



NSW DECARBONISATION INNOVATION HUB: Land & Primary Industries Network (LPI) Workplan 2023-2026 **(Extract)**

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CONTENTS

1	CONTEXT, PURPOSE AND SCOPE	3
1.1	Mission.....	3
1.2	Scope.....	3
	LPI Network Partners.....	5
2	LPI WORKPLAN SUMMARY	6
2.1	Land & Primary Industries Network (LPI) multi-year workplan.....	6
3	DETAILED LIST OF NETWORK ACTIVITIES AND PROJECTS.....	7
3.1	Priority focus areas (preliminary)	7
3.1.1	Accelerating adoption of sustainable practices in productive landscapes	7
3.1.2	Harnessing nature-based solutions: native and semi-natural ecosystems.....	8
3.1.3	Embedding sustainable bio-products in primary industry production and supply chains.....	8
3.1.4	Frontiers in carbon sequestration	9
3.1.5	Embedding low carbon and nature-based solutions in vibrant cities.....	9
3.1.6	Circular economy regional exemplars.....	10
	11	
3.2	Theme 1. Sustainable agriculture and land-use	11
3.3	Theme 2. Sustainable native landscapes	12
3.4	Theme 3. Digital and precision agriculture	13
3.5	Theme 4. Sustainable urban transformation	13
3.6	Theme 5. Carbon abatement horizons	14
3.7	Cross-Theme Program 1. Monitoring, modelling and assessment.....	16
3.8	Cross-Theme Program 2. Land-based circular economy	17
3.9	Cross-Theme Program 3. Sustainable bio-products	18
3.10	Impact Mission 1: Capacity building and outreach.....	19
3.11	Impact Mission 2: Knowledge translation and business development for SMEs and agribusiness	20
3.12	Impact Mission 3: Legal and Policy frameworks.....	21

1 CONTEXT, PURPOSE AND SCOPE

1.1 Mission

The Land & Primary Industries Network (LPI), as part of the NSW Decarbonisation Innovation Hub (Hub), brings together emissions reduction expertise in research, industry, community and government to coordinate and align efforts in the next wave of sustainable primary industry practices. The land sector is a significant contributor to NSW's emissions, but also offers significant near-term abatement opportunities based on existing or near-ready technologies and practices. Our mission is to grow a community of practice that fosters innovation and accelerates commercialisation and adoption of technologies, products and services with the greatest potential to combine material carbon abatement with co-benefits for the NSW economy, environment and people, **accelerating the role of NSW land and the primary industries it supports in contributing to NSW decarbonisation targets, while generating a range of positive outcomes for the State.**

1.2 Scope

NSW landscapes and primary industries can support substantial, deep cuts in NSW net carbon emissions. Carbon sequestration through management of ecosystem-based carbon sinks is currently the only viable and scalable option to offset remaining emissions in the transition to a decarbonised economy and society. A suite of known, land-based abatement options are available, but behavioural and knowledge barriers, as well as policy and regulatory constraints, currently limit scaled uptake. In addition, access to tools, services and demonstrations to support land managers to identify feasible abatement options which can be viably integrated into farm, forestry or other primary industry businesses/organisations, capitalising on co-benefits, remains very limited and difficult for individuals to access and navigate. Overcoming these barriers and constraints to assist landholders and companies to leverage existing decarbonisation solutions, accelerating their adoption, is a key opportunity and focus of LPI. There are also near-ready and emerging technologies and practices creating a pipeline of opportunity for future land decarbonisation. LPI work will work with members and stakeholders across the innovation ecosystem to identify options where coordination across research institutions, industry and government has the greatest potential to accelerate research and development, commercialisation and uptake, resulting in emission reductions and economic prosperity. Capacity building and extension activities building on the end-user networks, education and training programs and infrastructure such as demonstration farms hosted by our partner organisations will serve to promote uptake of proven solutions and prime the land sector to deploy future technologies and practices. Place-based, end-to-end demonstrations enabled through partnerships with land holders, enterprises and SMEs will have a key role in articulating and promoting the value proposition for the adoption of clean technologies and sustainable land practices. As an integral part of NSW Government net zero policy and programs, with access to access to extensive expertise across members and affiliates across the land sector innovation community, LPI will offer sector-specific advice to NSW Government on legal issues and carbon-aligned policy and regulatory frameworks in support of a rapid and effective deployment of low carbon solutions.

Most feasible decarbonisation solutions that might be envisaged for our State depend on the land and the natural capital it hosts. Therefore, LPI activities will extend beyond productive land and primary industries to diverse non-agricultural landscapes, and urban and peri-urban environments, also interacting with the Hydrogen and Powerfuels and Electrification and Energy Systems Networks of the Hub with regard to cross-cutting themes such as the sourcing and production of biomass as feedstock for green energy production, land use to host energy infrastructure, and decarbonisation of linking and dependent sectors such as transport and construction.

The organisational structure of the LPI Network has been designed to reflect the complexity of its scope, and the key decarbonisation approaches and opportunities it aims to advance, at least initially. Themes, Cross-Theme Programs and Impact Missions, collectively termed Streams, make up the organisational structure (Figure 1). Each Stream is led by a lead or Champion from one of the Core Partner Organisations who will take responsibility for monitoring and guiding network activities in that stream, and for promoting relevant opportunities and activities, both through the Network Committee, and in exchange among the Network Partners and Members. Stream leads will facilitate and expand capability within the stream's scope by spearheading the building of effective partnerships aligned with initiated activities and goals. Themes correspond to key sectors and decarbonisation approaches/opportunities to achieve LPI's mission. Cross-Themes map onto areas that cut across sectors and approaches or where integration across Themes is critical to success. Impact Missions will drive enabling activities to disseminate knowledge, pilot and scale new technologies, and advise on legal issues and offer advice to NSW Government on policy options and criteria in support of a rapid and effective deployment.

Land and Primary Industries Network

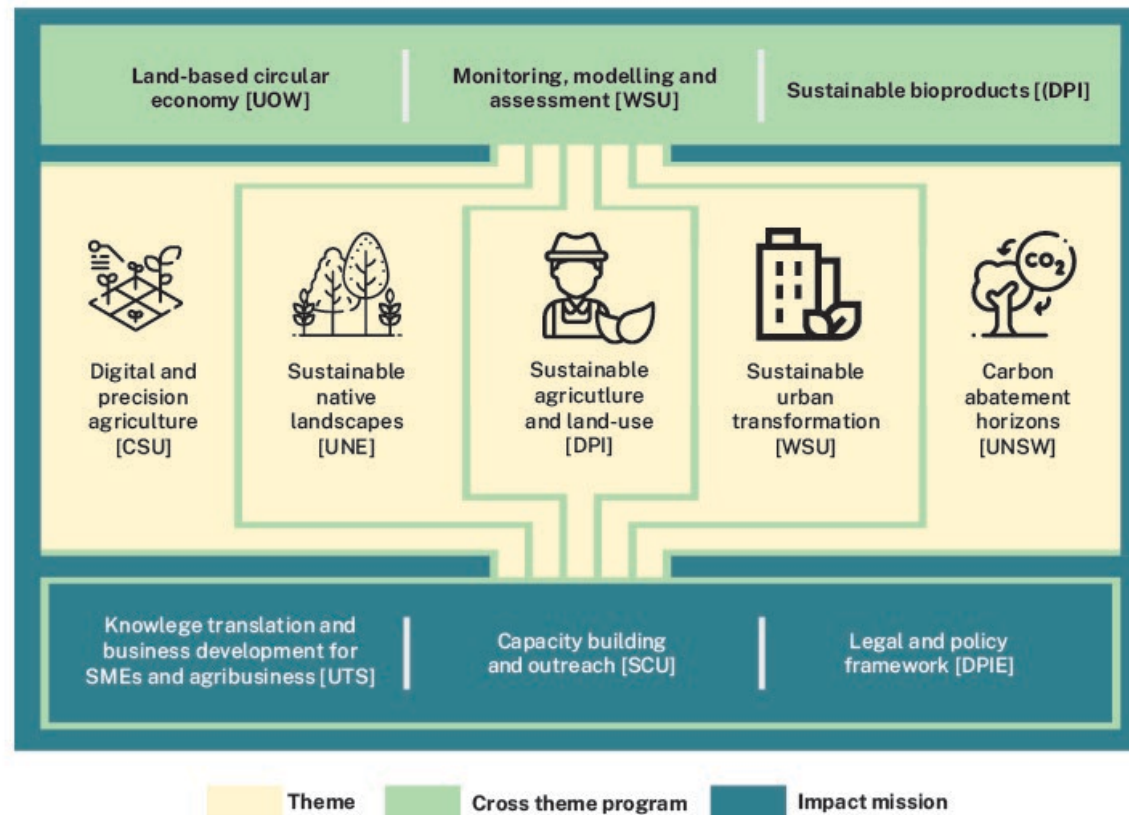


Figure 1: LPI activities are organised and delivered via five Themes, three Cross-theme Programs and three Impact Missions, each championed by an LPI core partner organisation.

LPI Network Partners

- Western Sydney University (WSU)
- Charles Sturt University (CSU)
- NSW Department of Primary Industries (DPI)
- NSW Department of Planning and Environment (DPE)
- Southern Cross University (SCU)
- University of New England (UNE)
- University of New South Wales (UNSW)
- University of Technology Sydney (UTS)
- University of Wollongong (UoW)

2 LPI WORKPLAN SUMMARY

2.1 Land & Primary Industries Network (LPI) multi-year workplan

Activity	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031+
Establish LPI governance and processes	█	█								
Recruit support staff	█	█								
Co-design of priority focus areas	█	█		█	█	█	█	█		
Call for project proposals		█	█	█	█	█	█	█		
Roadmapping emissions reduction pathways for NSW land and primary industries			█	█	█	█	█			
Allocation of industry-aligned collaborative HDR scholarships			█	█	█	█				
Develop and deliver projects:										
<i>Field trials</i>			█	█	█	█	█	█	█	█
<i>Place-based demonstrations and exemplars</i>			█	█	█	█	█	█	█	█
<i>Develop models and tools</i>								█	█	█
<i>Technical development and deployment of low carbon solutions</i>			█	█	█	█	█	█	█	█
<i>Develop and roll out education, training and extension programs/units</i>			█	█	█	█	█	█	█	█
Commercialisation and spin-off companies					█	█	█	█		
Community engagement			█	█	█	█	█	█	█	█
Develop policies, market instruments, standards								█	█	█

Scope of this document

3 DETAILED LIST OF NETWORK ACTIVITIES AND PROJECTS

Stream-level activities

The identification of **priority focus areas** to guide strategy in line with LPI's mission is part of an on-going co-design process among LPI Partners, prospective members, also informed by review and mapping of the literature and innovation ecosystem, for example through the ongoing CTI Market Mapping activity (Section 3.2). Initial priority focus areas are listed and described below. Each is aligned to one or more LPI streams and, in some cases, other networks of the Hub. One stream is designated as primary carriage for coordinating and facilitating proposals, projects and outreach relevant to each area. The priority focus areas will be further refined by co-design activities with external and prospective members (who engage with the network through participation in projects) during Q2, 2023, with a view to aligned projects commencing in Q4, 2023. **It is envisaged that the priority focus areas will frame strategy and activities for the initial 3 year phase of LPI.**

3.1 Priority focus areas

3.1.1 Accelerating adoption of sustainable practices in productive landscapes

Primary carriage: T1

Linkage: T2, T3, CT1, CT3, IM1, IM2, IM3

Synopsis: Sustainable land management approaches for emissions reduction from agriculture, and that combine retention and enhancement of carbon sinks in vegetation and soil with viable extraction/production levels and sustainable use of land resources, offer the highest opportunities for scaled contributions to the short-term (2030) Net Zero target, given widespread adoption by land holders. While important knowledge, data and technology gaps exist, key elements of suitable farming, forestry and fisheries systems across regions of NSW are understood and proven, but are not yet widely applied by land managers. An important bottleneck is that clear guidance on viable opportunities relevant to the farm business are often lacking or difficult for farmers to access. Current decision-support tools are also highly fragmented. To addressing these bottlenecks it is proposed to develop improved, more holistic and targeted decision support tools that make full use of available data as well as targeted, on-farm measurements and current modelling approaches. By delivering targeted advice to key landholder groups, improved tools are an important lever of change to facilitate accelerated adoption of sustainable practices, while contributing to Net Zero Plan targets. In the longer term, there is an opportunity to enhance commercial and environmental outcomes by incorporating the production of novel sustainable bioproducts in mixed farm systems. Overall, a major outcome for this priority area will be enabling the stacking of multiple abatement, production and environmental benefits for NSW farms and regions through the deployment and demonstration of new emerging technologies and practices, accelerating uptake via improved decision-support for early adopters.

Example projects:

- MRV-Plus: integrated decision support tools for land decarbonisation and sustainable management
- Mapping pathways to carbon neutrality for diverse farming sectors e.g. through livestock management, fertiliser applications, subsoil constraints etc.
- Review and link highly-instrumented research and demonstration farms (CSU, UNE, DPI) to showcase best practice land carbon and emissions monitoring, inform models and quantify benchmarks
- Coordinated knowledge and brokering of targeted, evidence-based guidance to land holders and managers
- Pilots, trials and demonstrators of regenerative agriculture practices for carbon sequestration, emission mitigation and multiple co-benefits
- Integrating biomass crops in mixed farming systems

3.1.2 Harnessing nature-based solutions: native and semi-natural ecosystems

Primary carriage: T2

Linkage: T1, T5, CT1, IM3

Synopsis: The state's extensive national park and reserve estate but also rangelands and other semi-natural ecosystems within diverse landscapes, marginal or retired agricultural land, revegetation on various land tenures offer the options for nature-based solutions that combine protection and enhancement of natural carbon sinks, with co-benefits for biodiversity, as well as significant cultural values including for first nations people. More data are needed across the diversity of NSW landscapes and ecosystems to quantify existing stocks and fluxes of carbon and other natural capital. New data are similarly needed to understand and model impacts of proposed management strategies such as targeted native vegetation recovery and forest expansion, improved techniques for planting/assisted regeneration; native vegetation management/thickening; innovative approaches to grazing, native and feral animal management; identification and protection of areas vulnerable to the impacts of climate change/carbon loss; and incorporation of cultural burning practices in hazard reduction and ecosystem management. Soils data across NSW regions are a key gap for quantification of carbon stocks, CO₂ exchange and validation of carbon assessment models.

Example projects:

- Accounting tools for nature: database collation and measurements for land capability mapping, filling key data gaps for NSW vegetation and soils.
- Exploring benefits and trade-offs of alternative land uses in diverse landscapes (Ecosystem restoration, regeneration, improved management, grazing pressure control, burning etc.)
- Activating the aboriginal land estate and economies for climate solutions

3.1.3 Embedding sustainable bio-products in primary industry production and supply chains

Primary carriage: CT3

Linkage: T1, CT1, CT3, PFH2

Synopsis: The low-carbon economy will rely on extensive development of biomass-based products and feedstocks, replacing fossil-based sources in the energy sector but also in other sectors such as transport and construction. NSW has large volumes of under-utilised biomass resources, as well as significant potential to grow dedicated biomass crops. The establishment of new industries and markets offers opportunities for the NSW economy and for farmers and other landholders, including income from carbon credits and offsets, but relies on overcoming a range of technical, cultural, business and infrastructure hurdles. Ensuring sustainability outcomes via the adoption of sound chain of custody principles and guidelines will be critical. This priority area focuses on the use of biomass for traditional bio-energy applications including on-farm fossil fuel substitution, soil amendment (biochar), biomanufacturing such as cellulose-based construction materials, synthetic fuels including sustainable aviation fuels (SAF), and integration of biomass and recycled materials in regional circular economies. Trials using Aboriginal land could support the establishment of local bioproduct industries, providing economic opportunities for first nations people to remain on country.

Example projects:

- Broad assessment of commercial and decarbonisation potential of alternative bio-products for NSW
- Matching feedstocks with production technology to realise a sustainable fuels industry for NSW
- Identification and testing of novel opportunities for the use of bio-based materials such as engineered wood products in construction
- Activating the Aboriginal land estate for climate solutions and wealth generation

3.1.4 Frontiers in carbon sequestration

Primary carriage: T5

Linkage: T1, T2, CT1

Synopsis: Non-traditional approaches to atmospheric carbon removal and storage in biological and geological reservoirs offer prospects for substantial deep cuts in net emissions if technological and other bottlenecks are addressed. Blue carbon systems, which include coastal kelp forest, estuarine seagrass, mangrove and saltmarsh communities, can sequester impressive amounts of carbon from the atmosphere relative to their areal coverage. Extensive portions of NSW's coastal and near shore marine ecosystems are degraded. Restoring these landscapes will store carbon with joint benefits for biodiversity, ecosystem function, landholders, and communities. Restoring these ecosystems can also mitigate hazards associated with sea level rise and flooding. Fugitive emissions associated with current and past mining are a significant component of NSW's total greenhouse gas (GHG) emissions. Feedlots, piggeries, meat works, farm dams, irrigated crops, liquid and solid waste management facilities, gas distribution systems and power generation can all be hotspots of GHG emissions if poorly managed. Improved monitoring using satellite- and aircraft-based GHG analysers will be used to detect the most significant plumes, model the rate of emissions from facilities and subregions, and guide implementing abatement measures. There is considerable uncertainty associated with NSW's emissions reported to the UNFCCC. The uncertainty for some categories can be plus/minus 50%. This theme will guide the development of atmospheric GHG gas observation products that will be used for: inventory verification, identification of quick-win mitigation opportunities, tracking Net Zero progress, and quantifying the land management and climate variability impacts on carbon pools. Technologies for direct air capture of CO₂ remain in early development but will become necessary for offsetting residual fossil fuel emissions as natural carbon sinks approach saturation. This theme will monitor national and international deployment of direct air capture approaches such as weathering materials generated from cement, aluminium steel production and coal combustion. We will identify industry partners who can scale these new technologies and encourage adoption.

Example projects:

- Enhancing blue carbon through tidal wetland restoration
- State-wide mapping of CO₂ and CH₄ emissions
- Feasibility and demonstration studies of blue carbon restoration and management
- Review and identification of implementation pathways for direct air-capture technologies

3.1.5 Embedding low carbon and nature-based solutions in vibrant cities

Primary carriage: T4

Linkage: T1, T2, T3, CT1, CT3, EES, PFH2

Synopsis: Growth regions such as Sydney's Western Parkland City and the Hunter region offer opportunities for positive urban transformation that entail the prospect of a sustainable, equitable and resilient future for residents, local industries and the NSW economy, but also come with a range of complex challenges. Low carbon and nature-based solutions are available or emerging that combine energy savings with benefits for liveability and sustainability in the built environment, urban green spaces and biodiversity conservation in a peri-urban environment. Opportunities exist in urban green design, natural capital assessment and management, transport and energy infrastructure and emerging peri-urban industries such as high-value indoor cropping. Place-based demonstrators and exemplars have been identified as a key gap and opportunity to demonstrate the feasibility and advantages of relevant solutions to entrepreneurs, developers, urban planners, government, prospective residents and established industries. Place-based demonstrations are amenable to promoting the adoption and uptake of low carbon and abatement solutions, illustrating the challenges and benefits of coordination in planning and implementation, while also expediting the commercialisation of technologies and their integration in construction, horticulture,

urban planning and other domains. Potential activities will leverage existing precinct developments that feature established industry links to LPI partners such as the WSU-hosted Hawkesbury Agri-Tech Hub, the Western Sydney Aerotropolis, and the Hunter Clean Energy Precinct.

Example projects:

- Climate-resilient urban forestry and heat mitigation: carbon, cooling and biodiversity benefits of urban trees
- Smart indoor cropping: high value, low emissions produce for discerning export markets
- Establishing living labs for sustainable solutions and innovation/demonstration precincts

3.1.6 Circular economy regional exemplars

Primary carriage: CT2

Linkage: T1, T4, CT3, IM1, EES, PFH2

Synopsis: Circular economy (CE) is a promising direction in societal organisation that offers huge potential for reducing emission intensity and enhancing the sustainable use of resources while accelerating green jobs creation and economic growth. CE work so far is asset-focused (building, infrastructure) or product-focused (food, furniture, clothing), but there is an enormous opportunity to design and deploy more holistic and spatial approaches that cut across sectors and bring together knowledge providers with industries, businesses, communities and government. This priority focus area will leverage regional CE initiatives such as the Bega Circular Valley Initiative to showcase on-farm and in-community solutions that contribute to a land-based circular economy. This knowledge and its outcomes will be an evidence-based and action-focused framework to successfully implement land-based circular economy, suitable for sharing with other regions and communities of NSW to encourage new CE initiatives.

Example projects:

- Turning Land and Primary Industries waste into energy and bio-inputs on farm and for local communities
- Turning urban waste into valuable soil amendments for agriculture
- Embedding CE within living labs and innovation/demonstration precincts such as the Hawkesbury Agri-Tech Hub
- Developing life-cycle assessment based on data and insights from regional CE projects
- Harnessing ash from biofuel combustion as a cement replacement.
- Using of Artificial Intelligence (AI) and Internet of Things (IoT) sensing for land and primary industries sustainability applications.
- Explore the creation of a showcase event in Bega that brings together end-users, researchers and community engaged in circularity projects.

Themes, Cross Theme Programs and Impact Missions (collectively, streams) are the interlinked and cross-cutting organisational elements of LPI and are envisaged as arenas that bring together key expertise, partnerships and linkages to external knowledge, innovation and delivery networks to facilitate outcomes within a domain of opportunities for land decarbonisation in NSW. Supported by the LPI Development Manager, streams and their leads will facilitate and expand capability within the stream's scope by spearheading the building of effective partnerships to seek funding and develop and deliver projects aligned with LPI's mission. Designated streams have primary carriage of a priority focus area (Section 3.1), leading efforts to initiate projects within that area, in collaboration across and beyond the Network and Hub.

3.2 Theme 1. Sustainable agriculture and land-use

Activities		
Theme lead: NSW Department of Primary Industries	Activity timeframe, Activity budget	Levers of Change: Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>Sustainable land management (SLM) practices can provide scaled abatement but also enhance business and landscape resilience by increasing the value of natural capital stocks and their sustainable extraction potential. To maximise the contribution of SLM to the NSW Net Zero emissions target, this theme will invest in technologies and practices, infrastructure, and capacity building to increase options for and adoption of sustainable and low carbon land management practices. The theme will put agricultural industries in NSW on the leading edge of innovation in respect to net emissions and support them to compete on world markets with heightened carbon concerns.</p> <p>The scope of this theme will include:</p> <ul style="list-style-type: none"> • new opportunities for carbon sequestration, • emissions avoidance and reduction in agriculture and livestock production • forestry and fisheries land-use. <p>A major outcome for this theme will be enabling the stacking of multiple abatement, production and environmental benefits for NSW farms and regions through the deployment and demonstration of new emerging technologies and practices.</p> <p>Theme 1 has primary carriage of the priority focus area Accelerating adoption of sustainable practices in productive landscapes (Section 3.4.1).</p>		
Stakeholders		
[tbd]		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		
<ul style="list-style-type: none"> • Collate content for and develop a farmer-centric community of practice website to demystify carbon farming and sustainable farming opportunities (Q2 2024) • Measure soil carbon stocks and fluxes in different farming systems to inform modelling of climate impacts at paddock scale (Q2 2024) • Establish field trials and modelling to evaluate carbon and productivity benefits of the incorporation of forage shrubs, biochar and multi-species cover crops in mixed farm systems (Q2 2024) 		

3.3 Theme 2. Sustainable native landscapes

Activity at a glance		
Theme lead: University of New England	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>The landscapes of NSW are diverse and retain significant areas that are not subject to ongoing agricultural management falling within varied tenures (private, leasehold, crown land, National Park and other protected lands).</p> <p>These non-agricultural landscapes offer an extensive, yet poorly coordinated, series of opportunities for the development of innovative approaches to manage the carbon cycle to minimise carbon loss and maximise carbon capture.</p> <p>Building on previous extensive work by Network Partners, we will focus on management practices that offer considerable promise for large scale, deep cuts in emissions:</p> <ul style="list-style-type: none"> • restoration of degraded land through affirmative on-ground actions (innovative use of native grasses, native tree and shrub establishment – optimum design and configuration); • improved management of protected areas – targeted native vegetation recovery and forest expansion, improved techniques for planting/assisted regeneration; native vegetation management/thickening; • innovative approaches to grazing, native and feral animal management; • identification and protection of areas vulnerable to the impacts of climate change/carbon loss; incorporation of cultural burning practices to ensure optimum landscape carbon management; • management of inland aquatic systems, wetlands, riparian zones and estuarine waterways for carbon management and ‘blue carbon’; • and integration of native vegetation systems within productive landscapes. <p>This theme will bring together an unparalleled resource of extensive research, implementation and adoption experience and expertise to develop and optimise these landscape management methodologies.</p> <p>Utilising laboratory-based, field-based and digital approaches (whilst intersecting with other themes, cross-theme programs and impact missions), these solutions will be refined to generate a toolkit of land-based options to achieve efficient, targeted and landscape-appropriate carbon positive outcomes.</p> <p>Theme 2 has primary carriage of the priority focus area Harnessing nature-based solutions: native and semi-natural ecosystems (Section 3.4.2).</p>		
Stakeholders		
[tbd]		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		
<ul style="list-style-type: none"> • Assess trade-offs between carbon, water, nutrients and biodiversity across native landscapes of NSW (Q2 2024) • Undertake stakeholder engagement and economic analysis around the development of local industries based on traditional management of aboriginal-owned land (Q2 2024) • Develop demonstration project on coastal blue carbon restoration (2024-2025) 		

3.4 Theme 3. Digital and precision agriculture

Activity at a glance		
Theme lead: Charles Sturt University	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>Digital and Precision Agriculture technologies provide a range of capabilities directly related to the addressing the challenges of meeting the NSW Net Zero emissions targets, specifically:</p> <ol style="list-style-type: none"> (1) measurement of agricultural system components required for modelling, assessment and monitoring of emissions; (2) implementation of management practices at scales and with a precision required to minimise negative impact of activities; (3) development, demonstration and adoption of new management practices; (4) opportunities to apply new technological developments generated within other Decarbonisation Innovation Hub themes and programs. <p>The Digital and Precision Agriculture Network contains recognised expertise in a diverse range of disciplines associated with:</p> <ul style="list-style-type: none"> • soil, crop, pasture and livestock management, • low emissions practices, • smart sensor systems, AI, IoT, robotics • and data management. <p>Additionally, The CSU Global Digital Farm, UNE SMART Farm and DPI Farms for the Future programs provide a network of digitally enabled dryland and irrigated, cropping, livestock and mixed farms distributed across regional NSW to develop, evaluate and showcase low emission technologies and systems developed within this and other themes and hub programs at commercial scale.</p> <p>Theme 3 has linkage to the priority focus areas Accelerating adoption of sustainable practices in productive landscapes (Section 3.4.1) and Embedding low-carbon solutions in vibrant cities (Section 3.4.5).</p>		
Stakeholders		
[tbd]		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		
<ul style="list-style-type: none"> • Review opportunity to link research farms and sites across LPI partners to improve access to data and experimental facilities to address knowledge gaps in land decarbonisation (Q4 2023) • Pursue industry partnerships around the deployment of smart sensor and automation technologies in smart indoor cropping (Q2 2024) 		

3.5 Theme 4. Sustainable urban transformation

Activity at a glance

Theme lead: Western Sydney University	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>This theme will accelerate research and development to support the prosperous development and transformation of urban and peri-urban environments underpinned by adopting nature-based solutions and establishing low-emissions industries aligned to growth in sustainable markets, while generating jobs and improving liveability.</p> <ul style="list-style-type: none"> Indoor protected cropping agriculture employs robotics and smart sensor technologies to lower emissions, inputs and costs while enhancing the production of quality produce. Precincts demonstrate the potential for industry and research sector partnerships to develop solutions that embed decarbonisation benefits in vibrant production industries. The WSU-hosted Hawkesbury Agri-Tech Hub is an exemplar that connects growers with research in sustainable protected cropping to access regional and global markets through the Western Sydney Aerotropolis. Urban green infrastructure such as parks, street plantings, passive stormwater recapture, green roofs, green tracks and rooftop city farms sequester carbon, provide cooling to mitigate urban heat island effects and generate co-benefits for biodiversity while creating more attractive and liveable spaces for residents. Research is needed to identify opportunity tree, shrub and cover species in a variety of urban contexts that provide cooling and carbon benefits while being resilient to future climate extremes such as heatwaves and drought. Research is needed to directly test, monitor and model the impacts of climate change on peri-urban ecosystems, including impacts of the urban heat island. Economic and governance tools and solutions are needed for land-use planning to address urban encroachment onto valuable peri-urban agricultural land and to support conservation of remnant native vegetation, biodiversity, and natural capital. <p>This theme also intersects with the cross-theme program on circular economy and sustainable bio-products, addressing opportunities for sustainable and low-emissions construction using bio-based construction materials sourced from NSW forests.</p> <p>Theme 4 has primary carriage of the priority focus area Embedding low-carbon and nature-based solutions in vibrant cities (Section 3.4.5).</p>		
Stakeholders		
Network members		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		
<ul style="list-style-type: none"> Establishing partnerships in sustainable urban transformation through stakeholder engagement and outreach Identification of place-based demonstration for protected cropping agriculture Identification of living labs for best practices in urban green infrastructure, urban cooling and decarbonisation Exploration of research funding opportunities in tree-based urban heat mitigation 		

3.6 Theme 5. Carbon abatement horizons

Activity at a glance		
Theme lead: University of NSW	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		

Taking a far-reaching approach to decarbonisation, the Carbon Abatement Horizons Theme looks to support the transition to a Net Zero economy through non-traditional approaches that promise substantial deep cuts in emissions.

In support of this endeavour, the mining industry in NSW will play an increasingly important role.

Working through the Hub and with our industrial partners, we will explore the potential to develop NSW sources for critical (including rare earth) elements, essential for decarbonising the state and national economy. The need intersects with an opportunity for NSW as demand accelerates globally but with most resources vulnerable to geopolitical disruption (95% of global mining of rare earth elements is currently undertaken in China).

In this theme, the Network will lead integration of scientific, business, social and policy research and development to exploit the substantial NSW waste and volcanic deposits that are rich in these strategically-important elements, providing support to key activities in the other Networks within the Hub.

During the period of the Network, we aim to engage with resources sector partners to address the potential to develop new mining operations with a low-carbon footprint, offering a substantial export market whilst also supporting rural Australian communities currently dependent on mining.

In parallel to these efforts, whilst aggressive emissions reduction will remain central to reaching Net Zero, permanent atmospheric carbon dioxide removal using negative emission technologies (NETs) will become an essential component for reaching this goal. In support of this, proof-of-concept trials have identified a number of land and oceanscapes that will complement activities in Theme 1, providing avenues for major drawdown of atmospheric carbon, notably:

1. weathering materials generated from cement, aluminium steel production, and coal combustion
2. sequestration in near-shore marine environments ('marine blue carbon').

There is significant potential for abatement by simply mapping fugitive emissions and locating quick-win mitigation targets. Aircraft- and satellite-based GHG observations will be used to identify where emissions throughout NSW have been over- or under-reported in inventories, identify mitigation opportunities, locate overlooked sources of GHG emissions and be used to reduce emission factor uncertainty. Atmospheric GHG observations reduce carbon-associated liabilities, by showing governments and industry if mitigation spending is effective and if they are offsetting the right amount of carbon. The use of atmospheric observations to verify National inventories aligns with the IPCC Taskforce on National Greenhouse Inventories (TFI) recommendations, and links to work under Cross-Theme Program 1.

Theme 5 has primary carriage of the priority focus area Frontiers in carbon sequestration (Section 3.4.4).

Stakeholders

[tbd]

Timeline of key phases and deliverable of the activity/project for the next 18/12 months

- Apply for 3 grants to support Theme 5 activities (2023-2024)
- Align 1 or more PhD candidates with Theme 5 projects (2023-2024)
- Establish a working relationship with the NSW EPA to guide policy development and monitoring support.
- Hold a workshop on GHG emission monitoring and tracking methods (Q4 2023)
- Establish a working relationship with the NSW DPE to enhance the use of atmospheric observations for verifying GHG emission inventories.
- Jointly, review the emission factor for open cut coal mines (Q2 2024)
- Seek approval at UNSW to develop course content on carbon measurement, accounting, and management (2024-2025)
- Identify a project leader to develop NSW critical element resources (2024)

- Identify a project leader to exploit the substantial NSW waste and volcanic deposits that are rich in strategically important elements (2025)

3.7 Cross-Theme Program 1. Monitoring, modelling and assessment

Activity at a glance		
Cross-Theme Lead: Western Sydney University	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>Monitoring and modelling is essential to support the planning, upscaling and verification of deployed decarbonisation technologies, particularly in the broad spatial context of land management and primary industries like agriculture, forestry and mining.</p> <p>For carbon balance measurement, verification and reporting, earth observation technologies including novel sensors, satellite or drone-based remote sensing and AI techniques offer unprecedented resolution and accuracy at relatively low cost.</p> <p>For prediction of how climate change will affect ecosystem carbon stocks and carbon uptake capacity, process-based models are needed and key data gaps including carbon dynamics and greenhouse gas exchange of soils across diverse landscapes and under alternative management need to be filled.</p> <p>There are opportunities to improve the accuracy and utility of models through the assimilation of novel datasets (including e.g. flux towers, novel EO techniques and global change field experiments) to inform the design, location and monitoring success of land-based carbon abatement measures such as carbon plantings and soil carbon retention measures in broadacre agriculture.</p> <p>LPI includes developers of some of the most established and trusted models for carbon cycle analysis internationally and in Australia, also hosting key measurement infrastructure, such as WSU's highly instrumented TERN ecosystem supersite in Western Sydney Cumberland Plain woodland, and CSU, UNE, SCU and DPI demonstration and research farms.</p> <p>Tools such as Australia's community land surface model (CABLE, part of the ACCESS Earth system model) are relevant to improving the accuracy and utility of climate change projections and assessment of impacts on water resources, ecosystem services, bushfire risk/impact as well as carbon stocks and fluxes.</p> <p>Cross-Theme 1 has linkage to the priority focus areas Accelerating adoption of sustainable practices in productive landscapes (Section 3.4.1), Harnessing nature-based solutions: native and semi-natural ecosystems (Section 3.4.2), Embedding sustainable bioproducts in farm businesses and supply chains (Section 3.4.3), Frontiers in carbon sequestration (Section 3.4.4) and Embedding low-carbon solutions in vibrant cities (Section 3.4.5)</p>		
Stakeholders		
Network partners and members		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		
<ul style="list-style-type: none"> • Develop collaboration to integrate state-of-the-art ecosystem process modelling with earth observation and land management input to improve decision support for landholders interested in the adoption of sustainable land practices (Q4 2023) • Engage with relevant NCRIS facilities (e.g. TERN, APPF, ACCESS-NRI) to improve integration of carbon and climate impact modelling with NSW monitoring and inventory networks (Q2 2024) 		

- Pursue funding opportunities in collaboration with theme partners and network members to link model-based analysis to evaluation of proposed decarbonisation solutions (2023-2024)

3.8 Cross-Theme Program 2. Land-based circular economy

Activity at a glance		
Lead Institution: University of Wollongong	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>Circular economy (CE) is a promising direction in societal organisation that offers huge potential for reducing emission intensity and enhancing the sustainable use of resources while accelerating green jobs creation and economic growth.</p> <p>A CE is restorative or regenerative by design, replacing the end-of-life concept with restoration, shifting towards renewable energies, eliminating unnecessary waste and decarbonising supply chains.</p> <p>CE work so far is asset-focused (building, infrastructure) or product-focused (food, furniture, clothing), but there is an enormous opportunity to design and deploy more holistic and spatial approaches that cut across sectors and bring together knowledge providers with industries, businesses, communities and government.</p> <p>Initially, this cross-theme program will focus on regional place-based opportunities, such as the Bega Circular Valley Initiative, a core partner of the Hub, of which UoW is a founding member.</p> <ul style="list-style-type: none"> • Demonstration examples and case studies will be developed with local stakeholders. For example Bega Circularity Centre showcases exemplars of circularity in agricultural and food production. The design and building of the centre itself are envisaged as a model of circularity in construction. • These regional initiatives will showcase on-farm and in-community solutions that contribute to a land-based circular economy. • This knowledge and its outcomes will be shared with other communities in NSW, via field tours, citizen forums and extension programs. <p>A key output of Cross-Theme Program 2 will be an evidence-based and action-focused framework to successfully implement regional land-based circular economy.</p> <p>The cross-theme program will leverage UoW's world-class research capabilities such as the SMART Infrastructure Facility (zero emission transport, water-energy nexus) and the Sustainable Building Research Centre (life cycle assessment, sustainable materials, micro-grids).</p> <p>The program will also benefit from UoW strategic focus on circular economy and sustainable futures, as demonstrated by the recently created Energy Futures Network, as well as its key role in the Southern NSW Innovation Hub and its presence with a campus in Bega.</p> <p>Cross Theme 2 has primary carriage of the priority focus area Circular economy regional exemplars (Section 3.4.6) and linkage to the priority focus area Embedding sustainable bio-products in farm businesses and supply chains (Section 3.4.3).</p>		
Stakeholders		
[tbd]		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		
<ul style="list-style-type: none"> • Assessment and characterisation of biofuel waste from Bega Group's Lagoon Street incinerator as a potential supplementary cementitious material. This can be extended depending on the outcomes. For example, the ash might be employed in the building of the circulatory centre (Q4 2023) 		

- Circularity in oyster farming operations – opportunities for recycled plastic in oyster production. Potential collaboration with PACT, Australia’s largest plastics recycler. (Q2 2024)
- Material recovery versus demolition study for Bega Circularity Centre. (Q2 2024)
- Examine energy recovery systems in dairy and food production (2025)
- Develop monitoring to capture real time information on soil carbon levels to quantify sequestration opportunities (2025)
- Assess water management in the Bega Valley as a case study in resource self sufficiency (2025)
- A tool to estimate potential carbon uptake of seaweed culture on oyster & mussel farms on the south coast of NSW (2025)
- Design and validate machine learning models for food condition classification (2025)

3.9 Cross-Theme Program 3. Sustainable bio-products

Activity at a glance		
Cross Theme lead: NSW Department of Primary Industries	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>There is significant scope for decarbonization using sustainably derived bio-products to displace fossil-fuel based products, as we transition away from fossil fuels. Existing feedstocks and new, dedicated crops will be needed to meet future market demands.</p> <p>This theme is focused on both the use of biomass for traditional bio-energy applications and also for a range of novel bio-products.</p> <p>The scope of this theme will include:</p> <ul style="list-style-type: none"> • feedstock options for different areas of NSW; • matching feedstock types with suitable bio-product applications and strategies for optimising climate mitigation goals. <p>DPI has strong capabilities in this area, with established research programs on biomass availability and use, including:</p> <ul style="list-style-type: none"> • leading spatial characterization of existing biomass sources, • the development and monitoring of a network of field trials investigating native woody species as biomass crops, • investigations around grid-scale biomass use for electricity generation. <p>In terms of new bio-products, DPI has conducted world-leading research on biochar development, and also of the development of microbial strains that use agricultural biomass and waste streams to create biochemicals, biofuels and biomaterials (building on DPI partnerships with Macquarie University under the ARC Centre of Excellence in Synthetic Biology).</p> <p>Cross Theme 3 has primary carriage of the priority focus area Embedding sustainable bio-products in farm businesses and supply chains (Section 3.4.3), and linkage to the priority focus areas Accelerating adoption of sustainable practices in productive landscapes (Section 3.4.1), Embedding low-carbon solutions in vibrant cities (Section 3.4.5), and Circular economy regional exemplars (Section 3.4.6).</p>		
Stakeholders		
[tbd]		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		

- Identify and engage with key industry and academic stakeholder to explore collaboration opportunities in bio-products sector (Q4 2023)
- Develop a high-level discussion paper outlining key challenges and opportunities for the bio-products sector in NSW (Q2 2024)
- Pursue funding opportunities for novel liquid bio-fuels and bio-feedstocks for hard to decarbonise sectors, such as aviation and shipping (2023-2024)

3.10 Impact Mission 1: Capacity building and outreach

Activity at a glance		
Impact Mission Leads: Southern Cross University	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>By bringing together researchers, practitioners and natural resource managers, this impact mission will support research adoption and practice change throughout NSW as well as nationally.</p> <p>As recognised leaders in regenerative agriculture education, lead partner SCU can offer short courses, workshops and mentoring programs to enhance skills development in all areas of ecosystem services and regenerative agriculture, forestry and aquaculture practices.</p> <p>Skills development could include:</p> <ul style="list-style-type: none"> • carbon farming, • soil health and water infrastructure, • establishing collaborative business models around a number of themes such a circular economies, • achieving carbon neutral economies and carbon cooperatives. <p>This leverages SCU's core institutional mission to achieve real and lasting impact through collaboration and regeneration.</p> <p>Key capabilities supporting capacity building and outreach include:</p> <ul style="list-style-type: none"> • the SCU Farming Together Program, which fostered innovative, collaborative models to help groups consisting of 28,500 farmers, fishers and foresters to tackle issues such as climate change and drought resilience, delivering triple bottom line benefits across the country • the Regenerative Agriculture Alliance, now with >11,000 members • the Regional Circular Economy Accelerator (Recirculator) program (capacity building and outreach program), which helps regional and rural communities find solutions to complex problems through transdisciplinary, participatory engagement. This circular economy initiative blends industry knowledge with university expertise to improve community outcomes in regions. <p>Impact Mission 1 provides a vital platform for communication of outcomes from LPI activities within all priority focus areas (Section 3.4), and their integration within education, training and extension programs targetted towards relevant end-users and industries.</p>		
Stakeholders		
[tbd]		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		
<ul style="list-style-type: none"> • Engage with LPI partners and external stakeholder to explore capacity gaps and training opportunities of various kinds (Q2 2024) 		

3.11 Impact Mission 2: Knowledge translation and business development for SMEs and agribusiness

Activity at a glance		
Impact Mission Lead: University of Technology Sydney	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>This impact mission will ensure that the agribusiness and other SMEs in the L&PI network are able to grow and scale their decarbonisation innovations.</p> <p>It will leverage lead partner UTS's long experience with successful support for startups, including through EnergyLab -- the Australia/New Zealand region's largest climate tech startup accelerator and innovation network, dedicated to reaching net zero emissions. They connect talented founders to the mentors, advisors, partners, peers and investors they need to succeed and will play a key role in growing new businesses to support the decarbonisation agenda.</p> <p>Activities will include end-user engagement such as:</p> <ul style="list-style-type: none"> • showcase events to help facilitate engagement; • tailored engagement for Small and Medium Enterprises (SME) in addition to larger industry engagement activities directed to research, business development and knowledge translation; local Council engagement; • and community engagement, particularly recognising the "coop" model has proven to work effectively for shared infrastructure within local communities in regional areas. <p>Building on successful support for university-based undergraduate start-ups such as Cicada and Fishburner, we will provide training, tailored advice and mentorship to assist promising start-ups within agritech, cleantech, and carbontech areas.</p> <p>Other involved LPI core partner universities will leverage access to existing innovation infrastructure and services (e.g. WSU's LaunchPad) to facilitate rapid market establishment and growth.</p> <p>Partners' existing engagement in precincts will facilitate knowledge exchange/community building through online and face-to-face events within knowledge precincts and place-based focus areas for the collaboration, particularly Bega Valley, Tech Central, Western Sydney & Aerotropolis and through to the Central West.</p> <p>Impact Mission 2 will become increasingly important over time as a platform to support SMEs and startups in progressing the commercialisation and deployment of novel decarbonisation technologies and services informed by initiatives in all priority focus areas (Section 3.1).</p>		
Stakeholders		
Network members, collaborators in Themes		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		
<ul style="list-style-type: none"> • Internal LPI workshop to inform the approach to knowledge exchange, translation and business development (Q3 2023) • Build stakeholder engagement with existing innovation infrastructure and precincts (Q4 2023) • External webinar and/or workshop on translation case study to identify SME needs (Q2 2024) • Showcase event at EnergyLab or WSU LaunchPad (2024-2025) • Collaborate to contribute to precinct-based events (2024-2026) 		

3.12 Impact Mission 3: Legal and Policy frameworks

Activity at a glance		
Lead Institution: NSW Department of Planning and Environment	Activity timeframe, Activity budget	Lever of Change (ie. what is the primary focus of the intervention?): Technology; Skills and capabilities; Organisation culture & strategy; Policy and regulation; Business models & markets; Data & information flows; Finance & investment
Summary		
<p>Institutional issues are a common source of innovation underperformance or failure. Initiatives developed within the Decarbonisation Hub will require some level of institutional change and policy relevance for effective implementation. Such change and policy formulation will require institutional capabilities - understanding of: public regulation, policy and implementation and reform through establishment or revision of rules, policies and standards.</p> <p>Effective public policy measures also rely on social licence to ensure public support for change, and large-scale adoption of proposed new technologies and practices, which requires understanding of socio-economic, behavioural and cultural factors that may constitute barriers to change.</p> <p>NSW DPE is the key regulatory body in NSW with regard to planning, industry and environment with a lead role in providing knowledge needs for evidence-based policy formulation and implementation across the State and are key to policy-relevant outcomes from the Hub and Network.</p> <p>Working with partners across the Hub and Network, SEI Division of DPE will guide this cross-cutting theme to ensure policy alignment and relevance of outputs and outcomes to optimise carbon positive benefits for the State.</p> <p>Note: This Impact Mission is not currently linked to a specific priority focus area (Section 3.4) as co-design work perceived that specific projects may be unfeasible with currently available resources and not deemed a priority. However, solutions for institutional change will become more relevant as projects under other streams of LPI (and across the Hub) yield new insights on opportunities and barriers for decarbonisation.</p>		
Stakeholders		
[tbd]		
Timeline of key phases and deliverable of the activity/project for the next 18/12 months		
<ul style="list-style-type: none"> No planned activities for the period covered by this workplan; opportunities to engage with government to inform policy and regulation are expected to emerge later in the program from insights and outcomes from activities in other LPI streams. 		