

Australian Forests and Climate Alliance (AFCA) Submission to ARENA Bioenergy Roadmap - 10 June 2020

Recommendations

- 1. The ARENA Bioenergy Roadmap excludes forest derived bioenergy from consideration as an energy source in Australia's future; for on- or off-shore consumption.**
- 2. Governments across Australia review and amend references to the use of native forest materials for fuel in legislation and regulation with a view to preventing this industry from taking hold and instead to protecting and regenerating our native forests.**
- 3. End industrial logging of native forests in Australia**



Exclude Forest Derived Biomass for Bioenergy

Contents

Opening Statement

Part 1: Context

The Climate and Biodiversity Crises

The Counter-factual

- 1. Impact on climate change**
- 2. Imperative to protect biodiverse native forests**

Assumptions re emissions reduction and renewability

Social licence

Part 2: Joint submission to the ARENA Bioenergy Roadmap - Nature Conservation Council NSW and the Australian Forests and Climate Alliance: "Exclude Forest Derived Biomass for Bioenergy"

Introduction

- 1. Forest biomass is not zero emissions**
- 2. Carbon from combustion of forest biomass is not recaptured within critical timeframes**
- 3. The claim of carbon neutrality is based on simplistic assumptions and flawed carbon accounting. Burning forests for bioenergy is not carbon neutral**
- 4. FDB is not cheap or efficient**
- 5. FDB has negative and unjust health impacts**
- 6. International experience tells a dark story – Deforestation and Forest Degradation for FDB**
- 7. In Australia risks to native forests are increased by adding FDB to the product mix**
- 8. Vested interests**
- 9. Recommendations**
- 10. Conclusion**

Part 3: Additional Information

Appendix 1: **Flawed Carbon Accounting and the Concept of Carbon Neutrality**

Appendix 2: **Jurisdictions Reappraising or Rejecting FDB as low Emissions**

Appendix 3: **International & Australian Scientists Media**

Appendix 4: **Health Impacts of Forest Derived Bioenergy**

Appendix 5: **National Position Statement Against Forest Bioenergy and other evidence refuting broad acceptance of FDB**

OPENING STATEMENT

The Australian Forests and Climate Alliance (AFCA) responds herein to ARENA's call for submissions to the development of a Bioenergy Roadmap for Australia. The Australian Forests and Climate Alliance is comprised of 20 member non-government organisations.

Central to this response is a combined submission of AFCA and the Nature Conservation Council of NSW (NCC). We specifically address the role of forest derived bioenergy, which we believe should be excluded from the Bioenergy Roadmap.

AFCA adds in this extensive document more information and views to further contextualise and explore issues around the use of forest biomass for energy, additional to that contained in the combined AFCA and NCC submission. An extensive list of references is supplied. This expansion of our contribution is flagged in the combined submission.

PART 1: CONTEXT

ARENA has made observations on the **context in which the Bioenergy Roadmap** is being developed that are narrow and overly optimistic given extensive global critiques and growing opposition to various forms of bioenergy that affect forests, availability of agricultural land for food production, and have serious impacts on communities.

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 expense of biodiversity and / or food production.

This calls for countries to move beyond treating these separately towards integrated approaches. Both IPCC and IPBES reports¹, 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.

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: ARENA 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. The example is stark as emissions from fossil fuel sources are fairly low because Tasmania is almost entirely reliant on renewable energy for power generation (hydro and wind), and forestry emissions contributed prominently to the state's emissions profile.

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.

2. Imperative to protect biodiverse native forests: ARENA 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.

Expert evidence currently before the Royal Commission inquiring into last summers' bushfires is of dramatic impacts on already threatened and vulnerable wildlife populations that may entail the total loss of some species and at least a large increase in levels of threat to survival, and also of heightened levels of threat and insecurity for hundreds of species previously regarded as secure.

In Victoria the court has just ruled that provisions for protection of native species were not applied and that logging must cease in a significant number of logging compartments. Victoria also has announced a cessation of native forest logging in 2030 so as to restrain impacts on the natural environment. It is unsafe and unwise to conclude an ongoing supply of native forest biomass in these circumstances. It is also important to consider the role of retaining intact natural forests outside of industrial scale wood production for promoting resilience in the face of climate change, and hence to climate mitigation and adaptation.

Assumptions re emissions reduction and renewability

ARENA'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.

Social licence

ARENA outlines alleged potential benefits of bioenergy and asks what conditions must be met for achieving 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 140 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 our National Position Statement on Forest Biomass: <http://forestsandclimate.org.au/publication/position-statement-against-forest-bioenergy/>

Please also note that this submissions is supported by 88 signatories.

Part 2: Joint submission to the ARENA Bioenergy Roadmap

Nature Conservation Council of NSW and the Australian Forests and Climate Alliance: "Exclude Forest Derived Biomass for Bioenergy"

Introduction

The ARENA Bioenergy Roadmap will identify the role of the bioenergy sector in Australia's transition to a low emission, renewable energy economy for ongoing emission reduction and to meet commitments under the Paris Agreement. ²

We, the undersigned, want the expansion of genuinely renewable energy that is low in emissions, clean, and does not harm people or biodiversity. Yet Forest Derived Bioenergy (FDB) 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 FDB 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 ARENA 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."

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

For these reasons we call on ARENA 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.

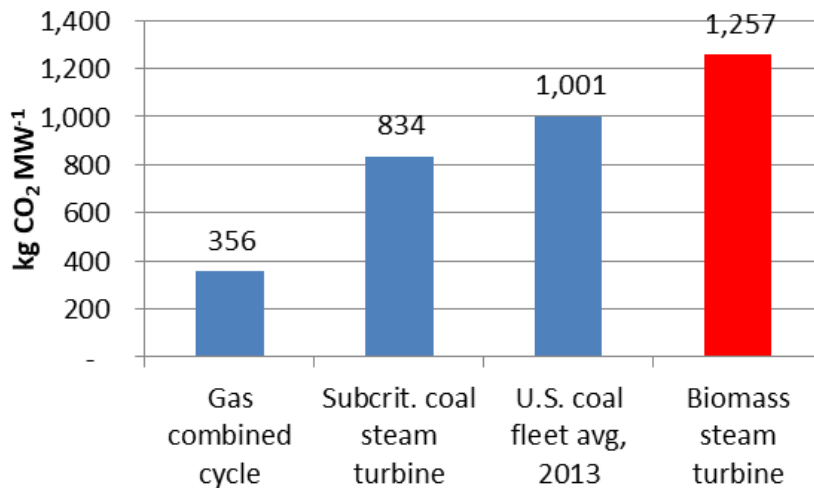
ARENA should concentrate on genuine low emission and non harmful technologies.³

This joint submission summarises the key reasons to rule out FDB. We refer ARENA to the more detailed submission by the Australian Forests and Climate Alliance and thank them for the contribution of their research to this document.

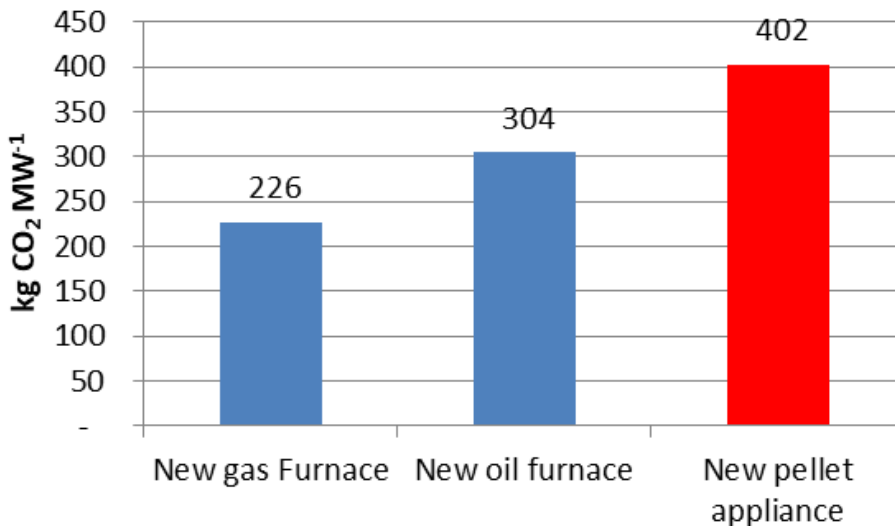
1. Forest biomass is not zero emissions

Burning biomass emits CO₂ to the atmosphere, just as burning fossil fuels does. In fact, generating a unit of energy from wood emits between 3% and 50% more CO₂ than generating it from coal⁴. 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

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.”

Drax is struggling for a way to talk about CO2 emissions from burning biomass that makes it sound better. Here they are trying “biologically sequestered carbon” on for size... Coal is also “biologically sequestered carbon”! In fact what matters is whether and how the CO2 emissions are offset over time.

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 CO₂ 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.**”¹⁵*

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.

FDB 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.⁶

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.⁷

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 FDB 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.⁸

FDB will increase, not decrease emissions, undermining the aim of the ARENA roadmap.

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.⁹

3. The claim of carbon neutrality is based on simplistic assumptions and flawed carbon accounting. Burning forests for bioenergy is not carbon neutral.¹⁰

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.¹¹

See Appendix 1. Flawed Carbon Accounting and the Concept of Carbon Neutrality

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."¹²

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. FDB is not cheap or efficient

FDB energy is expensive in comparison with genuine renewable energy sources. It incurs the costs of large scale infrastructure, air pollution control equipment and constant maintenance.¹³ 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.¹⁴ 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. FDB represents a massive opportunity cost in terms of emission reduction.

To supply only 3 per cent more energy from FDB globally, the world would have to double its commercial wood harvests.¹⁵ Land habitat for biodiversity would be severely impacted, at a time when all forests require expansion and protection.

Globally FDB 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.

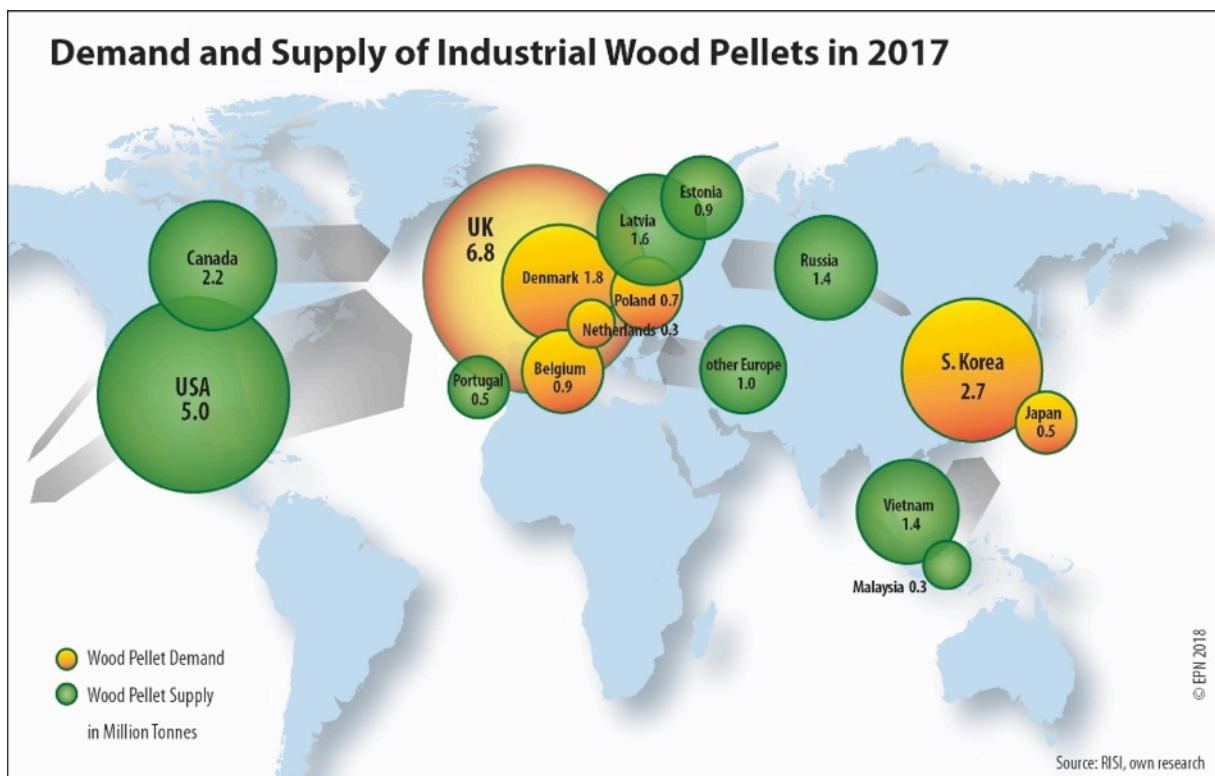
5. FDB has negative and unjust health impacts

Particulate pollution kills people.¹⁶ There is evidence that coal fired power harms the health of populations around power stations.¹⁷ 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.¹⁸

6. International experience tells a dark story – Deforestation and Forest Degradation for FDB

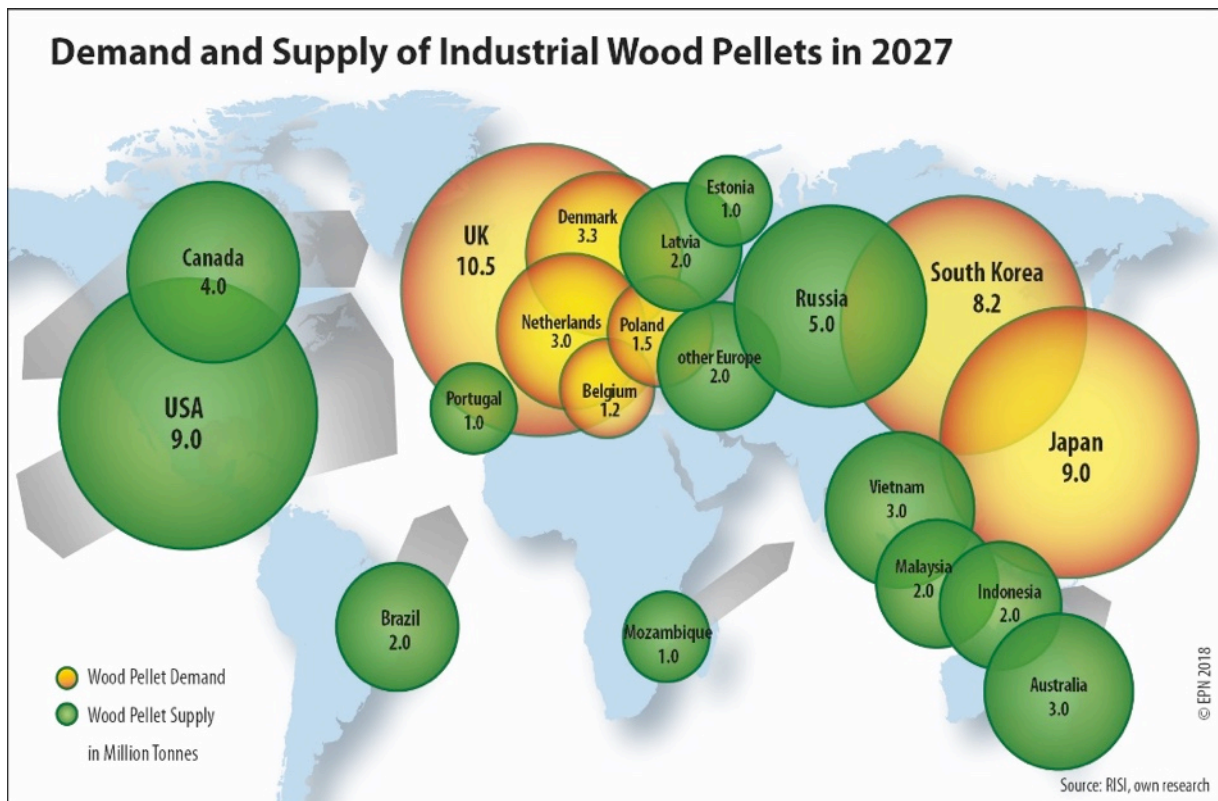
Europe's renewable energy policy is substantially built on burning trees. Biomass has expanded rapidly this century to provide approximately half Europe's 'renewable' energy. Most of the fuel is being harvested from North American forests.¹⁹

Despite the damaging combustion emissions, the policy error that allows FDB to be accounted for as 'renewable' is hollowing out and degrading valuable forests in British Columbia, Estonia, Romania, Russia, Europe and North America all while increasing CO2 emissions.^{20, 21, 22, 23, 24, 25} Europe is burning 21.7 million tonnes of wood pellets annually.²⁶



Without intervention, tree burning for fuel is predicted to escalate from 14 to 36 million tonnes per annum of traded wood pellets alone.^{27,28}

Australia runs the risk of sacrificing its forests to the international wood pellet trade. See predicated escalation by 2027 and note in our detailed section how the current Federal government is pushing to export Australian native forests to supply this demand.



Swift and wise policy reversals in multiple jurisdictions, including Australia, can stop our global forest carbon stores being felled to supply the unnecessary wood pellet trade.

Compelling and authoritative scientific opinion is now leading the call to review laws and regulations that incentivise FDB.²⁹ This has occurred in two jurisdictions recently, in Slovakia and in the US state of North Carolina.

7. In Australia risks to native forests are increased by adding FDB to the product mix

Australia is already exporting native forest biomass for FDB and the logging industry, supported by government is planning to increase exports³⁰ and promotes increase in domestic uptake. The argument is frequently made that FDB will not be a driver of increased native forest logging in Australia because it is derived from residue and waste materials.³¹ However, with the definition of 'residue' in Commonwealth and some state legislation being based on the economic value of a harvest, rather than on whether the biomass is real waste or mill 'residue', these definitions can include whole logs. NSW has specifically defined immature native forest trees (pulp logs) as 'residue' available for subsidy when combusted or otherwise processed as a renewable energy feedstock or fuel.

Any incentive for logging native forests in Australia 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 logging of forests is identified as a factor contributing to fire severity that is likely to have exacerbated Australia's recent catastrophic summer bushfires.³² 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.³³

The wood pellet trade is at the heart of the biomass trade and is central to the industry's global expansion plans.³⁴ It is important to note that woodchip is also extensively used and traded, as are whole logs destined for biomass burning, although it is difficult to differentiate the proposed end use when examining trade data. The industries and advocates that are driving FDB 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 FDB through lobby and advocacy groups including the Australian Forest Products Association, Forest and Wood Products Australia and the Commonwealth Government's Forest Industry Advisory Council.³⁵ 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 FDB. Evidenced by the signatories to this submission, they see it as potentially catastrophic.

Recommendations

- 1. The ARENA Bioenergy Roadmap excludes forest derived bioenergy from consideration as an energy source in Australia's future; for on- or off-shore consumption.**
- 2. Governments across Australia review and amend references to the use of native forest materials for fuel in legislation and regulation with a view to preventing this industry from taking hold and instead to protecting and regenerating our native forests.**
- 3. End industrial logging of native forests in Australia**

Conclusion

FDB 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 incredibly exciting that Australia is moving to replace fossil fuels with renewable energy. However, any engagement with FDB would be a gross misdirection of government subsidies and an assault on the climate. A roadmap 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 roadmap to a solution.

Please also see: <http://forestsandclimate.org.au/cms/wp-content/uploads/position-statement-against-forest-bioenergy.pdf>

¹ 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 1.5°C” (October 2018)

² Australian Government Department of Industry, Science, Energy and Resources. 2020. Report of the expert panel examining additional sources of low cost abatement. Available at: <https://www.industry.gov.au/sites/default/files/2020-05/expert-panel-report-examining-additional-sources-of-low-cost-abatement.pdf>

³ Bremmer, J. 2016. *Burning biomass for energy: a fast track to climate change and adverse health impacts*. National Toxins Network, NSW

⁴ <https://www.biofuelwatch.org.uk/2018/biomass-basics-2/>

⁵ <http://www.ipcc-nggip.iges.or.jp/faq/faq.html>

⁶ 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

⁷ Bowd, E.J., Banks, C.S., Strong, C.L. and Lindenmayer, D.B. 2018. Ibid.

⁸ Booth, M. 2018; Courvoisier et al., 2017 Schlesinger, 2018.

⁹ 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

¹⁰ (DeCicco and Schlesinger, 2018; Searchinger et al., 2017; Smyth et al., 2014; Stermann 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>

¹¹ Appendix 1: Flawed Carbon Accounting and the Concept of Carbon Neutrality

¹² 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)

¹³ Budischak, C., Sewell, D., Thomsson, H., Mach, L., Veron, D. E. & Willett, K. 2012. Journal of Power Sources, in Bremmer, J. 2016, *ibid*.

¹⁴ Kulman, W. & Putt, P. 2018. *Are forests the new coal? A global threat map of biomass energy development*. Environment Paper Network.

¹⁵ Modelled 2°C pathways assume a level of bioenergy production by 2050 that would require doubling the current harvest of all global biomass for all uses (food, feed and fibre), Dooley et al., 2018; Searchinger et al., 2015)

Field and Mach (2017, p.707) highlight the issues at stake, suggesting that converting land scale required for bioenergy in many modelled climate change mitigation scenarios would “pit climate change responses against food security and biodiversity protection”. Extracted from “The role of the land sector in ambitious climate action: **Missing Pathways to 1.5°C, CLARA**, Climate ambition that safeguards land rights, biodiversity and food sovereignty

Climate Land Ambition and Rights Alliance. Lead authors: Kate Dooley, Doreen Stabinsky. Contributing authors: Kelly Stone, Shefali Sharma, Teresa Anderson, Doug Gurian-Sherman, Peter Riggs. Also see: van Vuuren DP, van Vliet J, Stehfest E (2009) Future bio-energy potential under various natural constraints. Energy Policy 37:4220–4230.

¹⁶ 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

¹⁷ 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>

- ¹⁸ 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/>
- ¹⁹ <https://www.statista.com/statistics/748707/wood-pellet-exports-in-us/>
- ²⁰ <https://www.birdlife.org/europe-and-central-asia/black-book>
- ²¹ <http://www.ase.tufts.edu/gdae/Pubs/climate/ClimatePolicyBrief8.pdf>
- ²² Meyer, C. 2020, *B.C. says firms can chip down whole trees for pellet fuel if they are inferior*. Canada's National Observer. <https://www.nationalobserver.com/2020/04/30/news/bc-says-firms-can-chop-down-whole-trees-pellet-fuel-if-they-are-inferior>
- ²³ Danielsen, C. L, Ravno, L. & Ditzel, E. E., 2019. Når Danmark brænder træer af, bliver der ikke altid plantet nye, Nyheder. <https://nyheder.tv2.dk/2019-09-09-naar-danmark-braender-traeer-af-bliver-der-ikke-altid-plantet-nye?fbclid=IwAR2XmET2FTbxm27nr7O2XK3xzOK1ohbdMRykdz2-abvysjDBWDNKiwccsXI>
- ²⁴ <https://www.birdlife.org/europe-and-central-asia/black-book>
- ²⁵ <http://www.ase.tufts.edu/gdae/Pubs/climate/ClimatePolicyBrief8.pdf>
- ²⁶ Kuhlmann, Wolfgang and Putt, Peg *Are Forests the New Coal – a Global Threat Map of Biomass Energy Development*. Environmental Paper Network. November 2018
- ²⁷ <http://environmentalpaper.org/wp-content/uploads/2018/11/Threat-Map-Briefing-Are-Forests-the-New-Coal-01.pdf>
- ²⁸ <http://environmentalpaper.org/wp-content/uploads/2018/11/Threat-Map-Briefing-Are-Forests-the-New-Coal-01.pdf>
- ²⁹ https://www.dropbox.com/sh/sqhn0b4h6dwvq65/AADnK8Q18AAFaCeWvbZ40vFGa?dl=0&preview=UPDATE+800+signatures_Scientist+Letter+on+EU+Forest+Biomass.pdf ; https://www.dropbox.com/sh/sqhn0b4h6dwvq65/AADnK8Q18AAFaCeWvbZ40vFGa?dl=0&preview=Scientists+letter+to+lead+European+Parliament+negotiators+regarding+biomass+rules+in+renewable+energy+directive_June+2018.pdf ; <https://www.dropbox.com/sh/sqhn0b4h6dwvq65/AADnK8Q18AAFaCeWvbZ40vFGa?dl=0&preview=CIB-Summary-report.pdf> ; https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf
- ³⁰ Australian Forests & Timber News, *Australia-Japan forest products trade strengthened*, 20 December 2018
- ³¹ 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'.
- ³² 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>
- ³³ <https://www.economist.com/business/2013/04/06/the-fuel-of-the-future>
- ³⁴ Kuhlmann, Wolfgang and Putt, Peg *Are Forests the New Coal – a Global Threat Map of Biomass Energy Development*. Environmental Paper Network. November 2018
- ³⁵ For example, Forest Industry Advisory Council (FIAC) wrote a blueprint for the management of Australian forests to 2050. FIAC recommends that all levels of government remove regulatory barriers to using FDB as a renewable energy source and that FDB be eligible for Renewable Energy Certificates in *Transforming Australia's Wood Products Industry* http://www.forestry.org.au/images/IFA/News/1-June-16/Transforming_Australias_forest_products_industry_-_Recommendations_from_the_Forest_Industry_Advisory_Council_May_2016_reduced.pdf