Scientists, professionals and growers who manage, study and care for our forests

(formerly Institute of Foresters of Australia and Australian Forest Growers)

PORTFOLIO COMMITTEE NO. 4 - INDUSTRY

LONG TERM SUSTAINABILITY AND FUTURE OF THE TIMBER AND FOREST PRODUCTS INDUSTRY

Responses to Questions on Notice

Contents

Question 1

Mr JUSTIN FIELD: I am not sure if you had a chance to listen to the previous round of speakers. I wanted to ask you to respond but I will explain quickly their position, and I am doing that in contrast to your submission. On page 5 you make the comment in bold that, "Well-managed harvesting could be used to strategically manage bushfire risks and enhance forest health and resilience," and you point to silvicultural treatment including thinning of forests for strategic firebreaks. We heard evidence in the last session that contradicted that very strongly about thinning and highlighted that logged forests—indeed, in every instance—assessed since the 2019-20 fires burned more severely than unlogged forests. Could you address the information we received in the last session in that regard and cite, if you could, the evidence that you base your claim on?

Forestry Australia is focussed on the need to manage forests by objectively considering all the science. Science-based forest management is about the need to actively, adaptively and appropriately use the full suite of tools available, including silviculture, to maintain forest vitality to support biodiversity and mitigate fire risk in the face of climate change.

For some people, the term ‘silviculture’ may invoke images of traditional timber harvesting or forest exploitation. However, this is not the case. Silviculture is the toolkit of forestry - *the science and craft of creating, managing, conserving, using and caring for forests*. Using silviculture gives people the capacity to appropriately manage forests to meet ecological, social and economic needs. Silviculture can work to restore and enhance forest values, health and resilience in the face of climate change.

Professor Patrick Baker of The University of Melbourne recently presented an excellent summary of some the benefits of silviculture, as shown by scientific study, to the Royal Society of Victoria, in his talk “*Changing forests in a changing climate – What might the future hold?*”[1].

There are many forms of timber harvesting and silviculture and, as such, claims that “logged forest always burns at higher severity” are just as incorrect and misleading as if we were to claim that it never does. The problem with such claims is that they are over-simplistic and completely fail to acknowledge the complexity of forest ecosystems and drivers of forest fire, particularly at the landscape level, and, perhaps even more importantly, act to spark fear dangerously and unnecessarily amongst the community.

Silviculture in NSW

There are many forms of timber harvesting and silvicultural practice used in NSW, which vary by forest type depending on the ecological characteristics, species tolerance and natural processes of the particular forest, site history and operational objectives[2]. The forms of timber harvesting that may be used in NSW native forests are:

Single Tree Selection: Scattered individual trees are removed progressively over a ~90-year rotation, with harvests ~every 15 years. Trees regenerate in the small gaps created by harvest, maintaining an uneven-aged forest structure over time. Only suitable for shade-tolerant species such as conifers.

Selective Harvesting: Uneven removal of both individuals and groups of trees in mixed age and mixed species forests. Creates an irregular forest structure through small and larger canopy openings to facilitate both shade-tolerant and intolerant species regeneration.

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[1] Professor Baker presentation viewable at: https://www.youtube.com/watch?v=gRVJWXt__Vo&t=32s (accessed 24/10/2021)

[2] Silvicultural considerations and requirements for NSW are covered in the following documents:
Silvicultural Guidelines (Private native Forestry Code of Practice), available at: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/vegetation/10177silviculture.pdf, (accessed 24/10/2021)
Forestry Corporation of NSW Native Forest Silviculture Manual, available at: https://www.forestrycorporation.com.au/__data/assets/pdf_file/0005/438404/native-forest-silviculture-manual.PDF.pdf (accessed 24/10/2021)

Australian Group Selection: Groups of trees are removed in shade-intolerant eucalypt forests, creating an irregular forest structure, whilst creating large enough openings to facilitate shade-intolerant species to successfully regenerate.

Seed tree / Shelterwood: The majority of trees are removed, with individual scattered trees retained across the harvest area to provide a natural seed source for forest regeneration. Creates a more even stand structure, with scattered older trees.

Intensive Harvesting: All trees within the harvest unit, except those required to be retained for habitat or other prescriptions (e.g., stream buffers, habitat feature protection patches, cultural heritage protection patches) are removed. Creates even-aged forest structure across the harvest area. Used in forest types, mainly Ash-type eucalypts, where the natural regeneration process is driven by catastrophic disturbance, such as wildfire. Intensive harvesting is only permitted in a very limited area of State forests under the terms of the Integrated Forestry Operations Approval for the Coastal Region[3]. Intensive harvesting is not permitted on Private Native Forestry on private property.

Thinning: Removal of a percentage of individual trees to achieve particular ecological and/or economic objectives. Generally, thinning aims to remove unhealthy, suppressed stems and provide space for the healthier stems with the best growth potential. The aim is not to stimulate a regeneration event, but to influence the retained trees and promote certain forest structural attributes. There are many forms of thinning that may be undertaken, which will vary and depend on the forest type, forest condition and operational objective:

- Thinning from below
- Thinning from beside
- Vertical cut
- Spacing (non-commercial thinning)
- Culling (Timber Stand Improvement)

In addition to the above, the selective harvesting and **ecological thinning** of trees can be used to restore forests and habitat features that have been degraded by both natural causes, such as fire, drought and insect-attack, and past human management, in what is sometimes termed "**restoration silviculture**". **Mechanical fuel treatments**, such as selective removal of trees and understorey may also be used for fire risk mitigation[4]. The primary objectives of these harvesting operations are non-commercial; however, on-sale of harvested material could be used to offset the costs of undertaking these operations where there are suitable markets.

Importantly, the appropriateness and effectiveness of any timber harvesting, or non-commercial silvicultural operation strongly depends on a complex suite of factors, including but not limited to forest type, site history, ecology, topography, aspect, economic, social/community and biodiversity considerations. The results of different forms of timber harvesting and silviculture on forest structure and fuel loads are also highly variable and change over time, due to a range of factors.

Different forms of timber harvesting and silviculture can create very different results in the forest and, as such, it is inappropriate and incorrect to assume a complex set of management options can be reduced into a single cause and effect (in this case, as always causing increased fire severity)

Notes on fire severity and risk

Fire severity is a measure of the effects of a fire on the environment, typically characterised by the amount of plant biomass consumed or degree of canopy death, and so differs from both fire intensity (the measure of how much energy a fire produces and rate of spread) and fire risk (a

[3] Integrated Forestry Operations Approval for the Coastal Region, available at: https://www.epa.nsw.gov.au/your-environment/native-forestry/integrated-forestry-operations-approvals/coastal-ifoa

[4] See reference list below

measure of how likely an area is to burn and how serious the consequences will be if it does). Fire intensity is a good measure of how likely a fire is to spread and how difficult it will be to stop, and so is more directly related to fire risk than fire severity, which varies and is not comparable between ecosystems[5].

Fire severity has a direct relationship with vegetation height, continuity and density. It is highly variable and depends on the weather, local conditions and the vegetation. The severity of fire in one location does not necessarily influence the severity of fire next door, depending on fire intensity, fuel, weather, relative humidity and topography. For example, a grassfire will tend to be high severity (near-complete biomass consumption), but low intensity, whereas if the same intensity fire occurred in a forest, it would be of relatively low severity, consuming only a portion of the vegetation.

There are now multiple studies from different authors demonstrating that timber harvesting has not been a major driver of the extent or severity of bushfires in south-eastern Australia when taking a whole of landscape view[6]. The most recent study, commissioned by the NSW Natural Resources Commission, found that in NSW coastal forests: "Fire severity patterns in wildfire hotspots within State Forests were unrelated to harvesting within the last 20 years"[7]. No single factor accounts for fire severity and each vegetation type responds differently, in combination with a range of other variables[8].

Fire weather risk is measured as the Fire Danger Index, which is derived from temperature, wind speed, relative humidity and drought factor. This differs from overall fire risk, which also accounts for other factors such as fuel type, topography, proximity to assets and community, past management, and other variables that influence the ability to prevent fires from igniting and suppress them once they have started[9].

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[5] See, for example: Keeley, J. E. (2009). Fire intensity, fire severity and burn severity: a brief review and suggested usage. International journal of wildland fire, 18(1), 116-126.

[6] See, for example:

Attiwill, P. M., Ryan, M. F., Burrows, N., Cheney, N. P., McCaw, L., Neyland, M., & Read, S. (2014). Timber harvesting does not increase fire risk and severity in wet eucalypt forests of southern Australia. *Conservation Letters*, 7(4), 341-354.

Bradstock, R., Bedward, M., & Price, O. (2021), Risks to the NSW Coastal Integrated Forestry Operations Approvals Posed by the 2019/2020 Fire Season and Beyond: A Report to the New South Wales Natural Resources Commission, Centre for Environmental Risk Management of Bushfires, University of Wollongong and the NSW Bushfire Risk Management Research Hub

Bowman, D. M., Williamson, G. J., Gibson, R. K., Bradstock, R. A., & Keenan, R. J. (2021). The severity and extent of the Australia 2019–20 Eucalyptus forest fires are not the legacy of forest management. *Nature Ecology & Evolution*, 1-8.

Keenan, R. J., Kanowski, P., Baker, P. J., Brack, C., Bartlett, T., & Tolhurst, K. (2021). No evidence that timber harvesting increased the scale or severity of the 2019/20 bushfires in south-eastern Australia. *Australian Forestry*, 1-6.

Leonard, S. W., Bennett, A. F., & Clarke, M. F. (2014). Determinants of the occurrence of unburnt forest patches: potential biotic refuges within a large, intense wildfire in south-eastern Australia. *Forest Ecology and Management*, 314, 85-93.

[7] Bradstock, R., Bedward, M., & Price, O. (2021). Risks to the NSW Coastal Integrated Forestry Operations Approvals Posed by the 2019 / 2020 Fire Season and Beyond: A Report to the New South Wales Natural Resources Commission. (p. 32)

[8] Along with references under footnote 4, see for example: Kumar, L., Clarke, P., Muñoz, C., & Knox, K. (2008). Mapping of fire severity and comparison of severity indices across vegetation types in Gibraltar Range National Park, Australia. *International Archives of the Photogrammetry, Remote Sensing, and Spatial Information Sciences*, 37, 1477-1482.

[9] See, for example, Victoria's approach for assessing fire risk through the Safer Together program: https://www.safertogether.vic.gov.au/understanding-risk (accessed 24/10/2021)

Considering one factor alone, such as a site history of timber harvesting, is not an appropriate indicator of fire risk. There are a myriad of other variables that interact and must also be considered.

Scientific References – Silviculture for fire risk mitigation

Below is a list of peer-reviewed scientific papers, with key findings summarised, that address how well-managed harvesting could be used to strategically manage bushfire risks and enhance forest health, fire resistance and resilience. In the interest of brevity, the Key Finding summaries below address only the effects of the silvicultural treatment on fire risk mitigation, although we recognise that there are many other highly relevant considerations, including carbon, biodiversity, site nutrient status, community expectations and economics. A recent paper addressing important considerations for conducting mechanical fuel reduction highlights that there can be no one-size-fits-all approach, however when planned well, such operations can have a range of benefits beyond fire risk mitigation[10].

Internationally, particularly from the United States, there are numerous studies demonstrating how thinning and silviculture can benefit fire risk mitigation and increase forest resistance[11], however, to avoid doubt about their applicability to the Australian context, only Australian studies have been cited below. The peer-reviewed scientific literature is still incomplete in Australia, however a recent 2021 review of local and international literature, highlighted the following rationale, for using thinning to reduce wildfire risks[12]:

- Reduce forest stand density to reduce the probability of fires reaching the canopy
- Reduce the probability of trees dying from wildfire because thinning allows retained trees to grow bigger quicker, and bigger trees are more resilient to fire
- Facilitate the re-introduction of cultural burning practices to over-stocked and high fuel load forests for long-term fire risk mitigation and restoration of Indigenous land management practice

It is important to note that there are conflicting reports regarding the efficacy of thinning and silviculture, however this is logical and expected given the complex range of interacting factors involved, as we discuss above. Conflicting reports are not an argument for doing nothing. Although more research is needed, there is nevertheless enough evidence to support appropriate thinning and other silviculture as a required part of the toolkit for increasing forest resilience and addressing the very real and serious challenge of climate change and landscape-scale bushfire.

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[10] Ximenes, F., Stephens, M., Brown, M., Law, B., Mylek, M., Schirmer, J., Sullivan, A., & McGuffog, T. (2017). Mechanical fuel load reduction in Australia: a potential tool for bushfire mitigation. *Australian Forestry*, 80(2), 88-98.

[11] Some recent examples include:

Hood, S. M., Baker, S., & Sala, A. (2016). Fortifying the forest: thinning and burning increase resistance to a bark beetle outbreak and promote forest resilience. *Ecological Applications*, 26(7), 1984–2000. http://www.jstor.org/stable/24818167

Kalies, E. L., & Kent, L. L. Y. (2016). Tamm review: are fuel treatments effective at achieving ecological and social objectives? A systematic review. *Forest Ecology and Management*, 375, 84-95.

Lydersen, J. M., Collins, B. M., Brooks, M. L., Matchett, J. R., Shive, K. L., Povak, N. A., ... & Smith, D. F. (2017). Evidence of fuels management and fire weather influencing fire severity in an extreme fire event. *Ecological Applications*, 27(7), 2013-2030.

Piqué, M., & Domènech, R. (2018). Effectiveness of mechanical thinning and prescribed burning on fire behaviour in Pinus nigra forests in NE Spain. *Science of the total environment*, 618, 1539-1546.

Prichard, S. J., Povak, N. A., Kennedy, M. C., & Peterson, D. W. (2020). Fuel treatment effectiveness in the context of landform, vegetation, and large, wind-driven wildfires. *Ecological Applications*, 30(5), e02104.

[12] Keenan, R.J., Weston, C.J. and Volkova, L. (2021) Potential for forest thinning to reduce risk and increase resilience to wildfire in Australian temperate Eucalyptus forests. *Current Opinion in Environmental Science & Health* 23; 1-6

Further studies will be required to determine the appropriateness of thinning and other silviculture for fire risk mitigation in different forest types. It should be noted that the results of the Australian National Bushfire Mitigation Programme mechanical fuel reduction trials are due for release this year[13].

Cruz, M. G., Alexander, M. E., & Plucinski, M. P. (2017). The effect of silvicultural treatments on fire behaviour potential in radiata pine plantations of South Australia. *Forest ecology and management*, 397, 27-38.

Forest type/location: Radiata Pine plantations (*Pinus radiata*), Green Triangle, South Australia
Study type: Field measurement and fire simulation
Key finding/s: Pruning and thinning had long lasting effects by decreasing vertical fuel continuity. There were adverse impacts from the increase in surface fuel load from pruning and thinning, but these were short-lived, and residues decomposed relatively quickly. Cumulative effects of ongoing silvicultural prescriptions acted to reduce fire intensity and the likelihood of crowning in a simulated fire.

Proctor, E., & McCarthy, G. (2015). Changes in fuel hazard following thinning operations in mixed-species forests in East Gippsland, Victoria. *Australian Forestry*, 78(4), 195-206.

Forest type/location: Low elevation mixed species, East Gippsland, Victoria
Study type: Field measurement
Key finding/s: Fuel hazard was lower at thinned sites compared to adjacent unthinned sites due to reduced elevated fine fuel. Bushfire severity was lower in thinned areas compared with adjacent unthinned area. Coarse woody debris left on site may increase fire suppression difficulty, however overall lowered fire risk may persist for ~15 years.

Taylor, C., Blanchard, W., & Lindenmayer, D. B. (2021). Does forest thinning reduce fire severity in Australian eucalypt forests? *Conservation Letters*, 14(2), e12766.

Forest type/location: Wet sclerophyll forests, Central Highlands, Victoria
Study type: Desktop modelling, no field verification
Key finding/s: The effects of thinning on the probability of high severity fire is complex and varied with forest type, forest age, and fire conditions. When considered alone, thinning did not affect fire severity in ash-type forests, however it lowered the probability severe fire in young mixed species forests and increased it in older stands. The study does not analyse the effect of time-since thinning, which ranged between 0-30 years.

Taylor, C., Blanchard, W., & Lindenmayer, D. B. (2021). What are the associations between thinning and fire severity? Austral Ecology.

Forest type/location: Wet/damp forest and lowland forest, East Gippsland, Victoria
Study type: Desktop modelling, no field verification
Key finding/s: The effects of thinning on the probability of high severity fire is complex and varied depending on fire severity, forest age, and forest type. When considered alone, fire severity was lower in young, thinned forest relative to unthinned forest, but this relationship reversed with increasing time since disturbance.

Trouvé, R., Oborne, L., & Baker, P. J. (2021). The effect of species, size, and fire intensity on tree mortality within a catastrophic bushfire complex. *Ecological Applications*, e2383.

Forest type/location: Wet sclerophyll forests, Central Highlands, Victoria
Study type: Field measurement

[13] See: https://www.awe.gov.au/agriculture-land/forestry/national/nbmp#:~:text=The%20trials%20are%20investigating%20whether,for%20a%20range%20of%20reasons. (accessed 24/10/2021)

Key finding/s: Mountain Ash forests regenerating at high stand stem densities take ~35 years to reach 35cm diameter at breast height (DBH), which is the diameter at which trees have a 50% probability of surviving death by a moderate-severity wildfire. When thinned, retained trees take 12 years to reach 35 cm DBH. Thinning accelerates the growth of individual trees into fire-safe size classes more quickly.

Volkova, L., Bi, H., Hilton, J., & Weston, C. J. (2017). Impact of mechanical thinning on forest carbon, fuel hazard and simulated fire behaviour in *Eucalyptus delegatensis* forest of south-eastern Australia. *Forest Ecology and Management*, 405, 92-100.

Forest type/location: Alpine Ash (*Eucalyptus delegatensis*), Central Highlands, Victoria
Study type: Field measurement and fire simulation
Key finding/s: Thinning decreased surface fuel hazard ratings and overall fuel loads but had no significant effect on near surface, elevated or bark fuels. Fire simulation under severe to extreme weather conditions indicated thinning resulted in an almost 30% reduction in fireline intensity and ~20% reduction in the rate of spread and spotting distance compared with unthinned forest. Forests were more resilient to fire due to greater canopy openness and development of increased bark thickness caused by thinning.

Volkova, L., & Weston, C. J. (2019). Effect of thinning and burning fuel reduction treatments on forest carbon and bushfire fuel hazard in *Eucalyptus sieberi* forests of South-Eastern Australia. *Science of The Total Environment*, 694, 133708.

Forest type/location: Silvertop Ash (*Eucalyptus sieberi*), East Gippsland, Victoria
Study type: Field measurement
Key finding/s: Thinning followed by burning reduced overall fuel hazards from 'Extreme' to 'Low' due to removal of elevated fuels and breaking of vertical structure. The benefit was estimated to persist for up to 7 to 10 years. Thinning alone, without the removal of the leftover thinning biomass, did not reduce fuel hazard.

Summary and further commentary on timber harvesting and fire

Context is critically important, however the drivers of forest flammability, landscape-level fire severity and risk are complex, with multiple interacting factors that are almost impossible to untangle. Fire behaviour is driven by the interaction between fuel (influenced by forest type, site history including fuel reduction burning, ecological and climatic factors), weather and topography.

Of these drivers, fuel, is the only component that humans can influence.

Due to shortening windows of suitable conditions in which to conduct fuel reduction burns, alternative methods for managing fuel loads, such as mechanical fuel reduction and thinning, will be increasingly important for managing fire risk.

Ultimately, to address issues of risk and fire severity, a holistic, long-term and professional view of forest and fire management is needed rather than short-termed, single-issue and over-simplistic perspectives. A single factor, like timber harvesting, cannot by itself give rise to fires of the devastating scale and severity we saw in 2019/20, and suggesting this misleads the public by oversimplifying the complex task of forest and fire management.

Most scientific articles cannot and do not account for fundamentally important aspects influencing fire severity and risk, including:

- The location and timing of fire ignition points
- The weather conditions on the day
- The state of the fuel levels and dryness across the landscape (seasonal and diurnal)
- The nature of the terrain where the fires occurred (ruggedness, elevation)
- The ease of access to fires (tracks, steepness, density of vegetation)
- The effects of fire suppression operations including first attack strategies and backburning

- The level of training and experience of the firefighting crews and machine operators

Caution should be used in interpreting research that is solely based on computer modelling with no field validation or empirical data.

Forestry Australia supports and promotes the use of rigorous science as a basis for forest management decisions. Australia's forests need to be managed actively and adaptively across all land tenures, taking a long-term view and working with Traditional Owners to implement appropriate and effective management techniques informed by the latest science. Through such strategies, we can conserve forests for a broader range of values, and proactively manage current pressures and increasing threats to our environment from climate change and the interrelated impacts of bushfires.

Question 2

Mr JUSTIN FIELD: You also make the comment that forests are a very effective means of sequestering carbon. Would you accept though that the notion of leaving the forest to grow larger and more mature would be the best methodology to sequester carbon in the forest?

Forests are one of the most important natural resources we have for mitigating climate change through carbon capture and storage[14].

Younger forests sequester (absorb) more carbon from the atmosphere than mature and old forests, because they are more actively and vigorously growing[15]. Forests with larger trees store more carbon because large trees represent the greatest carbon stock of the forest (~50-70% of carbon at a site)[15].

Estimating the total carbon in a forest is very complex and variable, requiring the measurement of both aboveground carbon (large trees, small trees, tree ferns, stumps, coarse woody debris, litter) and below-ground carbon (soil, tree roots). There are differing reports and high levels of uncertainty around forest carbon stocks because it is difficult and complex to measure all of these variables comprehensively and accurately, and these components can vary significantly across the landscape depending on forest type, topography, site history, season, local conditions and climatic variability. How and what and when a scientist measures above- and below-ground carbon can significantly influence their results, which explains why there are conflicting reports[16].

The importance of mitigating wildfire

The area of NSW coastal forests exposed to high frequency and severity wildfire is likely to substantially increase into the future[17], with negative flow-on effects to carbon storage and

[14] "*Among nature-based solutions, the forest sector represents the largest, most advanced, shovel-ready and cost-effective solution* [to mitigating carbon emissions]" – Mario Boccucci, Head of the UN-REDD Programme Secretariat, quote from: https://www.un-redd.org/post/our-race-to-zero-why-nature-can-help-us-safeguard-our-planet-and-build-a-healthier-future (accessed 26/10/2021)

[15] Ximenes, F. A., George, B., Cowie, A., Kelly, G., Williams, J., Levitt, G., & Boer, K. (2012). Harvested forests provide the greatest ongoing greenhouse gas benefits. Does current Australian policy support optimal greenhouse gas mitigation outcomes? New South Wales through Department of Primary Industries

[16] For example, estimates in Ash eucalypt forests have ranged from 233 to 1,819 Mg C ha^{-1}, see citations in:
Fedrigo, M., Kasel, S., Bennett, L. T., Roxburgh, S. H., & Nitschke, C. R. (2014). Carbon stocks in temperate forests of south-eastern Australia reflect large tree distribution and edaphic conditions. *Forest Ecology and Management*, 334, 129-143.

[17] Bradstock, R., Bedward, M., & Price, O. (2021). Risks to the NSW Coastal Integrated Forestry Operations Approvals Posed by the 2019 / 2020 Fire Season and Beyond: A Report to the New South Wales Natural Resources Commission.

greenhouse gas emissions - the 2019/20 bushfires alone represented 35% of all Australia's greenhouse gas emissions in 2020 and burnt 112.3 billion kilograms of biomass[18].

In fire sensitive Alpine Ash forests in Victoria, high severity fire reduced above ground carbon storage by 58%[19] Frequent high severity fires can lead to reduced tree density and death of forest regeneration, leading to declines in carbon storage[20]. For reasons of complexity described above, there are mixed reports about carbon stocks and flows following fire. However, scientific study and the in-field anecdotal experience of foresters has shown fuel reduction burning can reduce carbon loss and mitigate greenhouse gas emissions in forests at high risk from wildfire and greatly improves the chances of firefighters extinguishing fires on the milder days[21]. Nevertheless, this does need to be strategically balanced against the effects of the high frequency of burning required to maintain fuel reduction effectiveness[22] As discussed above, appropriate silviculture can also be used to mitigate fire risk and to grow bigger trees quicker, storing more carbon and creating forests that are more resistant to fire.

The role of silviculture

Landscape-scale wildfire is by far the largest, cross-tenure creator of small trees and dense regenerating forest – for example, 25% percent of native forests were burnt by wildfire in 2019/20, compared to 0.1% of native forests subject to timber harvesting[23]. Using appropriate silviculture to thin out fuel loads and help grow bigger trees quicker can not only assist with managing fire risk and enhancing resistance of forests to fire (see above) but can also offset drought impacts. Drought and heatwaves, which are predicted to increase under climate change, can cause a greater loss of large trees from the landscape than wildfire[24]. Thinning can ease water stress during drought, thus improving forest resilience[25]

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[18] Li, F., Zhang, X., & Kondragunta, S. (2021). Highly anomalous fire emissions from the 2019–2020 Australian bushfires. *Environmental Research Communications*.

[19] Bowman, D. M., Murphy, B. P., Neyland, D. L., Williamson, G. J., & Prior, L. D. (2014). Abrupt fire regime change may cause landscape-wide loss of mature obligate seeder forests. *Global Change Biology*, 20(3), 1008-1015.

[20] See references in: Bowman, D. M., Williamson, G. J., Price, O. F., Ndalila, M. N., & Bradstock, R. A. (2021). Australian forests, megafires and the risk of dwindling carbon stocks. *Plant, Cell & Environment*, 44(2), 347-355.

[21] See, for example: Volkova, L., Meyer, C. M., Murphy, S., Fairman, T., Reisen, F., & Weston, C. (2014). Fuel reduction burning mitigates wildfire effects on forest carbon and greenhouse gas emission. *International Journal of Wildland Fire*, 23(6), 771-780.

[22]: Collins, L., Bradstock, R., Ximenes, F., Horsey, B., Sawyer, R., & Penman, T. (2019). Aboveground forest carbon shows different responses to fire frequency in harvested and unharvested forests. *Ecological Applications*, 29(1), e01815.

[23] Davey S.M. & Sarre A. (2020) Editorial: the 2019/20 Black Summer bushfires, *Australian Forestry*, 83:2, 47-51, DOI: 10.1080/00049158.2020.1769899

https://www.forestrycorporation.com.au/operations/silviculture (accessed 26/10/2021)

[24] See, for example: Walden, L. L. (2020). The effects of drought and wildfire on forest structure and carbon storage in a resprouting eucalypt forest (Doctoral dissertation, Murdoch University).

[25] See, for example: Qiu, S., Bell, R. W., Hobbs, R. J., & McComb, A. J. (2013). Overstorey and juvenile response to thinning and drought in a jarrah (*Eucalyptus marginata* Donn ex Sm.) forest of southwestern Australia. Plant and soil, 365(1), 291-305.

The role of biomass, timber and wood products

The management and silvicultural regime, amount of carbon stored in forest products and fossil fuel displacement by forest biomass all add up to determine whether or not timber harvesting and other silvicultural activities are carbon positive, neutral or negative[26].

Further, creating genuine carbon benefit only occurs where our policy decisions do not just shift carbon and emissions activity elsewhere (known as leakage). Leakage can be significant - reductions in local forestry activities and reliance on imports can cause significant leakage from Australia to other countries, up to ~70%[27]. As the reporting rules for UNFCCC require that emissions associated with imported products are reported by the country which emits them, not the country that uses the product, any shifting of activity from Australia to another country would reduce Australia's reported emissions, but not genuinely help combat climate change.

Internationally, countries have recognised the importance of and their moral responsibility to manage their forests and meet domestic demand locally. This is seen as part of the solution to climate change through establishing bio-economies based on sustainable biomass and timber[28]

Other relevant links requested as part of the Question on Notice

IPCC 2007:
Nabuurs, G.J., O. Masera, K. Andrasko, P. Benitez-Ponce, R. Boer, M. Dutschke, E. Elsiddig, J. Ford-Robertson, P. Frumhoff, T. Karjalainen, O. Krankina, W.A. Kurz, M. Matsumoto, W. Oyhantcabal, N.H. Ravindranath, M.J. Sanz Sanchez, X. Zhang, 2007: Forestry. In Climate Change 2007: Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, L.A. Meyer (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Available at: https://www.ipcc.ch/report/ar6/wg1/ (accessed 26/10/2021)

"In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual sustained yield of timber, fibre or energy from the forest, will generate the largest sustained [carbon] *mitigation benefit."* (p. 543)

IPCC 2021:
Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change

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[26] Carroll, M., Milakovsky, B., Finkral, A., Evans, A., & Ashton, M. S. (2012). Managing carbon sequestration and storage in temperate and boreal forests. In Managing forest carbon in a changing climate (pp. 205-226). Springer, Dordrecht.

Ximenes, F., Bi, H., Cameron, N., Coburn, R., Maclean, M., Matthew, D. S., ... & Ken, B. (2016). Carbon stocks and flows in native forests and harvested wood products in SE Australia. PNC285-1112, 198.

[27] See, for example:

Gan J. and McCarl B.A. (2007), Measuring transnational leakage of forest conservation *Ecol. Econ*., 64 (2), pp. 423-432

Ximenes, F., Bi, H., Cameron, N., Coburn, R., Maclean, M., Matthew, D. S., ... & Ken, B. (2016). Carbon stocks and flows in native forests and harvested wood products in SE Australia. PNC285-1112, 198.

[28] See, for example:

Winkel G, 2017. Towards a sustainable European forest-based bioeconomy. What Science Can Tell Us Series 8. Sarjanr (Finland): European Forest Institute

European Commission (2019). Bioeconomy policy. Brussels (Belgium): European Commission. Available from: https://ec.europa.eu/research/bioeconomy/index.cfm?pg=policy (accessed 26/10/2021)

Bioindustrial Innovation Canada. (2019). Canada's bioeconomy strategy: leveraging our strengths for a sustainable future. Sarnia (Canada): Bioindustrial Innovation Canada. Available from: https://www.fpac.ca/wp-content/uploads/b22338_1906a509c5c44870a6391f4bde54a7b1.pdf (accessed 26/10/2021)

[Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. Cambridge University Press. In Press.

Available at: https://www.ipcc.ch/report/ar6/wg1/ (accessed 26/10/2021)

"Sustainable forest management can help to manage some of these vulnerabilities [droughts, fires, insect outbreaks, diseases, erosion, and other disturbances]*, while in some cases, it can increase and maintain forest sinks through harvest, transfer of carbon to wood products and their use to store carbon and substitute emissions-intensive construction materials"* (p. 5)

Ximenes, F. A., George, B., Cowie, A., Kelly, G., Williams, J., Levitt, G., & Boer, K. (2012). Harvested forests provide the greatest ongoing greenhouse gas benefits. Does current Australian policy support optimal greenhouse gas mitigation outcomes? New South Wales through Department of Primary Industries

Available at: https://www.researchgate.net/publication/274640085_Harvested_forests_provide_the_greatest_ongoing_greenhouse_gas_benefits_Does_current_Australian_policy_support_optimal_greenhouse_gas_mitigation_outcomes (accessed 26/10/2021)

"For both case study areas, NSW North Coast and NSW South Coast, the 'harvest' option delivers greater climate change mitigation than provided by conservation forests, particularly as the simulation progresses in time." (p. iii)

Summary - Optimising forest carbon stocks and sequestration

"Leaving forests to grow larger and more mature" is not a viable methodology for maximising carbon sequestration and storage, or for mitigating climate change and the increasing frequency and intensity of wildfire. There is no simple fix to addressing climate change, and a full combination of active management approaches will be required across landscapes and tenures, including:

- Appropriately using silviculture to promote large tree growth, mitigate fire risk and to restore degraded forests
- Conserving old forests and large trees by conducting cross-tenure wildfire prevention and mitigation activities and protecting them from permanent land clearing
- Increasing forest cover by using carbon payments and incentives to establish new biodiverse plantings and commercial plantations on cleared land
- Sustainably sourcing and appropriately using biomass, wood and timber from forests that are regenerated, in place of non-renewable products

Question 3

The CHAIR: You talk about emerging technologies in processing, growing, harvesting and falling. On notice, could you provide examples to the Committee of those technologies that are emerging that we should be looking at investing in and supporting?

Technological advances in forestry, land management and throughout the forest industry supply chain are constantly evolving and the list of examples is extensive. As scientists, Forestry Australia supports and seeks innovative and science-based solutions to modern day forestry problems.

As per our submission, Forestry Australia would encourage the NSW Government to connect with and leverage off existing collaborative research partnerships, such as those with Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Forest & Wood Products Australia

(FWPA), the National Institute for Forest Products Innovation centres and the various forestry related Cooperative Research Centres (CRCs)[29].

Ultimately, Forestry Australia would encourage the NSW Government to engage with the Australian Government to establish a further National Institute for Forest Products Innovation Centre in NSW, to build on work being undertaken through the 3 existing centres at Mount Gambier, Launceston and Gippsland. The establishment of a NIFPI centre in association with the University of Southern Cross at Lismore has previously been raised with the NSW Government through the NSW Forestry Industry Taskforce.

Note that in their publication Department of Agriculture and Water Resources 2018, *Growing a better Australia – A billion trees for jobs and growth*[30], the Australian Government has already committed to establishing at least 4 NIFPI centres. The stated NIFPI Research Outcomes is "improving the returns to industry and the community from our plantation and native forest estates consistent with their sustainable management"[31].

Emerging technologies in timber processing

Whilst the NSW forest industry is often viewed as two largely separate streams – softwood and hardwood, changes to the traditional hardwood resource base has seen increasing cross over between the sectors. Changes in species mix, availability, product mix, age and log size has driven innovation, particularly in the case of native timber species. Finding alternative uses for and adding value to non-favoured species, odd sizes and what would previously been a waste product is becoming more commonplace.

Engineered wood products

The increasing adoption of engineered wood or mass timber as a substitute for steel and concrete in mid-rise construction for residential and commercial buildings is seen as significant step in fighting climate change. Its use in buildings such as International House Sydney, Barangaroo South (https://vimeo.com/226106323) and 25 King Street, Brisbane (https://brisbanedevelopment.com/lendlease-unveils-australias-tallest-timber-tower-25-king/) offers significant construction savings, less waste, lower carbon footprint and ongoing health benefits to the occupants.

However, all the engineered wood for these notable projects was produced and supplied from Europe spruce and hardwoods, due to a lack of our own domestic Laminated Veneer Lumber (LVL), Glulam and Cross Laminated Timber (CLT) manufacturing capacity.

Similarly, the use of Australian hardwood as a laminate to produce these products is rare, with more work required on effective drying, gluing and construction. However, the Hermal Group has invested in research and development methods to utilise environmentally managed plantation hardwood timbers (*Eucalyptus nitens*) for CLT and aims to build a CLTP mill in Tasmania. Similar R&D is required on hardwood plantation species in NSW.

With the increasing scarcity of durable large end section round logs, which have traditionally been used for bridge girders, Big River Timbers near Grafton developed engineered Laminated Veneer Lumber (LVL) girder beams from pine. The engineered beams are 25-30% stronger, 22% lighter and

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[29] See Department of Agriculture, Water and the Environment. 2003. https://www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/forestry/innovative_forestry_and_forest_industries_research_in_australia.pdf

[30] Department of Agriculture and Water Resources 2018, *Growing a better Australia – A billion trees for jobs and growth*, https://www.awe.gov.au/agriculture-land/forestry

[31] See National Institute for Forest Products Innovation 2021, Home page, https://nifpi.org.au/

have a longer in service life span than their round equivalent. The beams are treated against insect and termite attack[32].

BRT have also developed engineered plywood bridge decking from pine to replace traditional and hard to come by durable native species.

Continuous kiln drying

Hyne Timber has recently commissioned their new Continuous Drying Kiln (CDK) at their Tuan Mill[33] and anticipate it will increase their throughput by at least 20%. Similar kilns in North America have shown:

- significant increase in production compared to a batch kiln of equal capacity,
- lower energy consumption per lineal metre dried,
- tighter moisture distribution i.e., lower standard deviation,
- potentially ending up with a higher-grade product,
- having that product go through the planer more easily with increased uptime (since the timber lays flatter),
- and production flexibility.

Adding value to forestry residues

Recent work undertaken by MS2 (Martin Stewardship & Management Strategies Pty Ltd) on *Forestry and Sawmilling Residues Utilisation and Stewardship Strategies* examined barriers and opportunities for optimising residues along the north coast of NSW, a project commissioned by the North East NSW Forestry Hub and funded by the Australian Government.

The project identified significant opportunities that exist for forestry and sawmilling residues to be used for bioenergy projects and carbon-negative processes that generate biochar, as well as power, heat and other commercially valuable products. The project included industry-specific case studies and trial developments incorporating bioenergy, biochar, technology development and related activities. It also identified the industry-relevant benefits for investment in forestry and sawmilling residues usage opportunities, identified policy barriers and developed an integrated stewardship strategy across a range of product types and sustainability aspects for the north coast of NSW. Copy attached.

Industry-specific case studies and trial development options identified numerous opportunities to add value to what is currently classified as waste through the study, including (but not limited to):

- chemicals from wood including food additives, solvents, medical applications and recyclable food packaging
- nano-cellulose[34]
- biochar for stockfeed, soil additive, filtration, roads
- pellets for heating, power generation, cooking, animal bedding, compost
- briquettes for heating and power generation
- biofuels
- paper, cardboard and pulp[35]

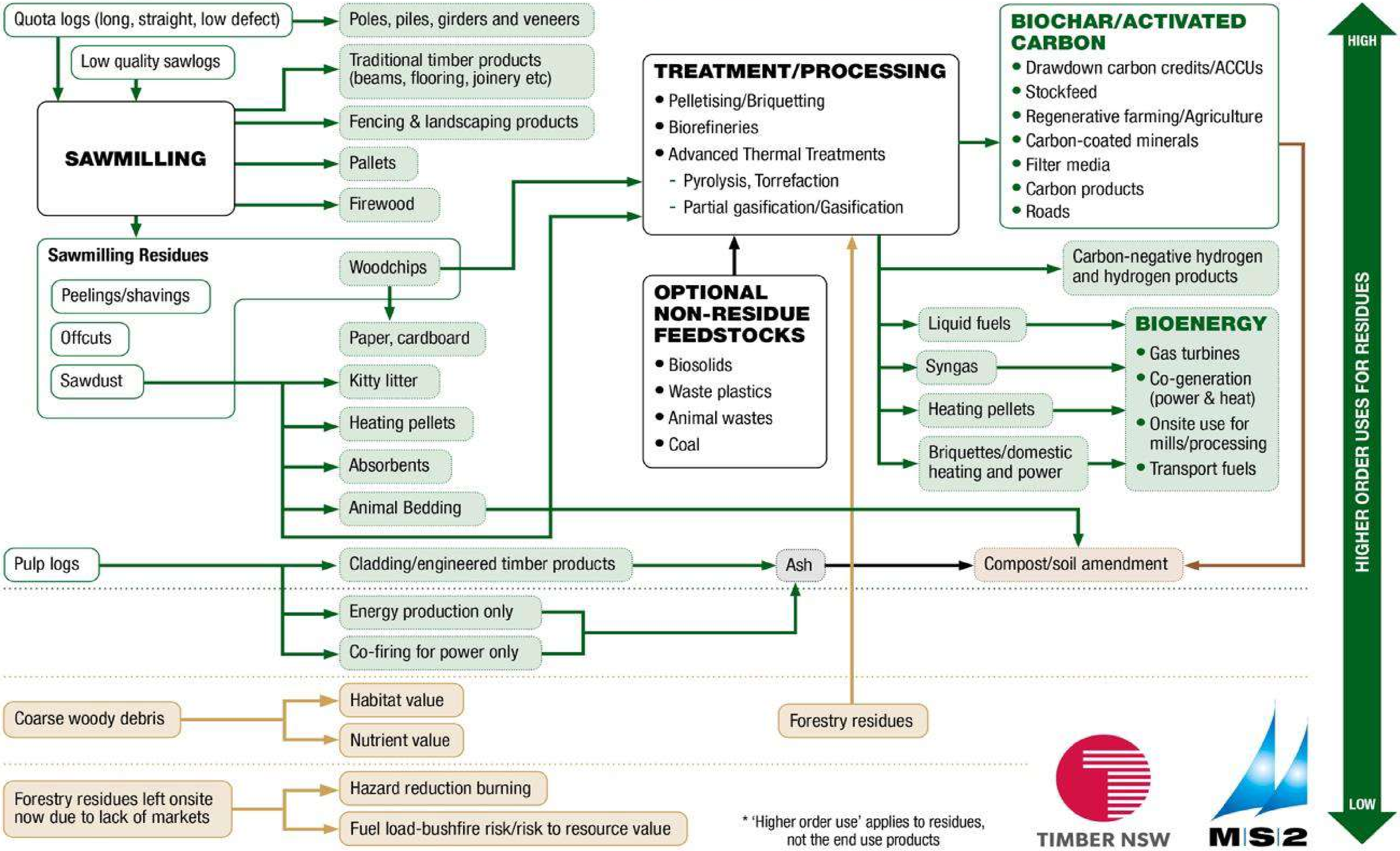
[32] See Big River Group, Engineered Girder Beams, https://www.bigrivergroup.com.au/product/engineered-girder-beams/

[33] See *Hyne Continuous Drying Kiln operational*, Timberbiz, 2021. https://www.timberbiz.com.au/hyne-continuous-drying-kiln-operational/

[34] See Department of Agriculture, Water and the Environment. 2020. *Technology and innovation lead the way in forestry*, https://www.awe.gov.au/agriculture-land/forestry/planning-tomorrow/innovation-and-technology

[35] Final Report: Residues Utilisation and Stewardship Strategy, prepared for North East Forestry Hub, MS2 (Martin Stewardship & Management Strategies Pty Ltd), July 2021

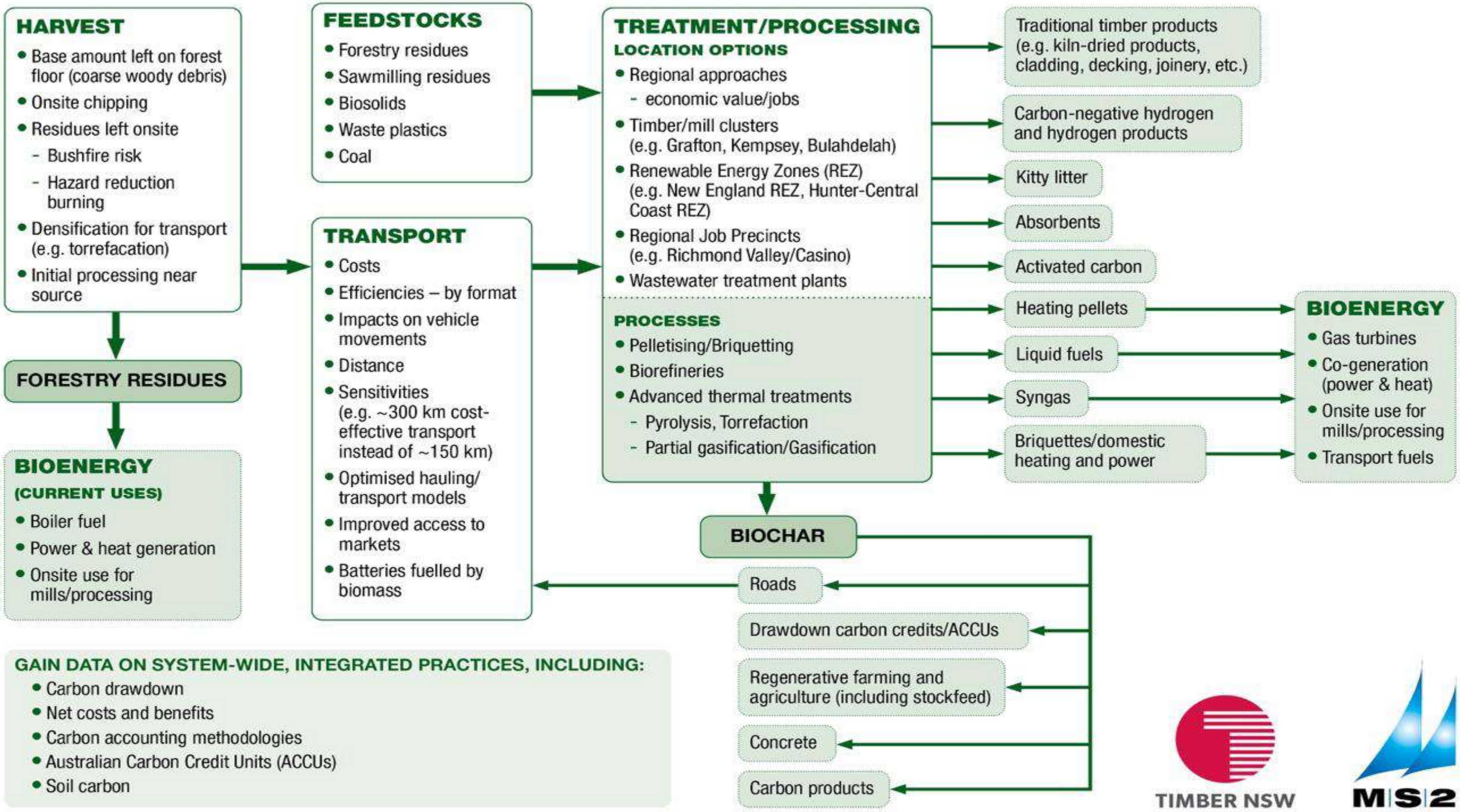
HIGHER ORDER USES AND VALUE-ADD FOR TIMBER AND RESIDUES*



* 'Higher order use' applies to residues, not the end use products

POSSIBLE TRIAL OPTIONS

Refine in conjunction with stakeholders. Actual flows depend on trials selected.



Emerging technologies in forest management

The opportunities of technology are endless; they are helping to better manage Australia's forests more sustainably.

Investment in new technologies has enabled the industry to minimise its ecological footprint, better manage fire risk, provides more detailed information for managers and planning, while maximising wood resources, including technologies such as:

- drones
- lasers
- ground based and airborne terrestrial scanners
- infra-red sensors
- 3D sensing and imaging
- advances in tree-breeding.

Advances in DNA timber profiling allows the tracing of wood products back to their forest of origin, helping in the fight against illegal logging.

"Technology is an important part of the science of forest management and it's going to become increasingly so. The work that we do now is going to determine the types of forests that are available for people in the future."[36]

Driven by investment in technology and innovation, the potential growth for Australia's forest industries is huge[37].

New technology and training result in productivity gains

As outlined in our submission and throughout our presentation, productivity gains will only be realised through well trained people applying and adapting new technology. Effective training opportunities and facilities are needed to ensure adequate skills for a future vibrant forest and timber processing industry. The following are examples of subject areas that can lead you to a career in the forestry and natural resource management sector:

- forest science
- environmental science and management
- biodiversity conservation
- forest silviculture
- forests, carbon and climate change
- biosecurity, pests and diseases
- fire management and planning[38]

Changes in the forest industry drive a continuing demand for degree-qualified foresters able to work in production, conservation and restoration forestry, in plantation establishment and management; native forest management, fire prevention and control; forest resource assessment; policy development; pest and disease management; agroforestry and farm forestry advisory services; forest growth modelling and yield prediction; protected area management and forestry research[39].

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[36] Mike Sutton, Manger, Innovation and Research, Forestry Corporation of NSW

[37] Department of Agriculture, Water and the Environment. 2019, Technology and innovation lead the way in forestry, https://www.awe.gov.au/agriculture-land/forestry/planning-tomorrow/innovation-and-technology

[38] See Forestry Australia, Forestry education: courses and pathways, https://www.forestry.org.au/Forestry/About/Forestry_education/Forestry/About_the_Forestry/Forestry_education/Education_pathways.aspx?hkey=3f0eef78-b116-4a17-9feb-9c6b1616eb56

[39] See Southern Cross University, Bachelor of Science, 2021 course information for Domestic Students, https://www.scu.edu.au/study-at-scu/courses/bachelor-of-science-3007004/2021/

Similarly, ForestWorks undertook a comprehensive investigation of the skills and training gaps in the forest management, harvest, haulage and processing sectors for prioritised investment in northern NSW[40].

Advances in forest harvest and haulage

Innovation and technological advances in forest harvest and haulage businesses in also commonplace across the sector, including:

Harvesting

- optimisation software in felling head/processors
- cable-assisted timber harvesting (for use on steep slopes)
- lightweight teleoperated (remote controlled) felling machinery
- automation
- training simulators
- machine vision
- precision forestry
- machine-mounted mapping software that assists

Haulage

- electric low-emission log trucks
- more efficient road haulage gazettal of B doubles and higher mass limits routes
- centralised haulage optimisation and dispatch
- CSIRO has been contracted by the North East Forestry Hub to identify transport bottlenecks and quantify co-benefits associated with infrastructure development, due to be completed in December 2022.

[40] ForestWorks, prepared for the North East Forestry Hub 2021, Interim Report, June 2021