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Submission in response to Low Carbon Liquid Fuels consultation paper

Introduction

The Superpower Institute (TSI) welcomes the opportunity to contribute to the consultation on Low Carbon Liquid Fuels (LCLF).

TSI supports the government's Future Made in Australia (FMIA) initiative, seeing it as a critical step to unlocking green exports opportunities that will form the basis of future economic prosperity and underpin a key part of global decarbonisation efforts.

Our submission covers five topics:

1. The barriers to accessing LCLF opportunities and how to address these
2. LCLF in the context of Treasury's National Interest Framework for the FMIA
3. An overview of significant LCLF opportunities for Australia
4. Recommendations on production-side policy support
5. The importance of comprehensive carbon accounting and low-cost measurement

1. Addressing barriers to unlock LCLF opportunities

TSI recently made a submission to the consultation process run by the Department of Industry in relation to green metals exports opportunities for Australia. That submission, included as Attachment A, identifies key barriers to realising green metals export opportunities for Australia and actions the Australian Government should take in respect of these.

TSI has identified four areas in which government action is needed:

1. Implementing a carbon price
2. Supporting innovation where positive knowledge spillovers exist
3. Government provision of essential infrastructure
4. Diplomacy to make the case that Australia's green exports can contribute to our trade partners' industrial and decarbonisation needs

These four pillars apply equally to the LCLF opportunity for Australia.

Carbon pricing

A carbon price would incentivise investment in LCLFs by creating a 'green premium' for these products. Combustion of conventional fuels (e.g. for aviation, shipping and diesel) creates carbon emissions which, absent a carbon price, imposes negative externalities (costs) on society. These costs are not reflected in the price of these fuels, nor the products and services in which they are inputs (e.g. travel, transportation, delivery of final products to consumers). A carbon price addresses this by ensuring conventional fuels face the costs of the negative externality. With a carbon price green versions of the product (LCLFs) can therefore compete with a 'green premium' in place.

Australia implementing a carbon price also signals strong action on climate change internationally and encourages others to also price carbon. In the case of aviation and shipping fuels, it is important for these sectors, which operate internationally, to be connected to other carbon markets to fully capture the cost of carbon in the aviation sector.

While a carbon price is the optimal policy solution in response to the negative externality of carbon emissions, in its absence, we should aim to match the European mandates for Sustainable Aviation Fuel set out in the ReFuelEU regulation. The regulation sets out a mandate from 2025 until 2050 for minimum SAF fuel requirements in airports across Europe, starting at 2% in 2025, ratcheting up to 70% by 2050. The ReFuelEU regulation has additionally set a mandate of 1.5% synthetic fuel by 2030, and 35% by 2050.

These mandates began much earlier in the European context, meaning Australian targets will need to be adjusted in line with industry development in Australia. Australia now has the benefit of learning from past mistakes and success stories from Europe, and taking these lessons on board for the development of this industry in Australia. We have our own challenges and opportunities, however there are parallels to be drawn around issues of labour costs, global trade policy incentives, processing technology readiness and coordination of long-supply chains.

More information on our recommendations in this area is included in Section 4.

Innovation spillovers

As with green metals, development of an LCLF industry in Australia will require costly and risky innovations which will generate broad benefits. This 'innovation spillover' is a positive externality which should be properly incentivised by government.

Critical infrastructure

Government investment in critical infrastructure will be essential to unlock LCLF opportunities in Australia.

High quality feedstocks (biomass) will often be located outside the existing footprint of electricity transmission networks, necessitating additional investment in this infrastructure to connect the two resources.

Investments in the infrastructure, such as electricity distribution, to underpin the development of LCLF industries cannot be funded by any one commercial entity. The infrastructure required is natural monopoly in nature, and having the infrastructure in place ahead of demand is critical to incentivise the investment in production. There is therefore a role for government in funding and building this infrastructure.

Diplomacy

Finally, government has a diplomatic role in advocating for action to price carbon internationally and to persuade our trade partners of the opportunity presented by LCLF production in Australia. Australian-produced LCLF can be both a secure and sustainable source of fuel as well as a meaningful contributor to decarbonisation for our trade partners.

Together with other green export opportunities, LCLF can underpin prosperity in Australia for decades to come and make a significant contribution to global carbon emissions reduction. Section 2 details how this can be supported within the context of Treasury's National Interest Framework for the FMIA.

2. LCLF and the National Interest Framework

The Treasury's *National Interest Framework* for FMIA provides important guardrails for identifying the appropriate use of public funds based on areas where Australia enjoys comparative advantage and where market failures require government action.

The LCLF opportunity for Australia is relevant for both the 'Net Zero Transformation Stream' and the 'Economic Resilience and Security' streams in the National Interest Framework. There is therefore a role for government in supporting the development of LCLF in Australia to achieve the objectives of both streams.

Net Zero Transformation

The National Interest Framework describes that the Net Zero Transformation Stream will include industries that:

> *…will make a significant contribution to the net zero transition and are expected to have an enduring comparative advantage, and public investment is needed for the sector to make a significant contribution to emissions reduction at an efficient cost.*

LCLF production in Australia meets this definition.

Countries around the world are already investing to build their production capability and purchase available feedstock, with Europe and Singapore setting blend mandates and the US providing generous government subsidies. However, many countries with high decarbonisation ambitions lack the key commodities and resources required to meet their green fuel needs, including:

- Access to land;
- Quality renewable energy and green hydrogen;
- Affordable and sustainable carbon feedstocks (biomass); and
- Refining and export infrastructure.

With strong global interest in green fuels development, Australia has the opportunity to capitalise on its comparative advantages. Our large land area, temperate climates, advanced farming practices and established supply chains give Australia a comparative advantage in the production of biogenic carbon feedstocks, a key ingredient of green transport fuels.

Costs across these long value-chains are dominated (often greater than 50%) by feedstock production. For each replacement fuel type there are feedstock needs which correspond to the types of technologies that are operational to create them. Both CSIRO's Sustainable Aviation Fuel Roadmap report (2023) and the Australian Biomass for Bioenergy Assessment (ABBA) (2022) have outlined resources of biomass for Low Carbon Liquid Fuels. The ABBA assessment demonstrated that 50 million tonnes of woody waste are produced every year across all states and territories in Australia. If converted into Sustainable Aviation Fuel, this could produce 15,000 million litres of SAF and reduce total CO_2e emissions by 38 million tonnes per annum.

Other waste residues include used cooking oils, effluent waste, forestry and agricultural residues and other wastes from the organics sectors. This is a very large resource and waste residues are well recorded and can be managed by the local government for the purposes of LCLF production. Australia's large agricultural industry supports high levels of waste residues that can help support the start of a LCLF industry through existing human resources and infrastructure.

These resources will define the first phase of biomass conversion into LCLFs and Australia is well placed to contribute to pathways relying on waste residues. Australia has a thriving Agricultural sector and some expertise in managing these waste streams for many different uses, for example a 80% recycling rate in the organics sector across the whole of South Australia[1]. Through careful

[1] SA Government (2021) SA organics sector analysis Summary (2021). Adelaide, SA.

management of existing biomass resources and sustainable growth of new biomass, Australia can meet its own needs for LCLFs, with extra to reduce emissions in the international market.

Australia has the highest land mass per capita of any country in the OECD with 770 million hectares of land, of which much has been cleared since European colonisation. Our woodland area per capita is 10 times the OECD average. 55% of this land is farmed, with around 50% for extensive grazing.

Growing plantations on 1% of this extensive grazing land could create 4,625 million litres of SAF per year, 60% of current demand in Australia. The 50 million tonnes of woody waste produced across all states and territories in Australia every year (ABBA, 2022) could produce 15,000 million litres of SAF. This is double the current annual demand for aviation fuel in Australia. This demonstrates the very large opportunity that Australia has to contribute to growing sustainable feedstocks for LCLF production. There is a significant need to invest in technologies that can continue to expand the feedstock flexibility, including woody biomass due to its large potential to scale.

In addition to Australia's comparative advantages in biomass production, as TSI's submission to the green metals consultation describes, Australia also has comparative advantages in renewable energy production and therefore green hydrogen production. These advantages, when combined with biomass comparative advantages, place Australia in a uniquely strong position to produce certain types of LCLF which require large amounts of energy or hydrogen to produce. These are discussed further in section 3.

Economic Resilience and Security

As the consultation paper identified:

> *Domestic production of LCLF's would help mitigate the risks of supply interruptions and help diversify Australia's liquid fuel security.*

Importation of petroleum and other conventional fuels is a source of vulnerability for Australia. We are exposed to international shocks (the Ukraine invasion being a recent example) and reliant on the willingness of our trade partners to deal with us. As fuels are a critical input to much of industry and mobility for society, the costs of shocks are potentially enormous.

The ability to produce fuels domestically, which Australia has in the case of LCLFs, enhances Australia's fuel security and this benefit should be recognised and paid for by government.

Government support for LCLFs, via subsidies described elsewhere in this submission, should reflect the benefits to economic and security in addition to the benefits under the Net Zero Transformation stream.

3. Australia's LCLF opportunities

In this section we describe some examples of fuels that are scalable and important for reducing emissions in the aviation, shipping and broader transport industries. These are:

- E-fuels/Power-to-liquid
- Sustainable Aviation Fuel
- Green Methanol and/or e-methanol

It is particularly important to identify fuels that will reduce emissions in hard-to-tackle sectors such as aviation and shipping. While electrification with battery storage will be the solution for short-haul aviation, road transport and heavy machinery use, these technologies will not provide the solution in aviation and shipping.

The LCLF consultation paper emphasised the projected demand for biomass into the 2030-2050 period. This projection demonstrates a scarcity which requires planning and support. Our view is that biomass production should be allocated to sectors with the greatest need and which otherwise lack options for decarbonisation.

We have included methanol in this submission as it is an excellent cost-effective option for reducing shipping emissions. By capturing the emissions from combustion of biomass, the CO2 can be re-used for chemical and fuel manufacturing. This CO2 is called biogenic CO2. Methanol is formed either by combining hydrogen with biogenic CO2 or syngas or can be formed directly from syngas from biomass gasification.

There are multiple avenues for renewable CO2 sources and production, these include biogenic CO2, Direct Air Capture, Process Emissions and there will be some further use of fossil fuel CO2 for processes that have not been able to replace fossil fuels. A comprehensive framework for biogenic feedstock use needs to anticipate these requirements in the future alongside current opportunities such as sustainable aviation fuel production.

E-fuels/Power-to-liquid fuels

Power-to-liquid fuels are synthesised liquid fuels from hydrogen via electrolysis and CO2 into carbon monoxide from either direct-air capture or biogenic CO2. E-fuels are powered by renewable energy and reduce emissions compared with conventional fuels by 90%, much higher than bio-fuels and comparable to methanol production cycles.

Scaling of hydrogen will rapidly lower the cost of production, and PtL fuels are already compatible with existing infrastructure such as fuel transportation infrastructure and pumps.

Sustainable Aviation Fuel (HEFA and Alcohol-to-jet pathway)

Sustainable Aviation Fuel (SAF) must have the same qualities and characteristics as conventional jet fuel in order to substitute it. This is important to ensure that manufacturers do not have to redesign engines or aircraft, and that fuel suppliers and airports do not have to build new fuel delivery systems, which could be necessary for alternatives such as hydrogen or electrification. At present, the industry is focused on producing SAF as a "drop-in" replacement to conventional jet fuel. Drop-in fuels require no adaptation of engines of associated delivery infrastructure.

Demand and production-side policies and incentives are being developed for rapid scaling of sustainable aviation fuel, such as SAF offsets with Singapore Air. The technology is ready and represents the most cost-effective alternative fuel currently available. Security of feedstocks remains as the greatest barrier to uptake.

Green methanol

Methanol is a commonly used chemical in manufacturing synthetic fibres and plastics, adhesives, pharmaceuticals and agricultural products. It is also a fuel used in shipping with a very low environmental impact, representing a 95% reduction in emissions across the life cycle compared to conventional shipping fuel. The benefits of green methanol over other alternatives are its suitability with existing infrastructure and its low cost of use. Upgrades are required to existing engines, and storage requirements are slightly larger than existing ships.

There are two main pathways to production of green methanol: the biogenic pathway and the Power-to-liquid pathway. Green methanol is produced from syngas (from biomass conversion) or green hydrogen and biogenic CO2.

Around 79% of international shipping is fuelled by Heavy Fuel Oil (HFO) which produces high emissions. Methanol is currently seen as the leading green fuel replacement candidate[2]. In 2018, just under 1 million tonnes of fuel oil for shipping was sold across all Australian ports. With the volumetric energy density of methanol just 40% that of heavy fuel oil, some 2.5 mtpa methanol would be required to replace it entirely.

Of the 100 million tonnes of methanol produced each year across the world, green methanol accounts for about 3 million tonnes per annum. This will grow rapidly with pressure to decarbonise the highly emissions-intensive production. A market of a million tonnes per annum of green methanol in the Australian shipping and fishing

[2] ABEL Energy_Knowledge-Sharing Report_Bell Bay_Jun2022

industries is achievable, which would give methanol production sound foundations for an early start in several locations. Within a few years, addition of export demand would support output of a million tonnes per annum or more in several Australian locations, including Darwin, Port Hedland and Newcastle. Each million tonnes would require a million tonnes per annum of biomass. The hydrogen, bio-oil and zero emissions carbon dioxide ecosystem would support development of industries producing methanol for export, other low carbon liquid fuels and a range of chemical manufactures as well.

4. Production-side policy support

Focusing on feedstock-specific incentives would help support the industry for the two main production pathways currently available for production in 2025; Hydroprocessed-Esters and Fatty Acids (HEFA) pathway and the Alcohol-to-jet pathway. Costs for SAF production are dominated (often greater than 50%) by the feedstock production stage of the value chain.

First-mover incentives are needed in trialling plants that are well-suited to changing climate conditions and drought across 50% of Australia's land mass which is grazed. This "marginal" land has been identified as suitable for a range of non-native and native plant species[3]. Marginal land can grow biomass for low carbon liquid fuels that do not compete with food production, and there is a lower risk for biodiversity loss.

It is important for LCLF producers to have strong policies in place for investment security. Using examples from the European context, we can clearly see where a lack of policy early on in the development of the biofuels industry has led to closures of biofuel plants, slow uptake and feedstock variability.

European-wide targets, national and regional or state support has had huge impacts in areas such as central Spain, and northern Italy in securing feedstocks for biofuel production[4]. Some of these have been successful despite tackling recalcitrant feedstocks such as lignocellulosic biomass in the case of the Beta Renewables Crescentino biofuels plant because of a strong local government support and European-wide biofuel production ambition.

Emission reduction criteria

To meet European standards for exported goods, we would seek to meet the emission reduction criteria of the EU. There should be two options for standards; with the higher

[3] Polglase, P., Reeson, A., Hawkins, C., Paul, K., Siggins, A., Turner, J., Crawford, D., Jovanovic, T., Hobbs, T., Opie, K., Carwardine, J. and Almeida, A. (20 II) Opportunities for carbon forestry in Australia: economic assessment and constraints to implementation. CSIRO, Canberra.

[4] IEA Bioenergy (2018) Crescentino Biorefinery – PROESA™, Italy Technology demo/industrial scale implementation. Bioenergy Success Stories.

option becoming the standalone criteria over time. This is in line with international pressure on carbon credits and the carbon market to incentivise high quality negative emissions due to integrity issues with lower quality carbon credits. We propose this be measured with a Comprehensive Carbon Accounting (CCA) framework which we have submitted to the ACCU method development EOI (see attached).

As a growing trade partner in feedstocks for LCLFs with Australia, meeting European standards for emission reduction and sustainability criteria would be required for any incoming feedstocks or fuels to Europe. Although the international standards for SAF emission reduction are much lower than those for Europe, it will be easier for Australia to meet European standards due to its comparative advantages in large land masses, and areas of land without competition with food crops and its renewable energy resources to reduce emissions across the life cycle.

The greatest differences between quality emission reduction and a standard emission reduction are the impacts at the land stage.. Australia would have an advantage here in its large land mass for growing biomass. Careful consideration of water use and the productivity impacts of a changing climate will be required to ensure long-term feedstock security and ensuring sustainability criteria is met.

Sustainability criteria

We support the sustainability criteria outlined in the CORSIA framework and the EU ReFuel, with particular focus on avoiding direct and indirect Land Use Change (dLUC and iLUC) and avoiding dedicated plantations for biomass production on land that competes directly with food production. The benefit of Australian land, as previously outlined is the large land masses relative to population size. 50% of Australian land mass is grazed meaning that there is a huge potential to plant trees for biomass on land that complements existing land uses (e.g. grazing) as shelter belts and wind breaks. Australia has a comparative advantage in producing feedstocks from dedicated plantations such as agave (which can be converted from ethanol to SAF through the alcohol-to-jet pathway), or Pongamia (HEFA pathway from oil seeds).

It is important that this criteria is outlined explicitly. ISO 14040 series Life Cycle Assessment criteria, which is the ISO standard process for certification under both the ReFuelEU programme and CORSIA, does not account for land-use change.

5. Comprehensive carbon accounting and low-cost measurement

Reducing emissions in the aviation, shipping and broader transport sectors requires comprehensive carbon accounting of emission reduction technologies and pathways.

Fuels from bio-based resources, such as agricultural waste, dedicated biomass plantations and the use of biogenic CO2 in methanol and e-fuels sequester carbon in their growth. This provides us with a renewable fuel, contributing to reducing our reliance on fossil fuel feedstocks and an opportunity to re-sequester that resource once it has been harvested.

The benefits of some types of plants for LCLF production are that they can continue to sequester carbon below-ground or even above-ground when the high value part of the plant is harvested, such as Pongamia oil seeds or coppiced Mallee. By rotating plantations and re-planting on harvested land, there will be consistent carbon sequestration within the total plantation area. These credits sustain the landholders that grow these feedstocks and make the production of biomass plantations an economic opportunity.

At present, there are limited ways for landholders to earn carbon credits for growing dedicated feedstocks for the LCLF industry. In particular, carbon credits are only administered to plantation forestry projects that grow trees, and are modelled and designed around timber plantations, where all biomass is harvested and restricted to set lifecycles. This approach limits the growth of many other types of feedstocks, such as Pongamia (*Milettia pinnata)* for seed production and Agave (*Agave tequilana/A.americana).*

Whether the emission reduction is passed to the end-user or is awarded to the grower of the biomass, there needs to be appropriate pathways to account for this carbon.

The amount of carbon that is sequestered in the growth of the plants needs to be measured by a system which has high integrity and which captures all types of sequestration afforded to the feedstock growth. For example, soil carbon sequestration as well as the above- and below-ground biomass growth. TSI recommends that an accounting framework, grounded in a Carbon Cycle Data Assimilation System could most-effectively support this new industry, and has a very broad application for other carbon farming projects.

It would have the following benefits:

- Carbon accounting of multiple carbon pools and stocks (e.g. soil + above-ground biomass + below-ground biomass)
- Non-woody feedstock approaches
- Improved measurement of carbon stocks to improve integrity of carbon market
- Forecasted with climate change impact to reduce risk of reversal of carbon and biomass

Our recent expression of interest for a method proposal under the Australian Carbon Credit Unit scheme outlines this Comprehensive Carbon Accounting framework in more detail. This EOI submission is attached (Attachment B).

[redacted]

Yours sincerely,

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Unlocking green metals opportunities for a Future Made in Australia

July, 2024

About The Superpower Institute

The Superpower Institute's (TSI's) mission is to help Australia seize the extraordinary economic opportunities of the post-carbon world.

A net zero Australian economy will reduce global emissions by just over 1%. But if Australia successfully seizes the economic advantage in exporting zero emissions goods, this can create a sustained economic boom, improving national prosperity and living standards, and reducing global emissions by around an additional 6-9%.

Renowned economist Ross Garnaut and economic public policy expert Rod Sims have joined forces through The Superpower Institute, to focus on practical research and policy to unlock this boom. The Institute specialises in the policy settings and market incentives needed to make Australia an economic superpower and provides practical knowledge to governments and industry to realise this opportunity.

TSI works across the building blocks of the Superpower Economy including: renewable energy, green hydrogen, land carbon and minerals processing; the potential zero carbon export products including green iron and green aluminium; and the enablers of this economy including economic and fiscal policy, trade policy and regional development.

https://www.superpowerinstitute.com.au/.

Australia's enormous green metals opportunity

The Superpower Institute (TSI) welcomes the opportunity to contribute to the Department of Industry's Green Metals consultation process.

This submission sets out TSI's positions on how to unlock Australia's enormous green metals opportunities. With the right policy settings addressing key market failures Australia could be exporting 10 million tonnes of green iron by 2030. Along with other green metals opportunities, development of these industries can underpin prosperity in Australia for decades to come and make a significant contribution to global carbon emissions reduction.

TSI's answers to the questions posed in the consultation paper are also attached to this submission (Attachment A).

The scale of the opportunity

The scale of this opportunity for Australia is immense, with the potential to secure a long period of high investment, rising productivity, full employment and rising incomes in Australia.

We estimate the annual export value of green iron to be $295 billion, or three times the current value of iron ore exports. Green aluminium exports could be worth an additional $60 billion, compared with the current value of bauxite and alumina exports of $10 billion.

Australia's comparative advantage

Australia possesses two key comparative advantages that position it uniquely to take advantage of green metals opportunities:

1. Abundant low cost renewable energy, in the form of high quality wind and solar resources across an expansive geography
2. Abundant bulk mineral resources as the largest (or one of the largest) producers of iron ore, bauxite, copper and many other rare/critical minerals

While other countries around the world have a combination of these endowments to varying extents, none match Australia.

Executives in the two largest investors in European green iron plants—ArcelorMittal and H2 Green Steel—have both remarked that Europe will not be able to produce most of its own green iron. Instead, Europe must:

> *[m]ake the green iron where the electricity is cheaper and then ship the green iron to where you have the steel plants, where you have the know-how and the existing infrastructure.*

This is true of most of Australia's major trade partners: they do not have enough cheap renewable energy resources to meet their future needs. China, India, and the EU have some quality renewable resources, but the scale of future electricity demand means that those resources will be exhausted and marginal prices will rise. Japan and South Korea confront starker shortages, and already have among the highest renewables prices in the world.

Australia's high-quality renewable energy resources vastly exceed its future domestic needs. This leaves a practically unlimited surplus available for exploitation by export industries. The most efficient way to export cheap renewable energy to the world will be by embedding it in value-added products such as green metals.

Obstacles to the green metals opportunity

In a well-functioning market, profitability is aligned with social return. Market actors allocate capital to activities with the highest private returns, and in doing so maximise social returns and so real economic growth.

In Australia, investments in green metals are currently unprofitable. This is a consequence of profound market failures that are well-characterised in standard economic theory. Failure to address these market failures will result in costly resource misallocations, and greatly diminish the Australian standard of living.

These market failures are of three main types:

1. The non-pricing of CO_2. The lack of a global carbon price is an enormous market distortion. Carbon emissions are a negative externality, imposing large costs on society that emitters currently do not bear. Steel and aluminium production using fossil fuels are responsible for more than 10% of world carbon emissions. The costs imposed on society by these emissions are not borne by producers, nor reflected in the prices of these products to customers. This makes it impossible for green manufacturing processes to compete on a level playing field and to deliver economically efficient and zero carbon supply of metals.
2. Innovation spillovers. Innovators and early-movers pay large capital costs, and take on large risks, to generate knowledge and expertise that largely benefits other players. Investments in this area therefore create positive externalities. The size of the innovation market failure is proportional to the future social return from innovation. Because Australia’s potential future income from green metals is so large, the innovation spillover is very large. It compounds with the

non-pricing of CO_2 market failure to further reduce the return to investments in green metals processing.

3. Common infrastructure spillovers. Regions with the greatest potential for efficient, large-scale green metals production will usually lack adequate transmission, and infrastructure for transporting and storing inputs such as green hydrogen. It is not profitable for a single private entity to provide these at efficient scale, and many of the benefits of increased regional economic activity cannot be captured by a single entity. Common user, or consortia, approaches and/or government support are likely to be necessary.

In addition to these market failures, a fourth potential obstacle is in the decarbonisation strategies adopted by our major trade partners. Steel and aluminium are essential materials for major industries and for economic development. Current "brown" metal producers around the world are exploring options for reliable supply. This includes extremely costly approaches for retaining a domestic industry (e.g. importing ammonia for injection into blast furnaces), and the possibility of imports from our competitors (e.g. Brazilian ores processed in the Middle East).

Australia must position itself as a credible partner. Our investments in supply will shape the expectations, and so the investments and decarbonisation strategies, of our trade partners.

Finally, we must ensure that Australian production satisfies the requirements of partners' green trade schemes, such as the EU's Carbon Border Adjustment Mechanism (CBAM).

Our policy recommendations

This leads to TSI's four pillars for an efficient policy response to the green metals opportunity:

1. pricing the negative externality (CO_2 emissions);
2. subsidising the positive externality (innovation);
3. Government provision of natural monopoly infrastructure; and
4. active international diplomacy to secure green premia

Many of TSI's responses to the consultation paper questions relate to these four pillars. Each of our policy recommendations is important, but the first pillar of carbon pricing (or alternatives to deal with the externality of carbon emissions), the second of innovation support, and the third relating to infrastructure are high priorities to deal with very significant market failures. It is worth briefly describing TSI's approach here.

Carbon pricing

Australia should impose a carbon price on emissions or an equivalent mechanism. TSI advocates for the Carbon Solutions Levy (CSL), to be introduced by no later than 2030. The CSL would apply at all fossil fuel extraction sites in Australia (around 105 sites) and on all fossil fuel imports into Australia.

Fossil fuel firms will remain profitable. By way of comparison, the Middle East's average tax rate on oil producers is 85%, and the Middle East retains an oil industry. What these fossil firms have in common is a return on capital vastly in excess of the market rate—i.e large economic rents. Two centuries of economic theory tells us that rent taxation is the most efficient and least distortionary form of taxation.

That part of the tax that does not fall on rents will flow through to consumers. Proceeds from the CSL would be more than sufficient to compensate or indeed over-compensate consumers through energy bill and fuel excise relief, and to fund the complementary green industry policy initiatives outlined in this section.

Global policies to efficiently price carbon emissions to deal with this negative externality are fundamental to unlocking green metals export opportunities. This will ensure different technologies compete on merit, having regard to the differences in the level of costs imposed on society by their respective carbon emissions (or lack thereof).

In Australia, until a policy such as the CSL is implemented, the government should provide for second-best carbon price surrogates, in the form of subsidies for crucial parts of the green value chain. The Hydrogen Production Tax Incentive of a $2/kg for renewable hydrogen (H2) is well targeted and supported by TSI. It will be of particular benefit to green iron production. A renewable energy subsidy, akin to the soon-to-expire RET, is another essential surrogate. It will be of particular benefit to green aluminium production, which mainly depends on low cost electricity.

Innovation grants/credits

An efficient approach to innovation grants or credits will be market-based: firms choose projects and retain a large stake in project outcomes. Grant criteria should be general and transparent, with grants made available to any serious project that meets the criteria.

Up-front capital contributions have the highest impact. This may take the form of a grant or a tax-based mechanism, with these being financially equivalent with the right design. For a taxed-based mechanism, we suggest immediate expensing of capital expenditure, an uplift on CAPEX for tax deductions, and allowing credits to be cashed out if the taxpayer has no taxed income against which it can be deducted.

For the first few commercial projects in a given technology category, we suggest capital grants of 50% or equivalent tax credits. Grants (or tax credits) thereafter should receive diminishing support on a sliding scale towards zero as the number of projects reaches a certain level. It may be appropriate to impose payment floors and ceilings. In terms of grant size, the design has similarities with the US Industrial Demonstrations Program, a US$20+ billion program that contributes up to 50% of the costs of innovative green industrial projects. Payments are capped at US$500 million, and the minimum size is US$35 million. If implemented through the tax system, the design is closely related to the R and D tax credit currently in operation.

Grants should be applied to the component of the project that requires innovation (where innovation includes bringing a technology to scale in Australia for the first time). For example, in a project with hydrogen electrolysers, a hydrogen direct-reduction-iron (DRI) plant, and renewable energy, the electrolysers and DRI are new to Australia and should attract the incentive. The renewable energy component should not be supported by innovation grants/credits, but it may be supported by renewable energy-specific mechanisms.

Government funded natural monopoly infrastructure

The third market failure to address is in supporting the essential infrastructure that will underpin investment and green metals production. We do not want a lack of ready infrastructure, or excessive costs, holding back development. Government should fund new natural-monopoly infrastructure that is essential for green iron, steel, and other green exports, to ensure low prices and to ensure that infrastructure gaps are not a barrier to private investment. In particular, the government needs to build ahead of demand.

The Government can, of course, recover its costs of infrastructure provision at a government discount rate through a government business enterprise which would be off budget. Further, it will be more economically efficient to have this infrastructure funded by government rather than the private sector where regulatory settings often see returns allowed which impose high costs on users.

An achievable target by 2030

We note that responses in this document mainly relate to the green iron/steel opportunity, with some comments on the simpler case of aluminium. However, similar principles apply to other metals processing which may be covered by the 10 percent production credit for critical minerals.

With the policy recommendations we suggest in place, an ambitious but achievable target for green iron would be 10 million tonnes by 2030.

The remainder of this submission addresses the questions posed in the consultation paper.

Attachment A - TSI's responses to the consultation paper questions

Future markets for green metals[1]

Summary

Over the next approximately 5 years green steel demand will exceed supply. The emerging role of green premia, for example the green premium that can be secured by the EU's CBAM, will be critical to encourage supply.

In the longer term, by 2050, global primary steel demand is expected to grow only slightly.

Australia's comparative advantage is specifically in contributing to green primary steel, in the production of green iron metal from renewable electricity (and biomass). By 2050, green steel must make up the large majority of global steel production—well over a billion tonnes—if countries are to meet their Paris commitments.

Australia's primary competitors in iron ore mining are Brazil currently, and Africa in the future. Nordic countries and Canada are other sources.

The primary competitors in green ironmaking are in the Middle East, which may import Brazilian and African ores and transform them with cheap solar and wind power. Brazil has lesser potential for competitive production.

As a share of global iron ore consumption, total investments in green iron production are small so far. These investments are primarily in hydrogen-based direct-reduction iron (H2-DRI), which are most likely to use high-grade magnetite ore based on current technologies. Analysts expect the high-grade ore premium to continue to grow. Without technology development, Australia's exports of lower-grade ore are guaranteed a sharper decline in both volume and price.

Countries in Europe and Asia will import green iron from whichever country, or set of countries, establish themselves as credible suppliers. So far, Brazil and the Middle East are winning the race. Australia must make equal or larger efforts to address market failures, or it will lose out on both iron ore exports and the larger opportunity to process green iron.

Top priorities include: establishing a low-cost green hydrogen industry, investing in hydrogen storage and transport infrastructure, overcoming technical barriers to iron

[1] This section covers questions 1-5 from the consultation paper

ore upgrading for DRI, and contributing to the development of non-DRI technologies that are compatible with lower grade ores.

1. What insights do you have on green metals markets? For example:

a. Expected current and future demand for green metals domestically and in key export destinations.

Short-term demand for green iron/steel (through to 2030)

In the short-term, green steel demand is expected to exceed supply. The World Economic Forum's Net-Zero Industry Tracker observes that customer demand is the only aspect of steel decarbonisation that is currently on-track to meet 2050 targets.

- Demand for low-carbon steel is increasing rapidly from a low base. Bloomberg NEF (2024) notes that "demand is rising faster than production", a view supported by McKinsey (2023), Berkshire Hathaway's Business Wire (2023), and various other analysts. McKinsey (2023) expects low-carbon steel demand to grow 13-fold, from 15 million tonnes in 2021 to over 200 million tonnes in 2030, and for demand to exceed supply to at least 2030.

- Because green iron is more expensive to produce than carbon-intensive steel, suppliers incur a 'green cost gap', or a 'green premium.' In the short term demand will be sufficiently strong that green iron producers will not only secure the cost-based green premium, but may also secure an additional premium due to scarcity. There will be "tight supply/demand balance over the next decade and substantial profit potential" for those firms that innovate successfully. McKinsey (2023), for example, expects premiums for low and zero-carbon steel of "$200 to $350 per metric ton by 2025 and $300 to $500 per metric ton from 2025 to 2030." These are premiums of 50% or more. Changes to the EU emissions trading scheme, and the EU's Carbon Border Adjustment Mechanism (CBAM), will be an important driver of demand for green iron and steel.

- Iron and steel producers in the EU have historically been protected from the full weight of the EU carbon price, and have received free EU allowances. This will change from 2026. Free allowances for EU producers will be progressively reduced, until they reach zero in 2034.
  At the same time, importers of simple iron and steel products will progressively be exposed to the EU carbon price through the CBAM, with the full EU carbon price applied from 2034. Based on an illustrative forecast price of €100/tonne of CO_2, conventional steel production, which emits 2 tonnes of CO_2 per tonne of

steel, will face cost increases of A$320 per tonne. Based on IEA figures—and on figures from major EU investments—the full weight of the forecast EU carbon price should be enough to make hydrogen DRI competitive.

- Producers of green iron will only be able to cover the cost-based component of the green premium in the longer term if there is a global price on carbon, or if there are other policies that mimic the effects of a carbon price.
  Short-term scarcity reflects early support from first-mover buyers, who are not representative of most commercial buyers and longer-term demand. In the automotive industry, for example, green steel may add as little as $100-200, well under 1%, to final product cost, and is the cheapest way to cut a large share of product emissions. These cars can attract a premium as low-carbon vehicles. The same is true for appliance and equipment manufacturers. .

Long-term demand for green iron/steel (through to 2050)

Global steel demand is expected to grow to 2050, driven by growth in the global population and in per capita steel demand. The IEA projects an increase in steel demand of, at minimum, 33% by 2050, and other sources (e.g. BCG) expect a nearly 50% increase to 2.8 billion tonnes.

Demand for primary steel—of most consequence for Australia—is expected to grow only slightly. While there is some uncertainty about scrap availability, the IEA, IEEFA, CSIRO, and many others expect that the share of scrap recycling in steel production will rise from 32% today to around 45% in 2050. The combination of increased demand with increased recycling implies an increase in primary steel demand on the order of 5-15%.

Our comparative advantage is specifically in green primary steel, in the production of green iron metal from renewable electricity (and biomass). Looking to the long-term, by 2050, green steel must make up the large majority of global steel production—well over a billion tonnes—if countries are to meet their Paris commitments. For Australia, demand in Northeast Asia, and rapidly developing Southeast Asia and India, will be of the greatest significance. The EU will be an important target market in the 2020s, although less significant in the long-run.

It is fundamental to note that none of these markets can get to net zero without importing green metals.

1.b Australia’s potential production volumes of green metals.

Long-term potential production volume

Around 37 percent of the world’s primary steel, around 500 million tonnes, is made with Australian iron ore.

While there are many barriers that need to be overcome, at the limit all exported ore could be converted into green iron metal (and potentially some into steel) before shipping. The potential is therefore around 500 million tonnes. How close Australia gets to this maximum depends on the competitiveness of its production and, most important, Australian policy settings..

Studies find that green iron and steel producers' competitiveness is overwhelmingly sensitive to electricity costs. The cost of capital is a distant second (and Australia is also well placed in this), and labour costs are insignificant as a fraction of costs per tonne.

The Government's Green Metals paper observes correctly that Australian renewable electricity costs will be the lowest among advanced economies. However, TSI strongly disagrees that Chinese and Indian costs will be lower than Australia's in the future. This is a simple consequence of available supply versus future energy demand. Demand for electricity in China and India will continue to grow with development, and will be greatly increased by electrification. Together, these cause electricity demand to outstrip the low-cost supply of clean electricity. China and India will ride up the clean energy supply cost curve as they exhaust their best resources.

Australia faces no such constraint—solar and wind resources are in great excess to any possible need, and its supply cost curve is effectively flat. By importing Australian green iron and other energy-intensive products, these countries import our abundant cheap energy.

Whether or not Australia grasps this opportunity depends on whether it successfully implements the four pillars of good policy set out in the Introduction, as well as sound macroeconomic conditions to allow for low cost access to equipment and capital.

Short-term potential production volume

Production within the next five years will remain modest. Demand does not appear to be the limiting factor; if McKinsey estimates are correct, then there may be demand for up to 200 million tonnes of low and zero-carbon steel by 2030, close to 10% of total steel demand. On current global investments, this will be undersupplied, hence McKinsey's expected increase in green premiums.

Australian production is limited by the availability of:

- low-cost green hydrogen, and for some potential producers of green iron, infrastructure to transport and store hydrogen.
- high grade ores, or cost-effectively upgraded hematite/magnetite, for DRI processes; and

- non-DRI technologies that can handle lower grade ores, such as high and low temperature forms of electrolysis.

These are key problems to solve, or at least to lead on, by 2030. In the interim, Australia has significant availability of magnetite in the period to 2030. Australia's capacity to process larger quantities later will depend on its ability to lower access technologies to process lower grade ores.

TSI recommends that Australia should aim to process 10 million tonnes of green iron by 2030. This is an ambitious but achievable goal.

1.c Which countries/markets are green metals currently being sourced from and used in?

There is relatively small-scale production and consumption of primary green steel in Europe, Northeast Asia, and the US.

Major billion-dollar investments have been made in Sweden, Germany, the US, and Brazil.

- As of June 2024, H2 Green Steel in Sweden had raised around A$10.5 billion in funding for its first plant. This is the second-largest hydrogen project in the world, and will produce 2.5 million tonnes of DRI each year. Half of this production has already been sold in 5-7 year binding contracts on the steel offtake market. Production is expected to increase to 5 million tonnes by 2030. Typical contracts are reportedly at a 20-30% premium to conventional steel, with premiums rising over the past year.
    - Purchasers reportedly include Adient, BE Group, Bilstein Group, BMW, Electrolux, Ingka/IKEA, Kingspan, Kirchhoff, Klockner & Co, Lindab, Marcegaglia, Mercedes-Benz, Miele, Mubea, Porsche, Purmo Group, Roba Metals, Scania, Schaeffler, Volvo, Zekelman Industries and ZF Group.
    - Investments are supported by a loan guarantee of A$1.9 billion from the Swedish National Debt Office.
- ArcelorMittal is building H2-compatible DRI plants in several European countries, receiving around A$5.6 billion in grants and subsidies. These include:
    - DRI in Hamburg. A$176 million, with 50% funded by the German Government. Capacity of 100,000 tonnes of DRI annually. Fed initially by "grey" hydrogen from steel plant waste gases, and to be fed by green hydrogen as more production comes online.
    - DRI in Bremen. Including one electric arc furnace (EAF) in Bremen, and two more EAFs in Eisenhüttenstadt. Use of green hydrogen will "steadily

increase", though is expected to be low at the start. The project is supported by a A$2.1 billion grant from the German state, and production is expected to be up to 3.8 million tonnes of green steel.

  - DRI in Gijón, Spain. A$720 million in state funding, and production of 2.3 million tonnes of DRI annually. Production will initially use natural gas, and switch to hydrogen as costs decline.
  - DRI in Ghent, Belgium. A$1.75 billion project, 2.5 million tonnes of DRI annually. Production will initially use natural gas, and switch to hydrogen as costs decline.

- In Brazil, CSN Mineração, the second-largest ore producer, is investing A$2.15 billion in a project that will produce DRI-grade ore (67% Fe) to sell to the EU market once the CBAM operates in 2026.
- In the US, the IRA has so far directed at least US$1.5 billion towards six green iron/steel projects. The following firms are at least at the award negotiation stage:
  - Cleveland-Cliffs' proposed H2-DRI plant with a 2.5 million tonne per year capacity (up to US$500 million in support).
  - SSAB Americas' proposed H2-DRI plant with HYBRIT technology (up to US$500 million in support).
  - Vale's iron ore preparation project (up to US$282 million in support).
  - Three smaller induction melting/conversion projects (up to US$75 million each).

1.d Which other countries/regions will supply / demand green iron/steel?

Demand: Europe, Northeast Asia, and South and Southeast Asia

Demand for Australian green iron/steel will be driven by countries with large manufacturing and construction sectors. Many of these countries and regions currently produce carbon-intensive steel as inputs to these industries.

In the nearer term demand will come from the EU, especially as the CBAM takes effect. Taken as a whole, the EU is the second-largest steelmaker in the world, producing 150 million tonnes in 2021.

Japan and South Korea will follow and together produced around 165 million tonnes in 2021. For Australia they will be particularly significant, given their proximity and existing trade relationships with Australia, and especially because of their severely constrained options for cheap renewable electricity.

In the longer-term, Southeast Asia, India and China will become major sources of demand. Chinese demand is, of course, exceptionally large; it produces more than half the world's steel. India is rapidly growing. Both India and China will, with development and electrification, confront clean electricity demand that outstrips available cheap renewable resources. Demand for steel is growing in Southeast Asia, which has poor quality wind resources and solar resources about on par with Melbourne (due to the monsoon climate). They too will have uncompetitive electricity prices for manufacturing green iron.

Supply: High-grade ores

High-grade ores are easier to process, and the leading technology for zero-carbon iron – hydrogen-based direct reduction – uses iron ore with an iron content above 67%.

Competing suppliers of green iron/steel include countries with abundant high-grade ore, and those with abundant renewable energy supplies. Political stability, and risk premia on investments, will also be an important factor.

The current trade in iron ore reflects investments in carbon-intensive processing, which uses lower-grade iron ore. Global iron ore consumption is about 2.1 to 2.2 billion tonnes, and the seaborne trade accounts for the large majority of this at around 1.6 billion tonnes. Only 3% of the seaborne iron ore trade is of direct-reduction (DR) grade, or >67% iron. The following countries have high grade iron ore in production or reserves.

The first is Sweden, which we can largely set aside as a minor, within-Europe competitor. It holds 60% of Europe's iron ore resources, although the total resource is small. Sweden's main mine, Kiruna, produces magnetite at a grade of around 44% (high for magnetite), which is upgraded to over 65%. In total, Sweden produced around 38 million tonnes of iron ore in 2023. Given the low initial ore grade, this is enough to feed into around 15 million tonnes of steel—or only 10% of Europe's steel production in 2021 and a little over 1% of global production.

Brazil is the second largest iron ore exporter in the world and produced around 380 million tonnes in 2023, mainly from the Pará and Minas Gerais regions. It has the second largest reserves, roughly 60% of the size of those in Australia. It mainly exports hematite, with an average grade of over 62%, but this grade is increasing and Brazil's mines have significant capacity to produce ores of over 65% grade. Brazilian firms are investing in delivering DR-grade ore products to DRI steelmakers:

- CSN Mineração is investing more than $1 billion to expand production of DR-grade ore to take advantage of the EU CBAM in 2026;

- Vale is working with the DRI-producing French firm Gravity to produce direct reduction briquettes from its high grade ore; and
- Samarco is extending a deal to supply DRI to Nucor's EAF plant in Charlotte, North Carolina.

Africa's ore reserves are relatively poorly explored. Countries with proven or likely reserves, and active or potential investment, include Cameroon, the Republic of the Congo, Gabon, Guinea, Sierra Leone, Liberia, Mauritiana, Morocco, and South Africa. These projects are generally high risk; the corruption that has slowed realisation of the Simandou mine by more than a decade is an obvious example. Guinea is worth the most attention, with the Simandou mine likely to deliver around 60 million tonnes of iron ore annually by 2028, much of it of grade >65%. This will comprise about 3% of global iron ore supply, a small volume, but its impact on the emerging DRI market would be large.

Supply: Electricity for DRI

Brazil will have the capacity to turn some of its iron ore into iron metal, but unlike Australia its capacity for green processing is limited. This is because Brazil has less renewable energy potential than Australia.

Brazil's population is eight times larger. Its electricity use is two and a half times Australia's, and it will grow with rising incomes. And while Brazil's grid is dominated by hydroelectricity, the resource is limited and its consumption of fossil fuels has increased in recent decades. Continued economic development will combine with electrification to increase Brazil's electricity demand at least threefold, far exceeding its hydroelectric potential. It has generally poor-quality wind, and some limited excellent solar resources to satisfy this demand. These constraints are reflected in Brazilian firms' early focus on exporting DR-grade ores and ore products.

The Middle East is Australia's most important competitor in cheap energy availability. China, Japan, and South Korea are exploring plans to process Brazilian ores in the Middle East, with Vale planning to co-invest in iron production facilities in Saudi Arabia, the UAE, and Oman. The potential is limited by the scale of Brazilian ore reserves, and the world's willingness to concentrate steel production in the Middle East. So far the Middle East focus (Saudi and the Emirates) is on brown iron (gas-powered DRI), but there is potential for renewables-based H2 to replace it.

3. Verification of green metal emissions reductions

For Australian green iron and steel to benefit from the EU carbon border adjustment mechanism (CBAM) and future CBAMs in other markets, the carbon content of Australian green iron and steel exports will need to be measured and documented with a system recognised by the EU and other governments.

The Australian government is developing a Guarantee of Origin (GO) scheme for green hydrogen and renewable energy. A goal is to align these GO schemes with international requirements.

The most recent Federal Budget allocated $11.4 million dollars over 4 years to fast-track the first phase of the GO scheme and to expand it to green iron, steel, and aluminium.

The Superpower Institute supports these measures and recommends that the government commits to a GO scheme for iron and steel that is formally recognised by the EU by 2030.

Factors influencing investment decisions in Australia and globally[2]

Summary

The scale of investment required to unlock green metals export opportunities is immense.

For green iron alone, we estimate around A$4 billion per million tonnes of green output is required. There is likely to be progress in the technologies between now and 2050 which would bring this cost down, perhaps by half.

Nevertheless, the total capital costs for green iron are likely to be in the order of A$1-1.5 trillion. Capital investments made before and during the mining boom show that this is achievable.

We advocate for early mover innovation grants targeting the $1450 per tonne required for electrolysers and DRI plant. Subsidies towards this could be in the order of $2-3 billion depending on how the subsidy declines.

6. Scale of investment

The required scale of investment is immense. The largest investment is in the renewables needed to power green hydrogen and green iron production. For a solar-powered H2-DRI plant, a rough breakdown:

- DRI plants come in at around A$450 per tonne of annual capacity.
- PEM hydrogen electrolysers cost around $1500-2500 per kW, and taking the middle value this is around A$1000 per tonne of capacity.

[2] Questions 6-7 from the consultation paper

- Renewable electricity purchased from the grid would not attract government support, and may be paid for as OPEX. However, if constructing solar with the plant, this would add around A$2500 per tonne of capacity.
- Hydrogen storage costs are relatively low per tonne of capacity.

These investments alone would require around A$4 billion per million tonnes of green iron output.

The price of electrolyser and renewables technologies will fall substantially , likely halving or more from here to 2050. Full conversion of Australia's iron ore to green iron over this period, with expected learning, would require capital investment of A$1-1.5 trillion in today's dollars. The scale of investment that will be required is substantial, but is achievable when considering the magnitude of the private investments in Australia's mining industry between 2002 and 2015.

Scale of subsidies

Early-mover innovation grants would target the A$1450 per tonne required for the electrolysers and DRI plant—or A$1.45 billion for a 1 million tonne plant. Grants of 50%, or equivalent tax credits, would be around A$725 million. Grants are only required to achieve initial learning and scale advantages, and should be limited to the first 2-3 projects in each technology domain. This suggests investment funding of nearly A$7.5 billion, across a small number of early projects, and potentially a further A$2-3 billion of subsidies depending on the rate of subsidy decline.

Like green iron and steel, Australia will have a comparative advantage in processing green alumina and aluminium, and this sector is also held back by the lack of a global carbon price.

Green aluminium projects will mainly face operational costs, so efficient government support for renewable energy projects will be crucial.

Innovation will not be required on the scale of green iron processing, although there may be some innovation in aluminium plant designs – for example, plants with increased power consumption flexibility, allowing them to take advantage of lower prices when renewable energy production exceeds grid demand. Whether such innovations warrant government support will depend on the particular innovations in question, whether they generate knowledge spillovers that proponents are willing to share conditional on government support.

For this reason, there may be a case for the first few green aluminium projects to receive government support beyond the standard R&D tax incentive, despite lower levels of innovation.

Even with an EU CBAM and an Australian policy to properly price carbon, such as the CSL, there are persistent distortions in international aluminium markets where carbon isn't priced. In the longer term, as more countries adopt EU-style carbon prices, and as countries move closer to their net-zero deadlines, Australia will be able to capitalise on its comparative advantage to produce green aluminium at scale.

Renewable sources of energy do not qualify for early-mover innovation funding, but in the absence of a carbon price the Australian government will need to use surrogate policies to create a sufficiently strong incentive to generate renewable electricity.

Principles for community benefit sharing and how this might apply to the green metals industry[3]

Summary

Community benefits from a green metals export industry are extremely large. For green iron alone, annual revenue from exporting green iron is estimated at up to $295 billion which is a little over three times current export revenue from iron ore. Revenue for green bauxite/aluminium could reach $60 billion, an increase of around $50 billion over current exports.

Importantly, direct and indirect employment benefits would be concentrated in provincial and rural Australia, and primarily in declining fossil energy regions.

8. Community benefits

There are two key community benefits from green metals industries.
The first is that export revenues will support a stronger budget, which benefits all Australians.

If Australia processes green iron on the same scale as current iron ore exports, it could produce around 560 million tonnes of DRI each year.
Based on conventional pricing for DRI that uses natural gas – about $530/tonne – annual revenue from exporting iron metal would come to **$295 billion**, or a little over three times typical export revenue from iron ore. While this estimate is based on the

[3] Questions 8-11 from the consultation paper

highest end of estimated exports, revenues per tonne could also be higher if green DRI continues to attract a premium

If Australia processed green alumina and aluminium on a scale that replaces current bauxite/alumina exports, this would result in production of around 17.25 million tonnes. At a typical aluminium price of $3500/tonne, expected revenue could leave $60 billion. This is a revenue increase of around $50 billion over bauxite/alumina exports.

The second key community benefit from green metals industries is employment. Direct employment would be concentrated in provincial and rural Australia, and primarily in regions that will have declining employment in fossil energy industries. These jobs would be the principal benefit to Australian communities.

9. How are you considering these benefits in evaluating projects? Are there ways to increase opportunities for the local community or broader industry?

N/A

10. How can the government support industry to enable communities and workers to share in the benefits of transitioning to green metals?

N/A

How quickly it is feasible to achieve different 'green milestones' as we move towards zero emissions production[4]

12. Key barriers to green iron investments

The key barriers to green iron processing are the three main externalities discussed in the introduction: innovation spillovers, infrastructure spillovers, and the absence of a carbon price. These externalities manifest in a number of ways, including low technology readiness, first-of-a-kind risk, limited skill availability, and limited supply chain development.

Domestic policy uncertainty is an ongoing obstacle to investment, which would be partly resolved by a commitment to upfront capital subsidies. Government support should also be coordinated across green hydrogen and green metal industries,

[4] Questions 12-16 from the consultation paper

because unavailability of green hydrogen will otherwise be a key barrier to the development of green iron.

Uncertainty about the balance of international supply and demand, and about the timing and magnitude of international action on carbon pricing, is also a barrier.

Demand is expected to be robust to at least 2030, delivering a sizable green premium. But, as noted earlier, as supply grows, the segment of the market that will voluntarily pay a green premium will be saturated; thereafter, the premium depends on carbon pricing and equivalent schemes.

This is why, in addition to addressing market failures, the fourth pillar of our proposed policy response is diplomacy. The government should use diplomacy to increase coordination with key trading partners, including the near-term markets of the EU, Japan, and South Korea, and longer-term markets including China, India, and Southeast Asia.

13. To what extent are barriers composed of upfront capital costs or ongoing operational costs?

In the case of green metals, two market failures affect both CAPEX and OPEX: first, the externalities generated by carbon emissions; and second, the knowledge and scale spillovers generated by innovators and early-movers. This is the justification for government intervention.

Capital grants address both CAPEX and OPEX challenges. Reductions in capital cost reduce the required return for investors. This allows better absorption of both capital and operational risks. Capital grants encourage production efficiency, and have clear budgetary implications for governments. Capital grants are the most valuable form of support for investors per dollar spent.

Production and OPEX subsidies risk reducing the incentive to innovate in operational efficiency, which reduces industry competitiveness. They also present budgetary risks, especially where support is long-running and uncapped. Finally, ongoing support raises politico-economic (and so budgetary) risks: industries that become dependent on OPEX and production subsidies may have incentives to threaten to exit if those subsidies are not extended. This risk is mitigated by one-time, upfront support for several producers.

Given modest green iron/steel price premia (20-30%), we expect grants of 50% to be sufficient to attract investment. Grants will need to be supplemented by investments in electricity transmission, and in hydrogen storage and transport infrastructure, to be used at green metals production hubs.

Other proposed policy mechanisms act as surrogate carbon prices and ease operational costs. The Government's production subsidies for hydrogen, and any extended support for renewables, will lower prices for green iron producers.

Finally, all green metals projects will benefit from a price on carbon. At least for the EU market, that price will come from the CBAM from 2026. It will be crucial to ensure that Australian green metal products are compliant and can benefit from the CBAM. This will require a mechanism to replace the Renewable Energy Target, which currently guarantees clean energy additionality.

Our preferred policy is the Carbon Solution Levy, described in the introduction to our submission.

14. What options are there at each intermediary step to reduce emissions for metal products?

Intermediate steps that produce piecemeal emissions reductions at conventional plants are a poor investment. They will not produce large and lasting economic spillovers, because the technologies involved have little future. Nor are they typically large innovations.

Natural gas DRI, for example, is not an appropriate target for innovation funding.

- It is not a frontier technology, but a well-established technology producing around 10 percent of primary steel globally. Nor will they provide the same scale spillovers to firms who are later entrants to the green-metal market. Australia has no meaningful comparative advantage in natural gas prices—none at all in eastern Australia, where gas prices exceed those internationally, and little if any advantage in Western Australia. WA's gas reservation has kept prices lower, but they have nonetheless doubled in the last few years. WA will in any case be outcompeted by the Middle Eastern states that have much lower gas prices, and already dominate natural gas DRI today.
- Finally, natural gas DRI reduces emissions by only 40%. This is not consistent with the necessary scale and pace of global reductions in carbon emissions. It is also inconsistent with increasing pressure and demand for near-zero emissions steel through the 2030s.

With green metal demand already growing faster than production, and deadlines for net-zero commitments looming, the transition will occur rapidly. In advanced economies, it will occur mainly as a switch from conventional steel to nearly zero-carbon steel. Some developing countries, mainly China and India, have stronger economic reasons to focus on modest efficiency improvements: they have a large fleet of relatively new conventional steel-making assets. They may also adopt approaches that would be uneconomic for new build plants—e.g. CCS—because of the sunk costs of the existing fleet.

In Australia, subsidies should focus on genuinely innovative technologies that
(a) exploit Australia's long-term advantage in renewable energy prices, and
(b) reduce emissions to near zero, defined as least 80% or 90%.

If a project combines natural gas DRI, or another conventional technology, with an innovative technology that has large benefits for Australia—e.g. a novel method of hematite processing—then only the component of the project that is innovative, producing large long-term spillovers, should receive support.

15. What are the technologies associated with meeting green thresholds?

The following technologies are of potential relevance to Australia:

First, those that require high-grade iron ore, and must be combined with advances in magnetite and hematite upgrading. This mainly includes standard hydrogen-DRI-EAF plants.

Second, technologies that are compatible with lower-grade ores:

- H2-DRI-SMELT-BOF — Hydrogen DRI with the addition of a melting step that allows the use of low-grade ores and makes production compatible with a conventional basic oxygen furnace.
- AEL-EAF / MOE — Alkaline electrolysis and molten oxide electrolysis.
- Low temperature electrowinning (e.g. see Australian firm Element Zero and US firm Electra).
- Fluidised bed reactors — Hydrogen DRI that is suited to lower grade iron fines (e.g. see Cicored, HYFOR, and Posco HyREX)
- Other biomass-plus approaches, including Rio Tinto's BioIron project south of Perth which combines biomass with microwaves, and HIsmelt. We note that biomass-based technology has limited potential at a larger scale, and is therefore less relevant.

The latter technologies are generally at a lower state of readiness, but apart from biomass-based approaches, may dominate if they cost-effectively solve the ore grade problem.

16. Are these technologies being developed or commercialised?

Green metals technologies are being developed, but too slowly given the three very large externalities: innovation spillovers, infrastructure spillovers, and unpriced carbon emissions. Addressing these market failures is the most efficient way to accelerate research and encourage commercialisation at scale.

Existing grant processes are often perceived as onerous. Simpler funding mechanisms, for appropriate technologies, would help speed technology development, but must not compromise vital consultation with First Nations communities, or other environmental protections.

What external constraints may be limiting the production of green metals[5]

17. What factors would enable the acceleration of metals decarbonisation? For producers, what levels of production would be feasible over time?

Addressing major externalities is the best way to improve the market for green metals. As discussed in the response to Q.13, capital investment will follow where there is an attractive return. The return to capital is reduced, inefficiently, in the presence of externalities.

Capital grants for early-mover projects substantially reduce the required total returns, allowing projects to go ahead. Alternatively, production may be subsidised, but such subsidies are of lower value per dollar, risk encouraging inefficiency, and present greater budgetary risks.

The feasible level of production is also constrained by demand. This constraint depends on the timeframe.

- A variety of market analysts expect green iron to be scarce and command a premium up to at least 2030, as discussed in the response to Q.1.
- Looking to the 2030s, the key question is whether Australia's trade partners have been persuaded
  (a) that their own domestic green metals production will be uncompetitive and

[5] Questions 17-21 from the consultation paper

will stretch their limited cheap energy resources, and
(b) that Australia is ready to be a reliable partner in the supply of essential green materials.

This is Australia's diplomatic challenge today. Large Australian investments in green metal industries will signal Australia's commitment and will be the most important tool of persuasion for its trade partners. This is most important for Japan and South Korea, which today express concern about how to decarbonise steelmaking given their high energy costs and high dependence on imported energy. Australian leadership, and the realisation of early contracts for competitively priced green iron, will strongly favour the Australia solution.

While short term political developments in the US and elsewhere may provide temporary setbacks, we regard the medium- and long-term risk that international decarbonisation efforts stall, blocking growth in the green metals market, to be small. Much more likely is mounting pressure for decarbonisation as countries approach the deadline for their Paris commitments, as policies such as the CBAM begin to reshape trade, and as the world continues to see increases in climate change-induced damage.

18. What are the best examples of a 'green premium' being established for low emissions products? What actions could improve demand for these products?

The EU ETS and CBAM is the most obvious and best example of green premia being built into international trade.

Green premia paid by automotive, appliance, and equipment manufacturers are also important, and reflect firm sensitivity to consumer preferences as well as explicit regulations that require minimum green content. However, premia based on consumer preferences and voluntary schemes are not a substitute for premia based on the social cost of carbon. Their effects are marginal and uncertain, and cannot drive the scale of metal decarbonisation that is required.

19. What are the key production volumes, cost profiles and price assumptions that would support minimum commercial viability for green metals production?

The Superpower Institute believes that the minimum production scale for commercially viable green iron or steel is about 0.5 million tonnes per annum, but there are economies of scale advantages for production up to 2.5 million tonnes per annum if electricity, hydrogen and other infrastructure is available to support current DRI technologies.

This proposed scale is consistent with international first-mover projects, which provide an indication of the production volumes that are expected to achieve commercial viability in the emerging green iron and steel sector.

As noted in Q1c, major billion-dollar investments have been made in Sweden, Germany, the US, and Brazil, with government support and expected annual production of:

- H2 Green steel in Sweden: funding of A$10.5 billion; expected production of 2.5 million tonnes per annum.
- ArcelorMittal H2-compatible DRI plants:
    - Hamburg: A$88 million grant; expected production of 100,000 tonnes per annum.
    - Bremen: A$2.1 billion grant; expected production up to 3.8 million tonnes per annum.
    - Spain: A$720 million grant; expected production of 2.3 million tonnes per annum.
    - Belgium: A$1.75 billion project, 2.5 million tonnes of DRI annually.
- In the US, Cleveland-Cliffs: up to US$500 million; 2.5 million tonne per year capacity.

20. How would adopting renewable energy and green hydrogen impact on your current costs and the commercial viability of your operations, if you were able to implement them right now? How does this compare to interim or transition fuels?

Production via “transition fuels”, notably natural gas, is more affordable than green technologies today because it is an established technology and because gas does not incur the cost of carbon. It has been adopted at scale in the Middle East because very low natural gas prices make it competitive there.

Crucially, the non-adoption of natural gas DRI in Australia is not sufficient to indicate the presence of an innovation market failure. As discussed in the introduction to this document, innovation market failures assume grand proportions where a technology is non-commercial but, once developed, can make a large and lasting contribution to national prosperity. Both criteria are met for green iron projects. Neither are met for natural gas DRI.

Some Australian firms will naturally prefer to receive large grants to pursue technologies that are already commercial, and that do not carry the same positive externalities. Limited funds should not be directed to projects that will add to national emissions, that have very limited future potential, and that do not help Australia to realise its comparative advantages in the emerging green metals trade.

21. What are your estimates of the cost-gap differences between producing green metals and traditional metals, across your planned decarbonisation pathway (per tonne)?

For steel, estimated green premia for H2-DRI-EAF range from US$100-300, or around 10 percent to 50 percent. These estimates depend on the steel price (typically US$600-900 per tonne), plant configuration, and energy costs. The IEA estimates the green steel premium to be in the middle of this range, at around 25%. The lower end of this range is relevant for Australia, for projects where electricity is sourced from the cheapest renewables.

A carbon price at the expected CBAM level of €100 or A$160 from 2026 is sufficient to provide a premium in the European market of around 25%, based on middle-range prices of US$750/tonne or A$1125/tonne for conventional steel.

a. How do you expect this to change over the next 20 years? Please include what data or assumptions you have factored into your calculations.

The cost-gap will close and green technologies will approach parity as costs come down for green producers, and as costs increase for producers of carbon-intensive metals. Standard economic analysis tells us that the social cost of carbon in an efficient system will rise at the real cost of capital (i.e. it will rise over time).

Costs for green metal producers will fall due to:

- Increased scale of all associated technologies—hydrogen electrolysis, green iron manufacturing methods, and management of different ore grades—taking them down the learning curve. Reductions in cost are mainly a function of scale, rather than time; costs will not come down if countries and firms do not make a start.
- Continued reductions in renewable energy costs, the most significant contributor to costs for all green iron production methods.

Cost for carbon-intensive producers will increase due to:

- Higher carbon prices – or stronger surrogate policies to reduce the carbon intensity of production – in countries with these policies already in place.
- Broader international application of carbon prices, via increasing scope of the EU CBAM and the expected introduction of other CBAMs.
- Increasing maintenance costs for existing plants, and large capital investments in new plants.

b. How do the cost gaps differ if you are able to use recycled metals as inputs?

Australia should recycle metals where it makes economic sense. For example, there is potentially scope to increase the use of recycled steel in electric arc furnaces powered by renewable energy. But the potential benefits of recycling metals with Australian green processing is expected to be small compared to the total value of exporting green metals.

How existing policies are shaping decarbonisation strategies and investment decisions[6]

22. To what extent has government support influenced investment thinking in Australia in respect to projects targeting decarbonisation?

The largest barrier to decarbonisation in Australia is extreme uncertainty about policy – both the nature of support for renewable electricity and green exports, and concerns that policies will change with political cycles. Policy uncertainty makes it particularly risky to invest in decarbonisation when there are interdependencies between green industries. For example, the green iron industry will depend on a green hydrogen industry – which in turn requires the green iron industry as a buyer. Both industries require substantial investments in green electricity.

For this reason, early developments are concentrated in Europe, where carbon pricing and innovation supports are clearer and have stronger bipartisan support—despite Europe's comparative disadvantage.

[6] Question 22 from the consultation paper

a. What impact will the government's industry investment measures, such as the National Reconstruction Fund and Future Made in Australia Innovation Fund, have on your transition?

This depends on how these policies operate. Australia needs general rules that compensate systematically for externalities for anyone who wants to invest, separate from discretionary official decisions of unknown outcomes and uncertain timing. The Government's measures, and the Treasury's National Interest Framework, are promising.

b. What impact will the government's recently announced renewable hydrogen measures have on your transition?

Support for green hydrogen is essential to the development of a green iron/steel industry, and we view government support for green hydrogen as helpful and necessary for green metal industries. The Superpower Institute strongly supports the subsidy for green hydrogen as a surrogate for a price on carbon, and the fact that support for hydrogen is available for any firms that meet the government's criteria.

c. What impact do the government's policies to incentivise renewable electricity generation, storage and transmission have on your transition?

Extreme uncertainty in the electricity sector is a major problem. The Capacity Investment Scheme will not be enough to decarbonise existing industry, especially as further support will disappear with the end of the RET. A carbon price is needed from the time the RET ends in 2030, to provide confidence in market direction and policy certainty.

The types and design of supply side options that should be considered[7]

23. What approach and features do you consider to be most effective? For example:

a. Which incentive would lead to the biggest increase in private investment in green metals production across production, investment, and innovation-linked incentives?

We refer to the proposed policies and incentives described in the introduction to our submission, which are designed to address the major market failures affecting green metals investment:

- taxing the negative externality (CO_2 emissions) [or subsidies in the meantime]
- subsidising the positive externality (innovation);

[7] Questions 23-30 from the consultation paper

- Government provision of natural monopoly infrastructure (electricity transmission and hydrogen transport and storage); and
- active international diplomacy to secure green premia.

b. What are the merits of receiving incentives through the tax system relative to grant based funding?

Tax-based and grant-based mechanisms can be financially equivalent depending on design, so long as tax incentives are made available for firms that do not have other income against which to deduct credits. R&D-type incentives are a good model, with the scale increased to reflect the magnitude and urgency of the innovation market failures in the case of green metals.

There is great advantage in certainty and timeliness—the availability of the incentive to anyone who meets known conditions.

c. Would a 'contracts for difference' scheme or other program designs be preferred?

This would not be preferred if allocated through an auction process, as firms must invest heavily before they know whether the support will be available.

d. What length and timing of support is required for long-term viability?

The impact on investment is greatest if tax credits are paid upfront, and the scheme wrapped up at a known date. .

e. Are there any additional features or design principles that would enhance the efficacy of support to produce green metals?

We describe our recommended policy-design principles in the introductory submission. We emphasise the special importance of:

- taxing the negative externality (CO_2 emissions) [or subsidies in the meantime]
- subsidising the positive externality (innovation);
- Government provision of natural monopoly infrastructure (electricity transmission and hydrogen transport and storage); and
- active international diplomacy to secure green premia.

24. Are there parts of the value-chain that require particular support (for example, energy inputs, green alumina or iron inputs, or green aluminium or steel production)?

Yes. Renewable electricity and green hydrogen inputs require investments in natural monopoly transmission infrastructure. Green iron depends on the four pillars of good policy we discuss in our attachment to this submission. Green aluminium will depend mainly on carbon pricing, given it mainly requires green electricity. However, innovations in plant design, e.g. flexibility of operation to better take advantage of fluctuations in electricity supply, may also be significant.

a. Should support be prioritised towards certain parts of the value chain in the first instance?

Innovations and early-mover projects across all aspects of the green iron value chain, from hematite/magnetite upgrading, to hydrogen production, and the various modes of green iron production, require support.

25. Where support is provided across a value chain, such as intermediate metal outputs, what design features are necessary to ensure support is effective for producers with different levels of vertical integration?

N/A

26. What eligibility thresholds would be appropriate to access production incentives?

Emissions reduction thresholds are most relevant. Otherwise, so long as projects are developed by serious firms, they will all add to forms of learning that are valued by other firms.

a. A minimum amount of green production output (for example, tonne of metal).

So long as firms retain a significant stake in project returns, we can expect firms to favour projects that are appropriately sized for the level of technology development. Major international H2-DRI projects are around 2.5 million tonnes capacity. Innovative, large-scale pilots will produce much less—e.g. Rio Tinto's BioIron will reportedly produce closer to 10,000 tonnes per year. Each of these project types are valuable: smaller grants will produce more learning per dollar; larger grants will contribute more to spillovers that arise from scale.

We advocate a market led approach: To a large degree, grants should be made available under simple rules, and firms should be allowed to make the choice about project size and production.

- For world-first-of-a-kind plants and technologies, firms will choose small-scale production. Grants will be smaller in absolute terms but larger in per unit output, and knowledge production will be higher per grant dollar.
- For plants and technologies that are used overseas, but first-of-a-kind in Australia, firms will choose larger scale production. Grants may be larger in absolute terms but smaller per unit output. The benefits will come from new knowledge, but also from the spillovers that arise from scale.

It is nonetheless appropriate to impose a high cap on support per project, e.g. $500 million, to balance project scale and project diversity.

b. Emissions intensity reductions per unit of production (for example, tonne CO_2 emitted per tonne of metal).

Projects with near-zero emissions, no less than an 80-90% emissions reduction, should be considered for grant funding.

For Australia, innovation spillovers are largest where technologies:

- are not yet widely commercialised; and
- can exploit Australia's long-term comparative advantage.

That includes the near-zero emissions technologies that require cheap electricity and, to a lesser degree, biomass.

Reduced-emissions ironmaking technologies are not associated with such spillovers. Most notably, natural gas DRI is a well-established technology with numerous commercial-scale plants worldwide. It has relatively little lasting potential in Australia, and will provide little or no scaling spillovers. The Western Australian gas reservation offers a small pool of lower-cost gas, and that gas is significantly more expensive than that used in natural gas DRI projects in the Middle East. Expected growth in carbon prices, cost reductions in alternatives, and the short timespan to 2050 all create the risk of stranding assets for technologies that are not zero-carbon.

c. Eligible business size (for example, minimum facility production capacity).

As discussed, smaller projects will tend to add more knowledge per unit of output, and per grant dollar, than larger projects. TSI sees little reason to be concerned about project size, so long as the company is reputable and retains a sizable stake in the project outcome.

27. Should incentive levels be varied for different thresholds? For example, different incentive levels for different emissions intensity reductions per unit of production.

Innovation grants should be limited to near-zero emissions projects, with reductions of 90% or more.

28. Should there be time limits for accessing production support? If so, what should the duration be and when should it commence, cease, or phase down?

Government support should be made available for a reasonable period, e.g. five years, enough to allow firms to carefully plan and begin construction. Projects would qualify for grants so long as construction begins within that period.

29. What would be an appropriate level of incentive to support the development of competitive production for green alumina, aluminium, steel and iron?

As noted earlier, we suggest capital grants of up to 50% or equivalent tax credits.

The capital grant support would be applied at a declining rate after a specified number of early followers.

30. How could eligibility criteria be most appropriately linked to the delivery of strong community benefits?

Projects should meet specified minimum standards—indigenous, environmental, community, and other standards required by law, regulation, policy and practice. Standards should not be different, neither lower nor higher, than those that apply to other investment projects.

Demand side options that could be considered[8]

31. What demand side options would best drive confidence for green metals producers? Should the government consider regulation, procurement rules for government purchasing, voluntary targets or other demand options?

The Superpower Institute recommends policies that would support Australia's green metal export industry by correcting market failures in an economically responsible manner; we otherwise support surrogate policies that mimic market corrections as cleanly as possible. Our recommended policies are summarised in our introductory attachment. We do not advocate procurement rules for government purchasing.

32. How could the introduction of new demand measures affect competition?

Other ideas

Are there any other issues or opportunities that can be addressed to unlock an Australia green metals industry?

For example, any workforce and supply-chain constraints, better investment facilitation, sequencing issues, scrap recycling or circular economy opportunities.

N/A

Further Information

Contact info@superpowerinstitute.com.au

[8] Questions 31-32 from the consultation paper

ATTACHMENT B

ACCU SCHEME
Expression of interest (EOI) template

Comprehensive Carbon Accounting (CCA) method

Isabelle Grant

July 2024

Using this template

Please use this template if you wish to submit an expression of interest (EOI) for a method or method variation proposal under the Australian Carbon Credit Unit (ACCU) Scheme. Your method proposal will be assessed by the Emissions Reduction Assurance Committee (ERAC). The ERAC is an independent statutory committee who assess the compliance of methods against the legislated Offsets Integrity Standards.[1] Its assessment will inform prioritisation by the Australian Government of EOIs that should be developed into a method. You should refer to the *Guide for submitting an expression of interest* (EOI Guide), available on the Department's website when filling out this template.

Please complete all sections of this template to the best of your ability. Please acknowledge any unresolved issues in your submission as this will assist the ERAC to understand outstanding work required to further develop your proposal, and any challenges you anticipate in developing the proposed method.

A completed EOI template should not exceed 20 pages. This excludes the cover page, introduction page and the appendices and declaration page. The page limit does not include any attachments that you submit. In the interest of accessibility please do not change the font or formatting beyond expanding the answer boxes as needed.

Method EOIs are to be submitted via the Have Your Say page website.

Supporting information

Supporting information is requested throughout the EOI. If you are referencing publications, please provide a reference list. Any reference style can be used.

Documents may be attached where appropriate and additional space can be created in the answer boxes if required. Additional information included in a separate document should be labelled with the item number it relates to.

You are encouraged to include the names and affiliations of technical experts consulted in the development of the EOI. You must have permission from the individual or organisation to include their names prior to submitting the EOI.

Please be aware that your submission is likely to be published on the ERAC Secretariat's webpage. Please DO NOT include any confidential material in your submission. If you have confidential information that you believe is essential to your submission, please contact the ERAC Secretariat on methodproposal@dcceew.gov.au to discuss how this can be managed. Where possible, information should be made publicly available.

Section 1: Method developer contact details

1.1 Method developer contact details

[1] Section 133 of the *Carbon Credits (Carbon Farming Initiative) Act 2011*.

Title of proposed method/variation, 10 words:	Comprehensive Carbon Accounting
Contact name:	Isabelle Grant
Email:	isabelle.grant@superpowerinstitute.com.au
Phone:	0452205004
Position:	Land Carbon Lead
Organisation name:	Full name of the legal entity you are submitting the idea on behalf of (or specify that you are representing no company or organisation). Please include your ABN, ACN, or equivalent (if applicable for your organisation).
Organisation type:	What type of entity are you? • Research/University • Aboriginal or Torres Strait Islander group or company • Carbon Service Provider • Environmental group • Other NGO • Peak body • Private Industry • Other
Public facing name and contact details:	Isabelle Grant isabelle.grant@superpowerinstitute.com.au 0452205004

Section 2: Eligibility

2.1 Registering your idea with the ERAC Secretariat

Have you registered your method idea on the Method Development Tracker?

☐ Yes – please provide details below.

Date of registration:

Registration ID:

X No – You are encouraged to submit an idea before an EOI. Please visit the department's website or email methodproposal@dcceew.gov.au to find out how to register your idea.

2.2 Eligibility of proposed carbon abatement

Appendix A to the EOI Guide lists the categories for which greenhouse gas emissions and removals are included in Australia's National greenhouse gas inventory. Following consultation with the Secretariat, indicate which of the below is correct. If you have not consulted with the Secretariat, please mark as unconfirmed.

Is the abatement described in your method proposal eligible carbon abatement under the ACCU Scheme? Which categories will your proposal impact? Please refer to Section 2 of the EOI Guide.

Please note that if it becomes clear proposed abatement is not eligible abatement, the Secretariat may not assess the remainder of your proposal.

☐ Yes – the EOI Guide (Appendix A) and the ERAC Secretariat indicate the activity covered under the proposed method is likely to result in eligible carbon abatement.

X Unconfirmed – feedback from the secretariat indicates further consideration is required.

Section 3: Experience and consultation

3.1 Your skills and expertise

Provide a description of your skills, expertise and experience and their relevance to the method proposal. Please list any organisations involved in/collaborating on development of the proposed method.

Professor Peter Rayner, Chief Scientist, The Superpower Institute.

Honorary Professor of Atmospheric Science, University of Melbourne

Expertise in Atmospheric Science, Carbon Cycle Modelling, Atmospheric Inverse Problems

Professor Ross Garnaut, Director, The Superpower Institute.

Professor Emeritus of Business and Economics, University of Melbourne.

Author of the Garnaut Climate Change Review (2008 & 2011).

Expertise in macro-economics, global trade, climate and economic policy.

Isabelle Grant, Land Carbon Lead, The Superpower Institute.

Author Land Carbon Chapter Superpower Transformation, Making Australia's Zero Carbon Future. Expertise in terrestrial carbon accounting, bio-based value chains, renewable energy regional development.

3.2 Expert consultation

Provide names and organisations of experts consulted in developing this EOI. You must have consent from them to include their names prior to submitting this proposal.

Name	Organisation	Will you continue to engage with this expert if your proposal is progressed to be developed into a method?

3.3 Community, organisations, and individuals

Please provide the names, communities, and organisations you have included, or engaged with on the development of this EOI including Aboriginal and Torres Strait Islander peoples and communities. You must have permission from the individual or organisation to include their names prior to submitting this proposal.

Name	Organisation	Will you continue to engage with this person or organisation if your proposal is progressed? If yes, what role will they play in the method development process?
	Yambangku Aboriginal Cultural Heritage and Tourism Development	YES

Aboriginal Corporation
(YACHATDAC)

3.3.1 First Nations opportunities

Does the proposed method idea apply to areas with a recognised Aboriginal or Torres Strait Islander peoples' rights or interests including Native Title interests or claims? What opportunities have you identified for Aboriginal or Torres Strait Islander participation? This includes during the method development process (such as recognition of Traditional ecological knowledge), at the project-level (through First Nations-led projects), or benefit sharing.

TSI has engaged with YACHATDAC on the importance of measurement technology to capture indigenous land management techniques that are not currently permitted under the Emission Reduction Fund methodologies. Of particular importance are those related to ongoing management of important cultural native plants, spring rehabilitation and cool burning techniques. TSI will continue to build this strong partnership with YACHATDAC at the project level, during the method development and in traditional ecological knowledge exchange between YACHATDAC, TSI and any future partners of the method.

Section 4: Similarity to existing or other proposed methods

EOIs should be drafted to be broadly applicable. EOIs that are substantially similar may be referred back to proponents, with a recommendation that a joint proposal be submitted instead. Registering your idea on the method development tracker will enable you to identify other, similar proposals under development, and help you to collaborate with proponents with similar ideas.

4.1 Similar methods under development

Are you aware of another method under development or method proposal which is similar to your proposal?

☐ There are no comparable methods under development.

X There are comparable methods under development – please list them below and explain why you are submitting a separate EOI.

Similar method under development	Difference in new methodology
Integrated Farm and Land Management (IFLM) methodology	Comprehensive Carbon Accounting differs from the IFLM method because of its measurement approach. The measurement approach allows carbon stocks to be measured at different intervals, through remote sensing technology and ground measurements, to inform a land surface vegetation model. The model is informed by large data sets including soil moisture, vegetation optical depth, direct biomass measurements, soil temperature (IST), among others. These measurements improve and validate the land surface vegetation model

	and the carbon stock is able to be measured from this model. This model incorporates climate change impacts to carbon stocks in its forecasts.

There are many methods which have activities suitable to the Comprehensive Carbon Accounting method. CCA can measure all changes in carbon stock through known relationships between landscape characteristics and carbon storage. Project boundaries extend beyond conventional examples; we can measure the interactions between carbon pools and aggregate multiple pools and emissions to work out net abatement. Therefore, there would be opportunity to add these "modules" in relatively short timescales (12-18 months).

4.2 Existing methods

Is this EOI adapting an existing ACCU method or method from another offsets scheme?

X No, this is a new method.

☐ Yes – please provide below:

1. The name of the scheme in which the method exists
2. Title/name of existing method
3. A reference/source for the existing method
4. Description of any major differences between this method proposal and the existing method.

Section 5: Activities and eligibility

5.1 Project activity

Describe the processes that would be involved in implementing the project activity/activities so it is possible to understand what would be required to conduct the applicable projects. Please identify whether projects using the proposed method would remove and/or avoid emissions. Provide supporting evidence when possible. (Note that details on how the baseline and project emissions are calculated are requested in Section 6.)

Comprehensive Carbon Accounting (CCA) method is a framework for modeling, measuring, monitoring and verifying changes in terrestrial carbon stocks. CCA is a framework to award all increases in carbon, no matter the method. Current remote sensing measurement technology, can effectively and reliably model and measure the following activities in a model-measurement hybrid approach. Other activities will be included over the coming years.

All activities are based on removal of emissions or carbon drawdown (inexhaustive list)

- Tree planting/seeding.
- Natural regeneration of forests and woodlands through suppression of grazing animals.
- Natural regeneration of forests and woodlands through fencing.
- Indigenous wildfire management through early burning and cool burning.
- Cover crops for soil carbon sequestration.
- Water management for soil carbon sequestration.

- Removal/harvesting of biomass for commercial purposes (e.g. biochar or advanced fuels) or weed management purposes

5.2 Project eligibility requirements

Clearly set out the requirements for projects to be eligible. The proposed eligibility criteria must describe the circumstances and conditions in which a project would be allowed to occur. Requirements may relate to ensuring newness, baseline setting and project boundaries.

Eligibility criteria[2]

- Newness test: the project must be new.
- The project must be above business-as-usual.
- The project must not be required by law.
- The project proponent must have the legal right to conduct the activities.

Beyond these core eligibility criteria there are no strict management or land type based criteria beyond the following principles:

- The projects must contribute to increases in carbon storage above a baseline. The activity must demonstrate changes in landscape characteristics, e.g. vegetation cover or change in plant species.
- The activity must be measurable, e.g. the activity conducted must have a recognisable effect on the carbon stock so that the model can measure the effect.

The model can measure outside of the current boundaries, e.g. combining the soil carbon pool, above and below-ground biomass, dead wood and leaf litter, however the project must fall within physical boundaries limited to the soil and aboveground carbon pools (see Figure 1 below). This means any removal of the biomass and carbon off the site is removed also from the carbon stock and is not accounted for outside of the physical project boundary. The only exception to this as previously mentioned is fuel use from machinery, fertiliser use and other on-farm emissions.

[2] General eligibility criteria as in all other Australian carbon credit methods.
https://cer.gov.au/schemes/australian-carbon-credit-unit-scheme/eligibility-accu-scheme

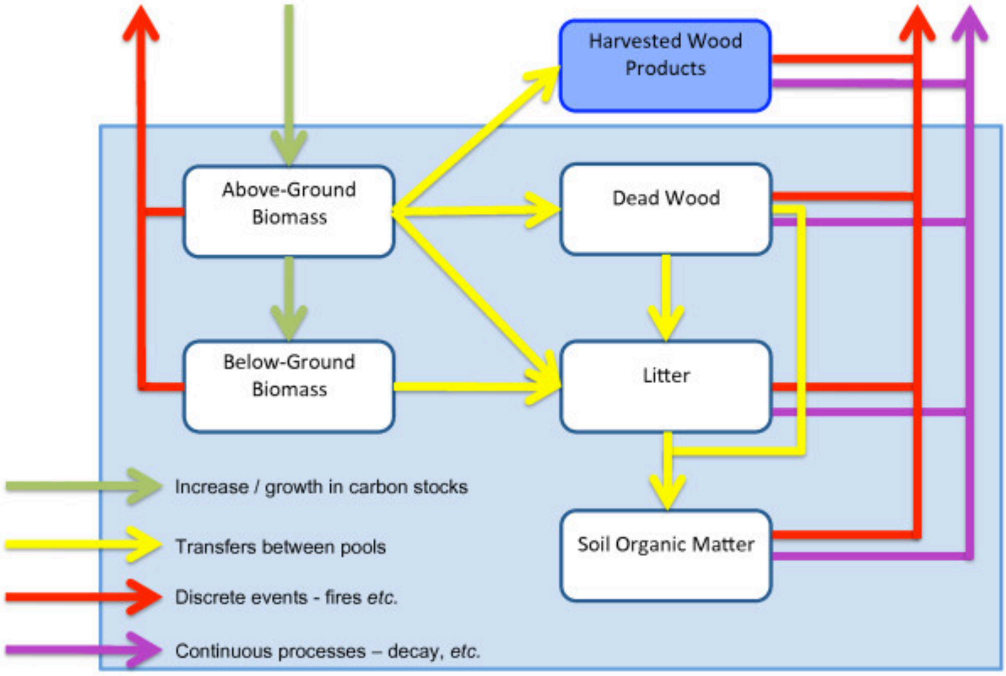

Figure 1. Terrestrial carbon pools and flows. CCA model and measurement boundaries are shown within the blue boundary lines and within the blue box. Taken from Maniatis & Mollicone (2010)[3].

Eligible projects will conduct activities which correspond to legitimate activities which increase the carbon stock. Comprehensive Carbon Accounting is not specific about management activities, therefore any activities that increase carbon via management of vegetation (some examples given above) should be awarded credits. Because we are measuring carbon stock we are measuring the outcome, which is not prescriptive. There are acceptable management practises which change this carbon stock, and any of these are eligible under Comprehensive Carbon Accounting. Outcomes that cannot be explicitly measured include changes in NOx emissions or methane emissions, though on-farm emissions such as NOx and methane emissions from fuel use must be recorded and kept a log book of. The addition of these non-CO2 GHG emissions would be an important next step in completing the Comprehensive Carbon accounting framework.

5.3 Potential for double counting

Is there a risk of double counting associated with the proposed method? Are relevant emissions counted in other contexts? Please describe how you propose to account for any potential for double counting in the method.

The risk of double counting may occur if projects are registered under the voluntary market as well as the compliance market. This may occur for scenarios such as biochar production and biomass that is used for low carbon liquid fuels such as sustainable aviation fuel. Double counting could occur if biomass is removed from the project boundaries and not accounted for. This model will account for the biomass that is removed by measuring the carbon stock and adjusting the

[3] Maniatis, Danae & Mollicone, Danilo. (2010). Options for sampling and stratification for national forest inventories to implement REDD+ under the UNFCCC. Carbon balance and management. 5. 9. 10.1186/1750-0680-5-9.

carbon stock based on these numbers. Therefore, the removal of the biomass will be accounted for in the updated carbon stock.

Because there is a measurement taken at the baseline, anything above the baseline, regardless of the activities conducted, will have credits awarded for every tonne of CO2e sequestered. Any reductions in this store of carbon will require credits returned to the administrator.

Double counting could occur if multiple activities are stacked. For example the interactions between different methods that impact the below-ground biomass pool and the soil carbon pool have their own emissions and carbon sequestration, however these will be integrated in the carbon cycle model that accommodates these interactions. The aim of the method is for this to be the only method (once all emissions are included), therefore there would be no risk of double counting with other methodologies as this method would be comprehensive. The voluntary market is not a compliance market and does not currently count towards national targets, and cannot be used to offset emissions under the safeguard mechanism, therefore the risk of double counting is reduced.

Section 6: Calculating net abatement

6.1 Baseline scenario

Identify and describe the baseline scenario or scenarios for the proposed method.

Provide a description and evidence of current industry practice and how baseline emissions can be quantified and calculated. Provide supporting evidence.

OLCAM model

CCA will measure changes in carbon stock through adapting the DARLEC and BETHY land surface vegetation models (Knorr et al, in review) to Australian vegetation types and requirements under the Open Land Carbon Assimilation Model (hereinafter referred to as OLCAM). The approach is known as Carbon Cycle Data Assimilation (CCDAS) in which a physical model including all relevant processes is continually adjusted to fit all available observations. The paradigm is weather forecasting where the model trajectory is "nudged" by observations. Although less discussed than its predictive aspect, weather forecast models provide continuous and complete estimates of all atmospheric variables as consistent as possible with our physical understanding and all previous observations. CCDAS provides the same outcome for the carbon cycle.

OLCAM consists of a core model with interfaces to different measurement types. These interfaces or observation operators map model variables onto measurements allowing feedback from measurements to the model behaviour. Introducing a new measurement requires writing a new interface not a complete new model.

Baseline scenario calculation

The baseline scenario is a counterfactual in which a parallel model run is performed without the landscape intervention. This is important since uptakes that would have occurred anyway should not be credited.

This counterfactual model can be calculated by running a land surface vegetation model without any planned intervention. There are common examples of this exemplified in the TRENDY Intercomparison Programme (Teckentrup et al, 2021). The TRENDY programme informs national and regional Net Biome Production data for the Global Carbon Budget annual assessment[4].

[4] https://blogs.exeter.ac.uk/trendy/

This baseline is an accurate measurement of the ongoing plant productivity, soil organic matter turnover and biomass of a given site. OLCAM baselines are never zero, they reflect the ongoing carbon cycle processes and storage of terrestrial carbon systems.

6.2 Baseline scenario over time

Please indicate whether, and to what extent, the baselines should change over time. This may help ensure the activities under the proposed method remain additional. Provide supporting evidence.

The baseline scenario will be a dynamic baseline which will change over time. This baseline will incorporate climatic conditions into the future, including the CO2 fertilisation effect on plant productivity. The baseline is a dynamic assessment of the counterfactual scenario, e.g. natural changes in landscape vegetation. The baseline is not a constant number, it is a scenario. For example, the baseline in 2050, is what you get in 2050 without an intervention.

6.3 Project activity emissions

Describe how you will calculate remaining emissions (in the project boundary) once the project has been carried out. This should include accounting for new emissions that may result from carrying out activities. Provide supporting evidence when possible.

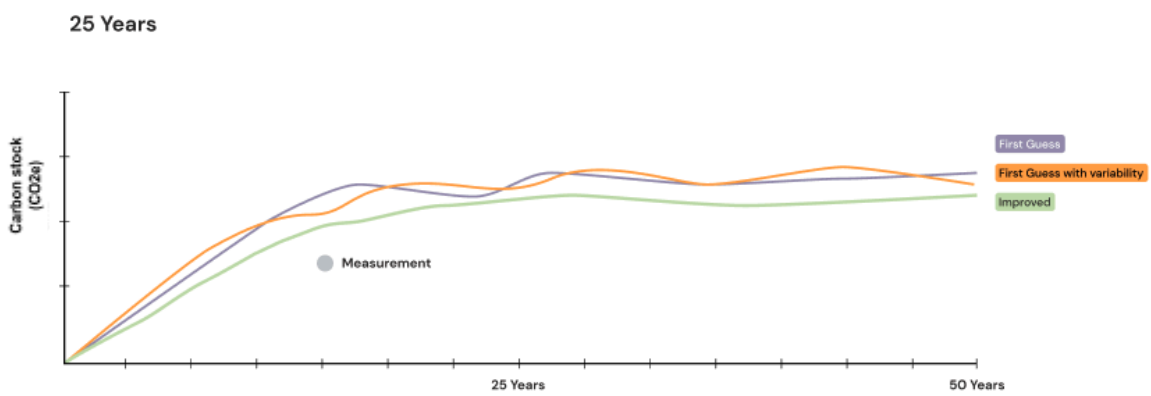

Figure 2. OLCAM carbon stock model forecast over time (First Guess), OLCAM model forecast with climate change impacts (First Guess with Variability), OLCAM model output with measurement (Improved). The graph is for illustrative purposes only.

The aforementioned OLCAM model forecasts the changes that will occur under the proposed management regime to give a First Guess (see Figure 2). This First Guess is then informed with the climate variability which helps to manage expectations of change into a warming and drying climate (some regions may see the opposite climate change). Periodic Measurement (in grey) adjusts this model trajectory to improve our estimate based on real measurements and data (these can be taken from remote sensing or direct on-ground measurements). Measurements for given land parcels help to inform the overall trend of the carbon abatement trajectory, as well as continuing to be dynamic to more measurements.

As with FullCAM guidelines, project proponents will be required to keep a fuel log and record of all machinery, fertiliser use and other GHG emissions during the project lifetime. These emissions records will be periodically audited, in line with existing inventory requirements, such as an inventory of purchased imports. These non land-based emissions and non-CO2 emissions are included in the final carbon abatement results.

6.4 Account for periodic variation

Describe how the method proposal would account for periodic variations that may occur in the amount of carbon stored or avoided (if applicable). Provide supporting evidence when possible.

The model is anticipating these changes. because it has the climatic variability impacts - models built for that task. Periodic measurement is there to inform the model. Abnormal years in the real world, should also be abnormal years in the model. We are accounting for this.

Seasonal variation is occurring and is accounted for in the model. Random climatic variations.

6.5 Account for carbon leakage

Provide detail on whether – and to what extent – the proposed method may result in carbon leakage and how that has been or could be accounted for in the proposed method's design. Provide supporting evidence when possible.

Carbon is conserved within the model. Leakage only occurs when exogenous interventions such as harvest or herbivory are not properly tracked. That is the task of the models for the various proposed interventions.

Carbon leakage can occur when industries that would be more sustainable in Australia, for example longer rotation, Forestry Stewardship Council certified plantations, are sourced from more unsustainable options outside of Australia. To support sustainable biomass growth or woody weed removal in Australia there needs to be pathways for accreditation and methodologies. CCA would provide pathways for these plantations to achieve carbon credits for the growth of the carbon in growing biomass for reducing emissions in hard-to-tackle industries through sustainable aviation fuel and renewable shipping fuel. This will reduce carbon leakage from importing biomass from other places for the same renewable fuel production here.

6.6 Calculating net abatement

Describe how the net abatement will be calculated and how the uncertainty of the net abatement will be calculated. Provide supporting evidence.

You are encouraged to provide a diagram which clearly shows the baseline relative to the proposed abatement over the life of projects conducted under the proposed method.

Net Carbon Abatement Curve Under Comprehensive Carbon Accounting

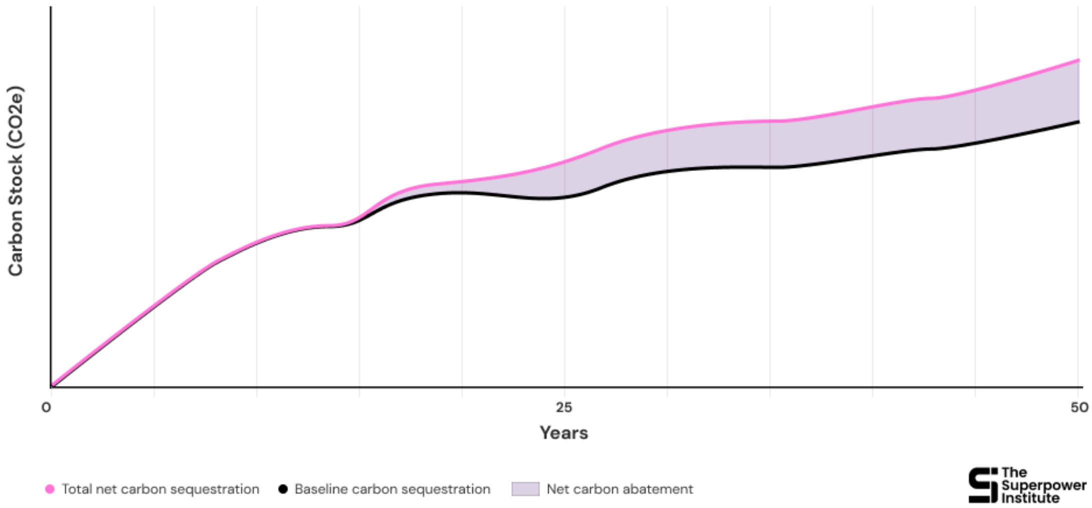

Figure 3. Net Carbon Abatement Curve under Comprehensive Carbon Accounting. This curve represents a scenario where there is continual growth of the carbon stock in the baseline and managed scenarios until an intervention, at which point the increase in carbon is recognised in the total carbon stock. This may be due to management choices that lead to above-ground carbon sequestration but is constrained by grazing, for example. A change in management to retain more carbon in plants (i.e. reduced grazing pressure or cell grazing practises) would lead to an additional sequestration benefit which would then be counted towards the net abatement. Any emissions from the management would be included in both baseline and new management scenarios. The three-step process for improving the first forecast (as seen in Figure 2), is embedded in the Total net carbon sequestration curve (pink line). The area under the curve (Net carbon abatement) represents the total net abatement over a 50 year period. The graph is for illustrative purposes only.

Managing uncertainty is inbuilt into the model. The model is designed to adjust the forecast in the case of measurement data and new model data updates. This reduces uncertainty in the baseline and in the activity emissions scenarios.

Section 7: Offsets Integrity Standards

The Offsets Integrity Standards are legislated in section 133 of the *Carbon Credits (Carbon Farming Initiative) Act 2011* that methods must meet.

7.1 How will your proposed method be additional to business-as-usual practice?

Provide supporting evidence when possible.

The baseline is a representation of the natural carbon stock baseline of the region, therefore presents an opportunity to compare business-as-usual with additional management. A baseline scenario prior to the project inception will assist in understanding any potential change in land management that artificially reduces the carbon stock and will inform business-as-usual trajectories. This baseline will be representative of the region and will consider neighbouring properties and baseline results from those from the surrounding land parcels to ascertain the business-as-usual practises.

7.2 How will your proposed method be measurable and verifiable?

Provide supporting evidence when possible.

The work will be partially verified by an ongoing quality control process within the model itself, which updates the model with more data as it is accumulated.

Measurements that are really rare and high quality are kept back as verification. High quality measurements, such as a very representative soil carbon measurement, would be used as a validation tool in OLCAM.

7.3 What evidence will your proposed method be based on?

Provide a summary of the type of evidence your method proposal draws on and describe any uncertainties or limitations associated with it.

The method will draw upon evidence from satellite measurements that link indirect measurements such as photosynthesis from chlorophyll fluorescence, vegetation optical depth, direct biomass measurements and soil temperature measurements (LST) to carbon content and sequestration of land systems. These data sets will be accumulated with others that inform our models of land carbon stocks. Other on-ground technologies and measurements include the following (inexhaustive list); flux towers, atmospheric concentration, chamber measurements, soil carbon core sampling, vegetation activity, biomass sampling, soil moisture sensors and surface temperature measurements.

There are parametric uncertainties in every model, one of the things that reduces our uncertainties is that uncertainties are actually calculated explicitly in this model. Therefore, we can refer to uncertainties when discussing exact carbon stock figures thus reducing the unknown source of any differences in actual vs modelled carbon stocks. The uncertainties will decrease over time due to better understanding in the model of carbon stocks relative to the changing climate, the region's physical characteristics and updated carbon cycle science.

7.4 How will your proposed method be conservative?

Provide supporting evidence when possible.

OLCAM is conservative because it isn’t strongly affected by one direction or another. The model is robustly constrained. Additionally, OLCAM calculates uncertainties explicitly therefore it can weight final carbon stocks by their uncertainties.

As per the ACCU Method Development Guidelines document, there is a 5% risk of reversal adjustment made to all carbon credits and a 20% reduction in total carbon credits with shorter, 25-year projects. The focus of CCA is that we are aiming to better understand and measure total carbon stocks. The risk of reversal will be better accounted for in the model as climate change impacts, including increased wildfires are inbuilt in the forecasts.

Section 8: Method proposal triage criteria

In addition to considering whether a method proposal has the potential to meet the legislated Offsets Integrity Standards, the ERAC assesses method proposals against the triaging criteria.

8.1 Total abatement potential, including likely uptake

Describe the possible total abatement potential of the proposed method, including:

- Likely uptake, including justification and evidence for your estimate and factors likely to influence the uptake.
- Possible locations of projects (i.e. particular regions/jurisdictions).
- Accessibility of the proposed method to all stakeholders.
- Given the above, the likely abatement in the short and longer-term from the method.

Provide supporting evidence when possible.

As suggested in Fitch et al, (2022) there is a role for extending fire management credits into semi-arid and arid landscapes, including outside of the Northern Territory into Queensland. Using the technical potential estimate provided in this study, and **expansion into 55.8 million hectares of new area** that could be included in cool burning or fire management techniques, the potential abatement of wildfires can help contribute to 3.5 million tonnes of CO_2 emission avoidance every year. This would result in 87.7 million tonnes over a 25 year period through early burning and reducing the intensity and area covered by wildfires. Because of the huge success of the current savanna burning, the likelihood of success in this new management option is high.

The OLCAM would be created as an open source platform to be used by many different user groups to help understand the potential of their land for many carbon farming opportunities. Highly accessible tool and there has been considerable time and effort placed on how best to interact with all stakeholders to provide the best outcomes.

Potential abatement has been estimated for a number of new and existing activities, such as biochar production and use of biomass for sustainable aviation fuel in the Superpower Transformation, Land Carbon chapter (Garnaut, 2022)

- Maximising current forest and woodland reforestation methods through CCA could result in 116 million tonnes of CO_2e sequestration per annum.
- 10% increase in mallee planting in annual crops and highly modified pastures could result in 18 million tonnes of CO_2e per annum.
- One million hectares of agave, strategically located as fire breaks could sequester 4.6 Mt CO_2e if sustainably harvested and converted into biochar and 6.6 Mt CO_2e in bio-oil as a fuel source.
- Use of cellulosic waste residues including forestry and agricultural waste to produce sustainable aviation fuels could avoid around 38 million tonnes of CO_2e a year.

There have been announcements in support of SAF and low carbon liquid fuels from the federal government, this plan can be supported by better quality measurement technologies and tools to measures the biomass stage of this industry.

8.2 Proposal complexity

Describe the complexity of the method proposal, including how difficult it may be, and how much time it may take, to develop, maintain, and regulate.

Project development for a proponent will be easy, developing the model will take time. We estimate 18-24 months until the model is fit-for-purpose, including validating the tool under different Australian landscapes and case studies. The tool will need maintenance, however the aim will be to create an open source platform which will be maintained for a large set of end-users. Work in dealing with complexity of the carbon cycle and the physical model assumptions and parameters has been ongoing for more than 20 years in the research community, therefore much of the complexity has been worked through and is now ready to be applied to a market setting.

8.3 Broader positive outcomes

Describe any positive environmental, economic, social and/or cultural outcomes and benefits, including for Aboriginal and Torres Strait Islander peoples, that might occur from the uptake of the proposed method. Provide a clear rationale for each proposed outcome, with supporting evidence where possible.

Environmental

Greater measurement potential of carbon stocks will allow more “restoration” opportunities to happen such as spring rehabilitation, deep soil carbon sequestration through erosion mitigation and rehydration management which encourages better environmental land management across Australia.

Economic

New avenues for crediting activities will improve the livelihoods of many landholders across Australia. Such credits can diversify existing land management, such as managing drought tolerant crops such as Agave for fire breaks on pasture land. Regions that sustainably grow biomass in innovative planting formations and long rotation cycles can support new industries such as sustainable aviation fuel. These industries have long value chains that can provide numerous long term job opportunities in technical and management fields as well as temporary jobs in construction and waste or weed management or plantation harvesting.

Social

These new industries can form the economic backbone of regions that are transitioning out of fossil fuel production and for regions that are suffering from decreasing populations due to urbanisation trends. The flow-on benefits to local communities present new commercial opportunities but also recreational, tourism and community development.

Cultural, including indigenous

Cultural benefits include greater ownership and engagement of indigenous peoples with a wider range of carbon projects. Potential for recognition of the resilience of indigenous managed land systems; greater permanence and high value credits.

8.4 Innovation

Briefly describe how the method proposal could foster innovation in the relevant sectors.

This tool could enable a vast set of new methods, so-called “modules” under OLCAM, to be developed to demonstrate many ways of increasing and maintaining carbon in the landscape. Additionally, due to flexibility of data and the use of multiple data sources, this method could take advantage of many new technologies in the field of remote sensing such as LiDAR, Radar and drone-technology, as well as satellite programmes to take advantage of latest science in identifying changes in plant productivity from space, such as chlorophyll fluorescence. These new technologies could easily be added to the OLCAM, or used as measurements to improve estimates of carbon stocks.

We think there can be added benefits, outside of carbon, for co-benefit measurement, monitoring and verification through this powerful measurement tool. Additions to measurement technology, such as acoustic sensors on eddy covariance towers can foster innovation in non-carbon benefits from land restoration and tree planting activities. Additionally, quantification of plant and landscape heterogeneity, resulting from indigenous land management practises, can foster new methods in indigenous carbon management such as return of invertebrate species, habitat provisioning and the benefits of cool burning techniques, for improved carbon sequestration outcomes and avoided emissions from wildfires.

8.5 Preliminary risk assessment and any potential adverse impacts

Please indicate what, if any potential adverse or negative environmental, economic, social and/or cultural impacts could result from the method. Consider the circumstances under which the risks or outcomes might arise and any method requirements that could avoid or minimise the risks.

The risk of reversal and reduction in carbon credits may occur from improved measurement technologies, making some carbon projects uneconomic. However, only carbon projects that are economically viable should be awarded carbon credits under a functioning carbon market. Improvements to the measurement help to award only good quality sequestration opportunities.

A situation may arise where OLCAM presents different forecast carbon sequestration outcomes than the existing measurement technologies. In this case, to minimise the impact to existing projects, there must be safeguards in place to ensure returns on investment.

Section 9: Method tools

9.1 Method tools (optional)

If applicable, describe any tools that would be used as part of the method, for example to model or calculate abatement under the method. Please provide information outlined in the EOI Guide.

The OLCAM tool has been explained in Section 7.

Section 10: Method Development Project Plan

10.1 Project plan for method development

Provide a high-level project plan for developing your proposal. The plan can take any form and be submitted as an attachment. Please provide the information outlined in the EOI Guide.

Project Plan

The time needed to undertake further method development work

- 12-18 months for demonstration sites and validation. Timeline below:

Month 0: start project

Month 3: OLCAM implemented over Australia

Month 6: OLCAM interfaced with key satellite data sets over Australia

Month 12: OLCAM calibrated and validated against existing in situ data sets such as flux towers, biomass and soil carbon measurements

Month 15: Modules for implementing planting and HIR methods interfaced to OLCAM

Month 18: OLCAM interfaced with climate scenarios for risk projections,

Month 18: Submission for acceptance as approved method

If relevant, indicative timelines for any further research needed

- Further research will be needed to make the tool fit-for-purpose for Australian conditions, as the tool has been developed in climatic zones in Europe.

When your method could be ready for each step in the method development process

- The method development process and the method would run parallel to one another and would be ready at the same time - around 12-18 months

The resources available to you to develop the method and whether they are sufficient

- Resource needs include post-doctoral researchers and site managers.

Key stakeholders you plan to engage with on further development of the method, and timelines for engagement (in addition to the mandatory public consultation period for all methods)

- Terrestrial Ecosystem Research Network (TERN). Additionally co-funded demonstration sites across key regions such as semi-arid rangelands in Queensland and WA (YACHATDAC and Barcaldine Regional Council), temperate forests in Victoria (other partners), among others.

Project risks and other matters that may affect delivery of the method

- Coordination of complex projects, project management issues.

Section 11: References

11.1 References

Provide a full citation for all reports, papers and journal articles cited in the method proposal.

Fitch P, Battaglia M, Lenton A, Feron P, Gao L, Mei Y, Hortle A, Macdonald L, Pearce M, Occhipinti S, Roxburgh S, Steven A, Australia's sequestration potential (2022) CSIRO.

Garnaut, R. (2022). The superpower transformation : making Australia's zero-carbon future / edited by Ross Garnaut. Collingwood, Vic: La Trobe University Press.

W. Knorr, M. Williams, T. Thum, T. Kaminski, M. Voßbeck, M. Scholze, T. Quaife, T. L. Smallman, S. C. Steele-Dunne, M. Vreugdenhil, T. Green, S. Zaehle, M. Aurela, A. Bouvet, E. Bueechi, W. Dorigo, T. S. El-Madany, M. Migliavacca, M. Honkanen, Y. H. Kerr, A. Kontu, J. Lemmetyinen, H. Lindqvist, A. Mialon, T. Miinalainen, G. Pique, A. Ojasalo, S. Quegan, P.J. Rayner, P. Reyez-Muñoz, N. Rodríguez-Fernández, M. Schwank, J. Verrelst, S. Zhu, D. Schüttemeyer, and M. Drusch. A comprehensive land surface vegetation model for multi-stream data assimilation, D&B v1.0 (in review).

Maniatis, Danae & Mollicone, Danilo. (2010). Options for sampling and stratification for national forest inventories to implement REDD+ under the UNFCCC. Carbon balance and management. 5. 9. 10.1186/1750-0680-5-9.

Teckentrup, Lina & De Kauwe, Martin & Pitman, Andrew & Goll, Daniel & Haverd, Vanessa & Jain, Atul & Joetzjer, Emilie & Kato, Etsushi & Lienert, Sebastian & Lombardozzi, Danica & McGuire, Patrick & Melton, Joe & Nabel, Julia & Pongratz, Julia & Sitch, Stephen & Walker, Anthony & Zaehle, Sönke. (2021). Assessing the representation of the Australian carbon cycle in global vegetation models.

https://blogs.exeter.ac.uk/trendy/

Section 12: Appendices

12.1 Appendices

List and attach all relevant documentation to support an assessment of the proposal including cited reports, papers and journal articles that are not publicly available.

Section 13: Declaration

This application must be signed by a duly authorised representative of the proponent. The person signing should read the following declaration and sign below.

Division 137 of the Criminal Code makes it an offence for a person to give information to a Commonwealth entity if the person providing the information knows that the information is false or misleading. The maximum penalty for such an offence is imprisonment up to 12 months.

By signing below, the signatory acknowledges that he or she is an authorised representative of the proponent, and that all of the information contained in this application is true and correct. The signatory warrants that they own or have a licence to use all of the relevant intellectual property rights in the application submitted. The signatory also warrants that they have read, and agreed to all information on the submission portal for this EOI, including the important information, privacy notice, public disclosure statement, intellectual property agreement, and declaration.

Full name of the person signing as representative of the proponent	
Position	

Signature		Date