 emissions between pellets and coal than there is between green chips and coal is that pellets are dryer and have less ash, and so burn more efficiently. But to make and dry pellets requires large expenditures of fossil fuels and biomass that are combusted "upstream."

TABLE 1
FOSSIL FUEL, OPERATIONS AND PURCHASED ELECTRICITY EMISSIONS

Activity	Unit of measure	2016 kt	2015 kt	2014 kt	2013 kt	2012 kt
Scope 1						
Fossil fuel combustion	KT	6,021	13,101	16,476	20,162	22,513
Operations	KT	<100	<100	119	157	180
Total Scope 1	KT	6,021	13,101	16,595	20,319	22,693
Scope 2						
Purchased electricity	KT	151	216	249	293	341
Total Scope 1 and 2	KT	6,172	13,317	16,844	20,612	23,034

TABLE 2
BIOLOGICALLY SEQUESTERED CARBON (BIOMASS COMBUSTION) EMISSIONS

Activity	Unit of measure	2016 kt	2015 kt	2014 kt	2013 kt	2012 kt
Biologically-sequestered carbon (biomass combustion)	KT	11,455	10,238	7,150	2,799	1,214

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Coal: 6,021 kt CO_2 ÷ 6.9 TWh = **873** kt CO_2/TWh

Biomass: 11,455 kt CO_2 ÷ 12.7 TWh = **902** kt CO_2/TWh

(equivalent to kg/MWh)

Under carbon accounting conventions adopted internationally, emissions from biomass combustion for energy generation are not attributed in the energy sector, unlike fossil fuel emissions. Instead the bioenergy emissions are supposed to be accounted in the land use sector.

This means that in energy sector accounts a zero appears next to biofuels whereas figures are given for fossil fuel emissions. An erroneous impression is created. It is important to understand that counting biomass CO_2 as zero in energy sector is not the same as saying it is *actually* zero.

The IPCC warns:

"The IPCC approach of not including bioenergy emissions in the Energy Sector total ***should not be interpreted as a conclusion about the sustainability or carbon neutrality of bioenergy****."*[iv]

2 Carbon from combustion of forest biomass is not recaptured within critical timeframes

Claims that forest regrowth nullifies these emissions of forest biomass combustion are incorrect.

Forest derived bioenergy harms our ability to avert dangerous climate change in compounding ways. As the Intergovernmental Panel on Climate Change (IPCC) has made clear, we have less than a decade to vastly reduce emissions. Carbon from the combustion of FDB cannot be recaptured within the timeframe we have left to reduce our emissions to zero and actively draw carbon down from the atmosphere.[v]

When trees are removed from forests, not only do we remove their function as a living carbon sink, we also liquidate the vast majority of these substantial standing carbon stocks to atmosphere and hamper the function of forest soils to store carbon. Any industrial logging depletes native forest carbon stores by up to 70 per cent, from both trees and soil.[vi]

Trees utilised for forest biomass may regrow however claims that forest regrowth nullifies the emissions of biomass combustion are incorrect. It will take decades, and sometimes centuries for forests to regrow and absorb all the carbon emitted (depending on the type and carbon density of the forest to be replaced).

Meanwhile the increased concentrations of CO2 from forest derived bioenergy will be add to global warming jeopardising our ability to prevent irreversible 'run away' climate change. This is regardless of where the wood comes from or whether medium and long term tree growth compensates in some nominal way.[vii]

Forest derived bioenergy will increase, not decrease emissions, undermining the aim of The Draft Bioenergy Vision for Tasmania .

It is also important to understand the latest science on the role of older trees in ongoing carbon sequestration. Replanting trees does pull carbon from the air, but not as much as letting existing forests keep growing would. The longer trees are left to mature the more carbon they capture and store.[viii]

3. The claim of carbon neutrality is based on simplistic assumptions and flawed carbon accounting. Burning forests for bioenergy is not carbon neutral.[ix]

Given climate emergency and the urgent need to preserve native forests to store and sequester carbon, it is shocking that the false claim can be made that emission reduction targets can be met through the clearing and logging of forests for the combustion of their biomass. That burning wood biomass is carbon neutral because trees regrow is based on erroneous assumptions and a complex of flawed forest carbon accounting protocols.[x]

Recapture: Current accounting procedures associated with the Kyoto Protocol estimate changes in carbon stock of the forest estate when logged, yet in many cases also assume that biomass sources are 100 per cent replaceable. Old growth forests, secondary forests and natural forests and plantations are treated as equivalent forest biomass sources, resorting to a simplified estimate of forest cover rather than the density of carbon stock within particular forests. The replacement of old growth forest by monoculture plantation is deemed to have offset the forest carbon loss even though the carbon carrying capacity of these different categories is vastly different.

It is also important to note that recapture should not be attributed to the fact that forests are already growing elsewhere in the forest estate than the location from which the forest biomass was taken. That would have occurred regardless of whether forest biomass from logging operations was used for energy generation. As the IPCC has stated:

"*If bioenergy production is to generate a net reduction in emissions, it must do so by offsetting those emissions through increased net carbon uptake of biota and soils*."[xi]

Combustion: as mentioned earlier, emissions generated by combustion of biomass for energy generation are not reported nor counted the energy sector and this means that when forest biomass is exported for consumption in energy generation, no emission from utilisation of that energy is recorded in the country that consumes it.

Nowhere is lost carbon carrying capacity from the voided lifecycle of the living matter used being accounted. This important opportunity cost to mitigation entailed in liquidating forests and burning substantial amounts of the biomass harvest is never calculated.

The implications of these accounting flaws are significant. A false zero emission signal has resulted in the wrong claim of carbon neutrality for burning FDB and led to increased biomass burning under the guise that it reduces emissions.

4. Forest derived bioenergy is not cheap or efficient

Forest derived bioenergy is expensive in comparison with genuine renewable energy sources. It incurs the costs of large scale infrastructure, air pollution control equipment and constant maintenance.[xii] Feedstock must be purchased on an ongoing basis, unlike renewables such as wind and solar for which wind and sun are free and upfront construction and commissioning costs are the major investment.

Huge and constant volumes of feedstock are required, the combustion of which generates huge volumes of emissions. Regardless of any definition of feedstock used, residue or otherwise, this inefficient form of energy form requires intensive production, distribution and consumption of forest resources.[xiii] Internationally the majority of the feedstock is not mill residue, but whole logs, and not only whole trees, but entire forests. In Australia whole logs are defined as 'residue' or 'waste', making this industry appear to simply be using leftovers. The reality is, as was experienced with whole logs taken for woodchip exports, the claim of residue or low value is used to justify the industry start up and demand for product then drives logging.

The definition of residue is based on the lesser merchantable value per unit weight or volume when compared to the few high quality sawlogs generated by the same logging operation. The 'residue' stream can often compromise the majority of the product arising from a logging operation. The income generated by high intensity harvests may make logging more financially viable as the income stream from vast quantities of low value logs adds substantially to that from the small volumes of high quality, higher priced wood taken. Where the community is struggling to retain natural forests the advent of a lucrative, incentives-based residues trade can drive further logging incursions into areas previously thought financially unviable and promote clear-felling as a more intensive logging method. Rotation lengths are then also be shortened to feed the residue trade.

Native forest and other trees are not being allowed to grow to maturity to sequester and store maximum carbon from the atmosphere. Forest derived bioenergy represents a massive opportunity cost in terms of emission reduction.

Globally forest derived bioenergy relies on government subsidies which are forthcoming because countries are (falsely) claiming emission reductions from this source.. In effect, companies are being subsidized to increase emissions. Without flawed accounting procedures and misrepresentation this would not be occurring.

5. Forest derived bioenergy has negative and unjust health impacts

Particulate pollution kills people.[xiv] There is evidence that coal fired power harms the health of populations around power stations.[xv] Burning biomass also has significant public health impacts. Data from the Drax power station in the UK shows that biomass burning has increased particulate pollution by 400% since switching four of six boilers to FDB, while power output has remained constant.[xvi]

6. In Tasmania risks to native forests are increased by adding forest derived bioenergy to the product mix

Australia is already exporting native forest biomass for forest derived bioenergy and the logging industry, supported by government is planning to increase exports[xvii] and promotes increase in domestic uptake. The argument is frequently made that forest derived bioenergy will not be a driver of increased native forest logging because it is derived from residue and waste materials.[xviii] However, with the definition of 'residue' being based on the economic

value of a harvest, rather than on whether the biomass is real waste or mill 'residue', these definitions include whole logs.

Any incentive for logging native forests in Tasmania is a risk. The native forest carbon stores need to be retained intact, not released to atmosphere. As systems, intact native forests must be retained and secondary forests must regrow to maturity to sequester and store exponentially more carbon as they age. In addition, industrial lologging of forests is identified as a factor contributing to fire severity that is likely to have exacerbated recent catastrophic summer bushfires.[xix] It is now impossible to justify logging in native forests, and in particular not for a purpose that will exacerbate global warming and put biodiversity under yet more threat.

8. Vested interests

Around the world, companies operating under the aegis that forest bioenergy is carbon neutral have profited from the subsidies it attracts because it can be wrongly characterised as a 'renewable' energy. The public purse has been depleted and the world's forests have fallen. [xx]

The industries and advocates that are driving forest derived bioenergy expansion in Australia are those who benefit from flawed forest carbon accounting protocols, policy and legislation. Logging and wood product businesses have been pushing for forest derived bioenergy through lobby and advocacy groups. These groups represent the interests of businesses that sell wood and paper products. They have financial interests in the continuation and expansion of logging in Australia. No groups with expertise in clean and renewable energy whose primary mission or vision is emissions reduction advocate for forest derived bioenergy.

9. The Biodiversity and Climate Crises

It is vital to seriously consider the global and national context in relation to the two major, interlinked environmental crises facing the world – the climate crisis and the biodiversity crisis – in any consideration of utilising and expanding the role of bioenergy, especially that derived from forests and from carbon and biodiversity rich natural ecosystems more generally.

These two crises pose serious threats to life on Earth. Major global intergovernmental assessments, including from the IPCC and the IPBES, have demonstrated that they are strongly interlinked.

- Climate change is exacerbated by biodiversity loss and ecosystem decline, which in turn increases stresses on natural systems caused by a changing climate.
- The escalating risk to biodiversity and ecosystem integrity has direct implications for the success or failure of climate action.

The Secretariat of the Convention on Biological Diversity has emphasised the important role biodiversity plays in climate mitigation. It has expressed deep concern not only about the impact of climate change on biodiversity and ecosystem function, but also *"deep concern that escalating destruction, degradation and fragmentation of ecosystems would reduce the capacity of ecosystems to store carbon and lead to increases in greenhouse gas emissions, reduce the resilience and stability of ecosystems, and make the climate change crisis ever more challenging".*

The IPCC has noted that immediate response options in land and forests include increased protection for carbon dense ecosystems. It warned that expanding bioenergy would likely come at the expanse of biodiversity and / or food production.

This calls for countries to move beyond treating these separately towards integrated approaches. Both IPCC and IPBES reports[xxi], along with an increasing body of literature, highlight and stress the importance of intact resilient ecosystems in meeting the goals of the Paris Agreement. Indeed, nature-based solutions, with appropriate safeguards, can provide 37% of the solution to meeting the 1.5 C target by 2030 (IPBES 2019).

The IPCC has made it clear that to meet a 1.5C target, but also for a 2C target, large near term emissions reductions allied with increased removals of carbon from the atmosphere will be required. This is where native forests can be most effectively deployed.

Most recently, the COP 26 Decision CP/26 from Glasgow, at Cause 38 supports the importance of protecting and restoring forests and other ecosystems as sinks and reservoirs of greenhouse gases (note that forests are some of the most carbon rich ecosystems)"

"38. *Emphasizes* the importance of protecting, conserving and restoring nature and ecosystems to achieve the Paris Agreement temperature goal, including through forests and other terrestrial and marine ecosystems acting as sinks and reservoirs of greenhouse gases and by protecting biodiversity, while ensuring social and environmental safeguards;"

It is vital to recognise the fact that large immediate emissions are generated by loss and degradation of terrestrial carbon stores, including the logging of forests and the combustion of large volumes of that biomass for energy production. The capacity for those ecosystems to continue to remove carbon from the atmosphere and sequester it in growing vegetation is also adversely impacted. Recent science has overturned the assumption made by the forest industry that older forests do not continue to sequester carbon, instead showing that it is the older, more mature forests that are able to sequester the most. The claim that young trees are better for carbon removal is a misconstruction of the fact that they may sequester a comparatively greater proportion of their volume per year - a doubling of a sapling that is a small stick is not a great achievement in sequestration!

The Counter-factual

1. **Impact on climate change**: The Draft Bioenergy Vision for Tasmania must take into account the counter-factual scenario in which native forests are deployed for immediate emissions reduction and ongoing sequestration.

   To understand the impacts this can have, examine Tasmania's ghg inventory subsequent to the collapse of the forest industry and cessation of almost all native forest logging in 2012.

Emissions from forestry (termed Forest Management) dropped by an order of magnitude, and subsequent sequestration in those forests then occurred, enabling Tasmania to then reach net zero emissions.

It is very relevant to bioenergy in particular because the majority of product taken from the native forests was pulpwood destined for export woodchip markets. This falls into the same categorisation as that of 'residues' or 'waste' supplied to the bioenergy industry - a low value, high volume product stream.

The vision completely ignores this reality despite the claim that reduction of climate change impacts is one of the aims. This is a very serious omission and a fatal flaw in the vision document. Tasmania has led the world with this very effective form of emissions reduction, no bioenergy from forests required as they are deployed more effectively by simply being allowed to grown on.

2. **Imperative to protect biodiverse native forests**: the vision must also recognise competing priorities for the use of native forests beyond the various claims to address climate change. Australia is party to the Convention on Biological Diversity and has a national commitment to protection of biodiversity. Here, the counterfactual is urgent prioritisation of protection of biodiversity. Again the vision claims the protection of the environment is an aim, but has completely missed this one.

Assumptions re emissions reduction and renewability

The Draft Bioenergy Vision for Tasmania's context assumes renewability and emissions reduction, both of which assumptions are under question especially in regard to forest derived biomass. In assuming renewability it ignores the most important factor involved in tackling climate change – that of time. We have a short period in which to make substantial reductions to global emissions, so activities that increase atmospheric carbon during that period and rely upon some alleged potential reduction via sequestration occurring many decades or even centuries later are far from a helpful contribution. Instead those large emissions immediately exacerbate the situation.

10. Social licence

The Draft Bioenergy Vision for Tasmania apparently assumes local community support, but the situation with native forest biomass is that it is highly controversial to log native forests at scale for any reason, and even more so when the use is immediately destructive to the forest concerned, exacerbates climate change within relevant timeframes, and entails erosion of biodiversity. We present evidence that bioenergy from native forests does not have a social licence.

When native forest logging is not accepted by the community and /or use of native forest derived biomass is unacceptable, the highest and best use of existing plantations becomes an imperative. In Europe this concept is of 'cascading' use prioritisation of wood harvested. Hence the material generated from plantations should be used to substitute for native forest materials and go first to high end sawn timber, other long-lived products (including engineered wood products), and not be dedicated to forest derived bioenergy.

Internationally, use of forest derived bioenergy is very controversial. A position statement on forest biomass energy has been signed by over 180 non-government organisations: https://environmentalpaper.org/the-biomass-delusion/

In Australia, the Australian Forests and Climate Alliance has 79 signatory NGOs from within Australia to their National Position Statement on Forest Biomass: http://forestsandclimate.org.au/publication/position-statement-against-forest-bioenergy/

In Europe a petition of 260,000 signatures urges the European Union to "protect forests, not burn them for energy" https://you.wemove.eu/campaigns/the-eu-must-protect-forests-not-burn-them-for-energy

Recommendations

The Bioenergy Vision for Tasmania excludes forest derived bioenergy from consideration as an energy source.

Reorient climate and biodiversity policy to protecting and regenerating our native forests.

End industrial logging of native forests in Tasmania.

Conclusion

Forest derived bioenergy harms the climate, harms forests, harms people and harms the clean energy transition. To avoid catastrophic global warming, we need to reduce emissions sharply and increase the uptake of carbon into natural ecosystems. Intact, mature and recovering native forests are our best hope for taking carbon out of the air.

It is important to replace fossil fuels with renewable energy. However, any engagement with forest derived bioenergy at scale becomes an assault on the climate. A vision that considers forest derived biomass in any form would derail, delay and undermine genuinely clean energy development. It would simultaneously be a great injustice to communities that love their bushland, workers who deserve sustainable industries and flora and fauna that we need to survive.

We must move to secure a genuinely sustainable future for subsequent generations. Energy from forest derived biomass will add to the problems we are setting our sights on overcoming. This bioenergy has no place in our vision.

[i] https://environmentalpaper.org/2019/05/warning-issued-to-investors-forest-biomass-is-risky-business/
[ii] Bremmer, J. 2016. *Burning biomass for energy: a fast track to climate change and adverse health impacts*. National Toxins Network, NSW
[iii] https://www.biofuelwatch.org.uk/2018/biomass-basics-2/
[iv] http://www.ipcc-nggip.iges.or.jp/faq/faq.html
[v] Bowd, E.J., Banks, C.S., Strong, C.L. and Lindenmayer, D.B. 2018. *Long-term impacts of wildfire and logging on forest soils.* Nature geoscience. Available: www.nature.com/naturegeoscience

[vi] Bowd, E.J., Banks, C.S., Strong, C.L. and Lindenmayer, D.B. 2018. Ibid.

[vii] Booth, M. 2018; Courvoisier et al., 2017 Schlesinger, 2018.

[viii] Stephenson, N.L. et al. *Rate of tree carbon accumulation increases continuously with tree size*. Nature 507, 90–93 (06 March 2014) doi:10.1038/nature12914

[ix] (DeCicco and Schlesinger, 2018; Searchinger et al., 2017; Smyth et al., 2014; Sterman et al., 2018) and https://www.chathamhouse.org/publication/woody-biomass-power-and-heat-impacts-global-climate, https://www.chathamhouse.org/publication/impacts-demand-woody-biomass-power-and-heat-climate-and-forests

[x] Appendix 1: International Forest Carbon Accounting Flaws Explained
[xi] IPCC AR5 WG III 11.13.4 GHG emission estimates of bioenergy production systems, 2014 (https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_full.pdf p. 877)
[xii] Budischak, C., Sewell, D., Thomspon, H., Mach, L., Veron, D. E. & Willett, K. 2012. Journal of Power Sources, in Bremmer, J. 2016, ibid.
[xiii] Kulman, W. & Putt, P. 2018. *Are forests the new coal? A global threat map of biomass energy development.* Environment Paper Network.
[xiv] Ewald, B. 2018. *The health burden of fine particle pollution from electricity generation in NSW*, University of Newcastle. Available at https://www.envirojustice.org.au/wpcontent/uploads/2018/11/Ewald_B_2018_The_health_burden_of_fine_particle_pollution_from_electricity_generation_in_NSW.pdf
[xv] Environmental Protection Authority NSW, 2016. *Clean Air for NSW consultation paper*. Available: https://www.epa.nsw.gov.au/- /media/epa/corporate-site/resources/air/clean-air-nsw-160415.pdf
[xvi] EU Biomass Legal Case, 2019. *Drax (UK): 1000 tonnes of deadly particulate pollution a year, a 400% increase since they switched from coal to biomass.* Available: http://eubiomasscase.org/2019/03/08/drax-uk-1000-tonnes-of-deadly-particulate-pollution-a-year-a-400-increase-since-they-switched-from-coal-to-biomass/
[xvii] Australian Forests & Timber News, *Australia-Japan forest products trade strengthened*, 20 December 2018

[xviii] Debating the exclusion from the national Renewable Energy Target of native forest biomass in 2012, and then its inclusion in 2015, the arguments were that the legislation and regulatory mechanisms would ensure that residue based operations only would be eligible for subsidy as 'renewable'.

[xix] Lindenmayer, D., Kooyman, R. M., Taylor, C., Ward, M. & Watson, E. M., 2020. *Recent Australian Wildfires made worse by logging and associated forest management.* 'Nature, Ecology & Evolution' Published online 5 May 2020 at https://www.nature.com/articles/s41559-020-1195-5
[xx] https://www.economist.com/business/2013/04/06/the-fuel-of-the-future

[xxi] Intergovernmental Panel on Climate Change "Climate Change and Land" (August 2019); The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem (IPBES) report (May 2019); Intergovernmental Panel on Climate Change "Special Report on Global Warming of 1.5C" (October 2018)