

NSW Innovation and Productivity Council

Innovation in the NSW environmental goods and services sector

Research by the NSW Innovation
and Productivity Council

February 2019



Foreword from the Chair

We are experiencing a global renaissance in technological innovation. This new wave is increasing productivity, raising living standards, and tackling issues around climate change and sustainability. There is a boom in environmental technology, which, fuelled by significant investment in research and development, has seen global patents for green innovations grow four times faster than average.¹

The environmental goods and services (EGS) sector is growing at a faster rate than the wider economy, with the global market for environmental goods projected to triple between 2011 and 2020. In Europe, the EGS sector has created over one million new full-time equivalent jobs in the last 15 years.

The NSW Innovation and Productivity Council's (IPC) research examines international best practice approaches for supporting the growth of the EGS sector. It found that NSW has significant research and industry strengths, which create a strategic regional advantage and provide strong potential for innovation-led growth that will help transition us to an innovation economy.

In 2017-18, the NSW EGS sector was worth around \$43.9 billion and growing at a rate of 7.1% per annum. Currently, NSW EGS exports are worth \$3 billion. Much of the demand is from our key trading partners, including mature markets with stringent regulatory standards.

Despite NSW's competitive advantage, the EGS sector is currently fragmented with linkage gaps between researchers, innovators, industry and end users in the product life cycle. Creating a coordinated innovation agenda sends a strong, consistent signal that EGS is a priority sector for the state, and will create opportunities to develop and build on our international networks and tap into global markets.

I am pleased that the IPC's research is already being used—it has provided the foundation for the NSW Chief Scientist and Engineer's recently launched NSW Circular Economy Innovation Network, which aims to improve connectivity, address supply chain gaps and technology development.

The research has also contributed to the NSW Environmental Protection Authority's (EPA) NSW Circular Economy Policy, which provides a framework for implementing initiatives to improve product life cycles, and reduce waste and pollution.

It is also encouraging to see the development of supporting policies, which can be further informed by this research, such as the 20-year waste strategy being led by the NSW EPA in partnership with Infrastructure NSW. The strategy will set the state's vision for reducing waste, driving sustainable recycling markets, and identifying and improving the waste infrastructure network.

These are all exciting developments, and we commend this research as a catalyst to continue to stimulate discussions about the economic importance of the EGS sector in NSW.



Mr. Neville Stevens AO
Chair, NSW Innovation and
Productivity Council

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Executive summary

This report was developed by the NSW Innovation and Productivity Council (IPC) to examine the environmental goods and services (EGS) sector in NSW, Australia and internationally. This report presents an economic profile of the EGS sector, examines the state's competitive advantage including its research and industry strengths, and explores ways NSW can capitalise on market opportunities.

The EGS sector and its economic value

The EGS sector is a multidisciplinary set of corporations, local businesses and research organisations delivering waste, wastewater, water, energy management, renewable energy, adapted goods, biodiversity and landscape, and air and climate services.

There is a growing recognition that new technologies and other innovations can provide a tangible means to achieve sustainability and improved wellbeing. This is seeing a shift away from treating environmental impacts as expensive externalities and a move towards a more sophisticated integration of economic and environmental value. The EGS sector provides technologies, goods and services to reduce the environmental impacts and increase the resource productivity of a broad range of industries critical to the NSW economy.

Recent global growth trends in the sector far exceed those of the wider economy. In the European Union (EU), the EGS sector's output-to-GDP ratio rose nearly two percentage points between 2000 and 2014, and created over one million new full-time equivalent (FTE) jobs. The size of the global market in environmental goods is expected to reach US\$3 trillion by 2020.

In NSW, domestic EGS sales grew by 7.1% in 2017-18 to reach \$43.9 billion², while the current value of NSW EGS exports is estimated at \$3 billion. The top four export markets for the NSW EGS sector are Japan, South Korea, China and India.

The EGS sector employs a growing proportion of the global workforce. In NSW, the number of jobs in the EGS sector is estimated at 152,000, larger than the total number of jobs in agriculture and mining combined.³ Coupled with an average 6% employment growth rate,⁴ employment in the EGS sector is growing at a faster rate than the NSW average annual employment growth of 1.6%.⁵ A quarter of the sector's new jobs are projected to be located in regional NSW.

NSW has a competitive advantage in EGS

In NSW, EGS is an innovation-rich sector with recognised research and industry strengths, and a competitive advantage over neighbouring states.

NSW is home to 43% of Australia's EGS businesses and 44% of its 'innovative' EGS businesses—double Victoria's share. Major sub-industries in NSW include recovery and recycling, water and wastewater treatment, building technologies, cleaner manufacturing, processes and materials, and renewables. In addition to environmental and economic benefits, research shows that a strong and mature EGS sector has spillover productivity gains that compound along supply chains and across industry sectors.

NSW owes much of this advantage to its strong higher education and research sector. Our universities lead the world in 10 EGS-related fields, and 17% of university patents since 2014 were for EGS innovations.

The EGS sector has a strong presence in regional NSW, with more than 2,000 businesses located in regional areas.

NSW also has a number of internationally recognised best practice policies in EGS. These include the NSW-run National Australian Built Environmental Rating Scheme (NABERS) and the white certificate Energy Savings Scheme (ESS).

International experience

A comprehensive review of international environmental policies and NSW initiatives identified common elements that provide a framework to address local barriers and successfully drive innovation. These include:

- understanding what works and disseminate and replicate lessons through the market
- knowing the market and engage with the actors that can bring about the desired change
- creating the space for market-led actions through a clear mandate, funding support and long-term signals
- brokering adoption of innovation at scale, with local relevance to provide the strongest support for market delivery.

This research identified three factors that are specific to NSW and are vital to optimise its research and industry strengths, and capitalise on market opportunities:

1 Networks and collaboration

Strong relationships between universities, industry and end users

2 Importance of markets

Investment confidence and market demand

3 Scaling for export

International demand for EGS products and services

Network and collaboration

The NSW EGS sector is highly diverse and includes researchers, startups, businesses and end users working across a broad range of subsectors. Research of the NSW sector found that a lack of formal networks to link innovators, businesses and end users was hampering collaboration and innovation efforts. International and local examples, such as US-based Clean Energy Smart Manufacturing research network, and the NSW Energy and Resources Knowledge Hub, identified successful networks/hubs as a mechanism to overcome these information barriers and make connections that broker institutional and professional connections and build a strong sector ecosystem.

Importance of markets

A major challenge facing innovators in the NSW EGS sector is proving to a sceptical market that their products have the right environmental credentials, and providing the right market signals. International research identified a number of successful approaches, including sustainable procurement practices that can drive demand and improve credibility, and financial rewards to provide strong market signals through innovation challenges and competitive grants.

Scaling for export

EGS innovators can face difficulties getting to the scale needed to exploit export opportunities, particularly for new-to-world or new-to-market innovations. Clear market signals and the importance and value of EGS to the economy are important factors, while growing the local market demand for EGS products can also help providers scale up for export.

These international best practice approaches and experiences in growing EGS sectors provide insights on how the EGS sector can be best supported and boost its performance in the NSW context. By leveraging its significant research and industry strengths, and its physical advantages of a clean natural environment, NSW can create a strategic regional advantage in EGS. This will provide strong potential for innovation-led growth that will help transition NSW to an innovation economy.

1

The EGS sector and its economic value

Made up of a multidisciplinary set of corporations, local businesses and research organisations, the EGS sector delivers economic value by improving resource efficiency, mitigating negative environmental impacts and enhancing natural assets.

1.1 What is the EGS sector?

The EGS sector includes businesses delivering waste, wastewater, water, energy management, renewable energy, adapted goods, biodiversity and landscape, and air and climate services.

It operates economy-wide, with core customers in government and the construction, utilities, manufacturing, mining, agriculture, forestry and fisheries industries.⁶

Environmental goods and services are designed to make more efficient use of resources, prevent or repair costly environmental damage caused by economic activities, or create new economic value by enhancing the quality and health of natural spaces.

The EGS sector delivers productivity co-benefits by:

- reducing input costs
- increasing outputs
- creating new opportunities for revenue
- avoiding the expense associated with environmental remediation
- protecting natural spaces that provide critical ecosystem and economic services.

1.2

Drivers and opportunities

There is a growing recognition that new technologies and other innovations can provide a tangible means to achieve sustainability and improved wellbeing. There is a shift away from treating environmental impacts as expensive consequences that are borne by unrelated third parties, and towards a more sophisticated integration of economic and environmental value.

1.2.1

The global shift

New technologies and process innovations are changing the economic value of resources embodied in consumer goods and primary waste streams. This supports the global emergence of secondary markets in reprocessing waste into new resources. In NSW, newly developed mining process innovations are maintaining and even improving yields while significantly reducing onsite water consumption.⁷ These kinds of innovations deliver a direct benefit to the business's productivity and bottom line. Reducing the environmental impact and increasing the ease of regulatory compliance allows more expansive operations that can more efficiently extract resources to increase the amount of saleable product.

A stronger EGS sector can also mitigate the impact of environmental issues on business. Twenty per cent of Australian businesses report being significantly affected by environmental issues and 43% are taking measures to minimise their impact on the environment.⁸

Innovation-active businesses are also nearly 1.4 times more likely to be taking action to reduce their environmental impact than other businesses.⁹

The most common activities relate to reducing inputs of resources like water and energy, and lifting the rates of material reuse and recycling. Producing more with less is the very definition of productivity growth.

1.2.2

The market opportunity

Recent global growth trends in the EGS sector have far exceeded those of the wider economy. The global market for environmental goods was valued at US\$1 trillion in 2014, and is projected to expand to US\$3 trillion by 2020.¹⁰

The EGS sector employs a growing proportion of the global workforce. Over five million professionals—more than 1% of the global LinkedIn user base—include the word 'environmental' in their job description. Environment-focused businesses are almost three times more likely to be hiring than other businesses globally.¹¹ In the EU, the sector's output-to-GDP ratio rose nearly two percentage points to 5.1% between 2000 and 2014. This created over a million additional FTE jobs.¹²

Many of the World Economic Forum's annual top 10 most promising technologies have a clear environmental focus, from energy-efficient water purification and carbon dioxide conversion, to bio-based chemistry. A local example in NSW is the CSIRO's development of GraphAir, a new graphene membrane made from renewable bio-based materials. GraphAir outperforms conventional filters and has wide applications from decentralised rural water supplies to end-of-pipe solutions for industrial wastewater.¹³

Figure 1
ANZSIC industry codes mapped to EGS subsectors

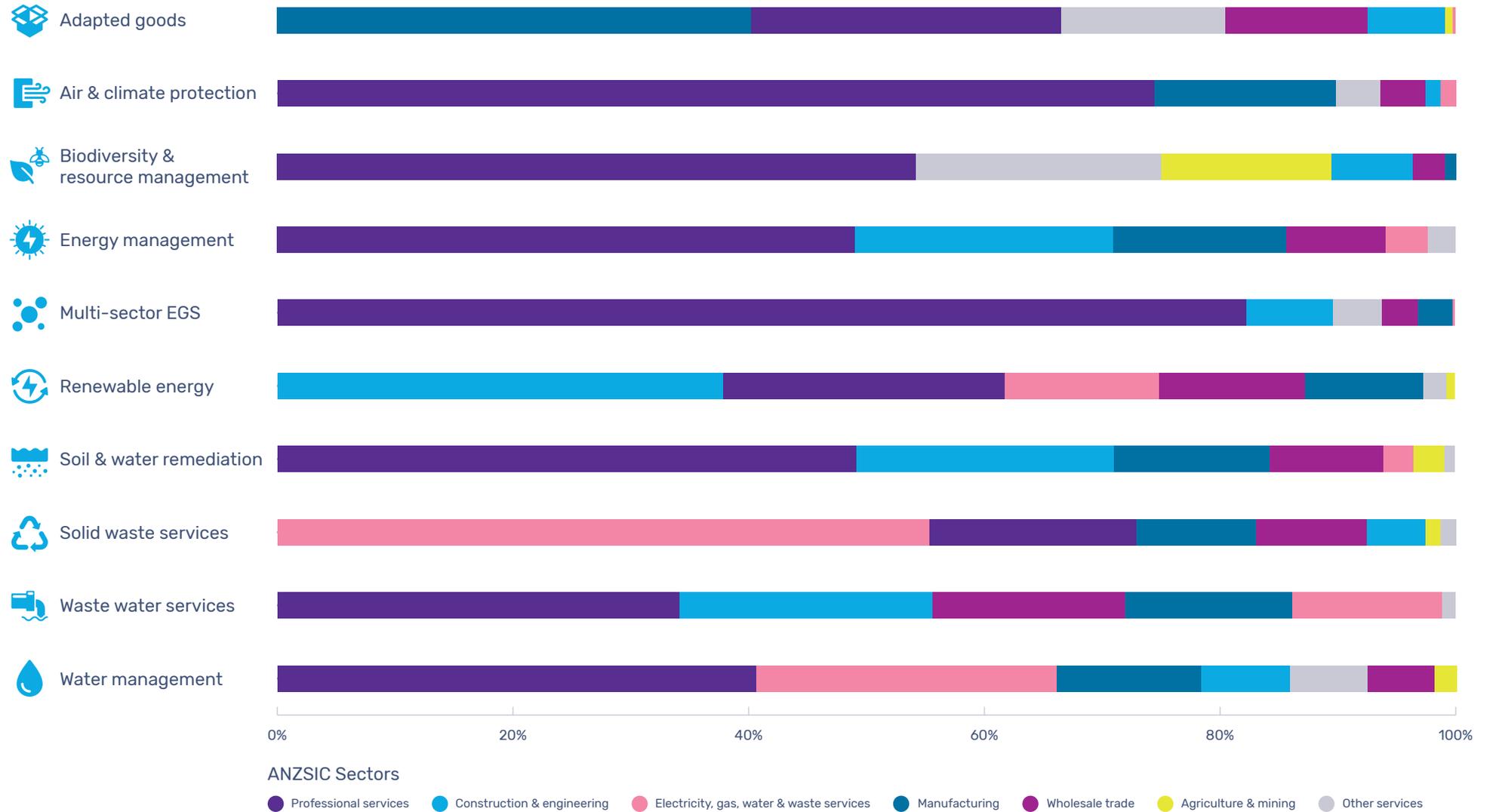


Table 1

NSW EGS subsectors mapped to Eurostat industry categories

NSW subsectors	NSW activities	Eurostat classification
 Adapted goods	<ul style="list-style-type: none"> Adaptation in: health, transport Low carbon built environment Building technologies Cleaner manufacturing and cleaner processes and materials 	13C Minimisation of the intake of fossil resources as raw material for uses other than energy production
 Air & climate protection	<ul style="list-style-type: none"> Air pollution control; carbon capture and storage 	1 Protection of ambient air and climate
 Biodiversity & resource management	<ul style="list-style-type: none"> Adaptation in: agriculture and forestry; disaster preparedness; natural environment Environmental resilience; biodiversity; environmental monitoring, instrumentation and analysis; marine pollution control 	6 Protection of biodiversity and landscape 11 Management of forest resources 12 Management of wild flora and fauna 14 Management of minerals 16 Other natural resource management activities
 Energy management	<ul style="list-style-type: none"> Adaptation in: built environment; energy; professional services Additional energy sources; energy management 	13B Heat/energy saving and management
 Multi-sector EGS	<ul style="list-style-type: none"> Environmental consultancy and related services; noise and vibration control 	5 Noise and vibration abatement 9 Other environmental protection activities
 Renewable energy	<ul style="list-style-type: none"> Biomass; geothermal; hydroelectric; photovoltaic; renewable energy consultancy; wave and tidal; wind 	13A Production of energy from renewable sources
 Soil & water remediation	<ul style="list-style-type: none"> Contaminated land reclamation and remediation 	4 Protection and remediation of soil, groundwater and surface water 7 Protection against radiation
 Solid waste services	<ul style="list-style-type: none"> Energy from waste; recovery and recycling; waste management 	3 Waste management
 Waste water services	<ul style="list-style-type: none"> Water supply and wastewater treatment 	2 Wastewater management
 Water management	<ul style="list-style-type: none"> Adaptation in: water 	10 Management of waters

1.2.3

Challenges in defining the EGS sector in Australia

In the EU and other leading economies, environmental goods and services is a recognised and economically valuable sector, with strong administrative and policy datasets¹⁴ that track industry performance, jobs growth and economic impacts. In Australia, EGS is relatively young and has not yet been recognised as a discrete industry, so does not feature in economic or policy reports as such. There have been some efforts from the ABS and others to research the boundaries of the sector,¹⁵ but in wider publications EGS tends to be described under the banner of ‘environmental technologies’ or ‘cleantech’. This does not cover the full range of activities and services provided by the sector, which works across a range of ANZSIC industry codes (Figure 1). The EGS subsectors have also been mapped to the Eurostat categories (Table 1).

1.3

The economic value of the NSW EGS sector

In NSW, domestic EGS sales grew by 7.1% in 2017–18 to reach \$43.9 billion,¹⁶ of which \$10.9 billion was in renewable energy. The GDP for NSW as a whole in the same period was \$593 billion¹⁷ while the overall NSW economy grew by 2.6%.¹⁸

1.3.1

A growing export market

The current value of NSW EGS exports is estimated at \$3 billion,¹⁹ including \$784 million in renewables. This reflects Australia and NSW’s strong trade relationships with regional partners across Asia, where booming economies and an increasing concern for environmental issues from a growing middle class have produced strong regional demand for EGS.

NSW EGS businesses confirm that much of the demand for their products comes from overseas, including mature markets with more stringent regulatory standards.²⁰ For example, demand for NSW concrete products made from fly ash (a by-product of coal combustion) is driven by markets where end users pay levies based on a product’s embodied carbon (i.e. fly ash products are more cost-effective than traditional emissions-intensive cement).

In China, a long-term plan to improve water quality has created significant opportunities for an Australian company that is commercialising CSIRO technology to remove phosphate in waterways in order to prevent algal growth.²¹

The top four export markets for NSW EGS are Japan, South Korea, China and India, all of which are priority markets with dedicated NSW Government international trade teams. These countries have made public statements that signal their intention to make extensive use of EGS in the coming years, with China setting ambitious targets to improve air quality in its cities, and India relying heavily on photovoltaic solar to improve energy access for its citizens. These types of environmental targets—whether they be self-imposed or the result of international negotiations—will continue to be a feature of global politics and a central driver of EGS sector growth into the future.

1.3.2

NSW EGS jobs are significant and growing

The number of jobs in the NSW EGS sector is on par with the agricultural and mining sectors combined.²² EGS is the core business for almost 65% of a sample of more than 1,200 NSW businesses involved in the sector—that is, the primary purpose of more than 50% of their business is to deliver an environment benefit.

This includes categories such as:

- energy and heat management
- energy and renewables
- waste water services
- solid waste services
- adapted goods
- biodiversity and natural resource management
- water management (non waste)
- soil and water remediation
- air and climate protection
- general EGS.

EGS allied businesses are those in the sector that have less than 50% of their operations focused on environmental benefit.

Detailed analysis of the NSW market estimated 152,000 EGS jobs in NSW, including 40,000 in renewable energy. In 2016, the combined total number of FTE jobs in agriculture (73,000) and mining (32,000) was 105,000.²³ EGS employment in the state is also growing at an average of 6% p.a.²⁴—compared with NSW's average employment growth of 1.6% a year²⁵—and this is expected to increase as domestic and global EGS markets expand.

A quarter of the sector's new jobs are projected to be located in regional NSW.²⁶

Figure 2

Australian EGS businesses, subsectors and jobs

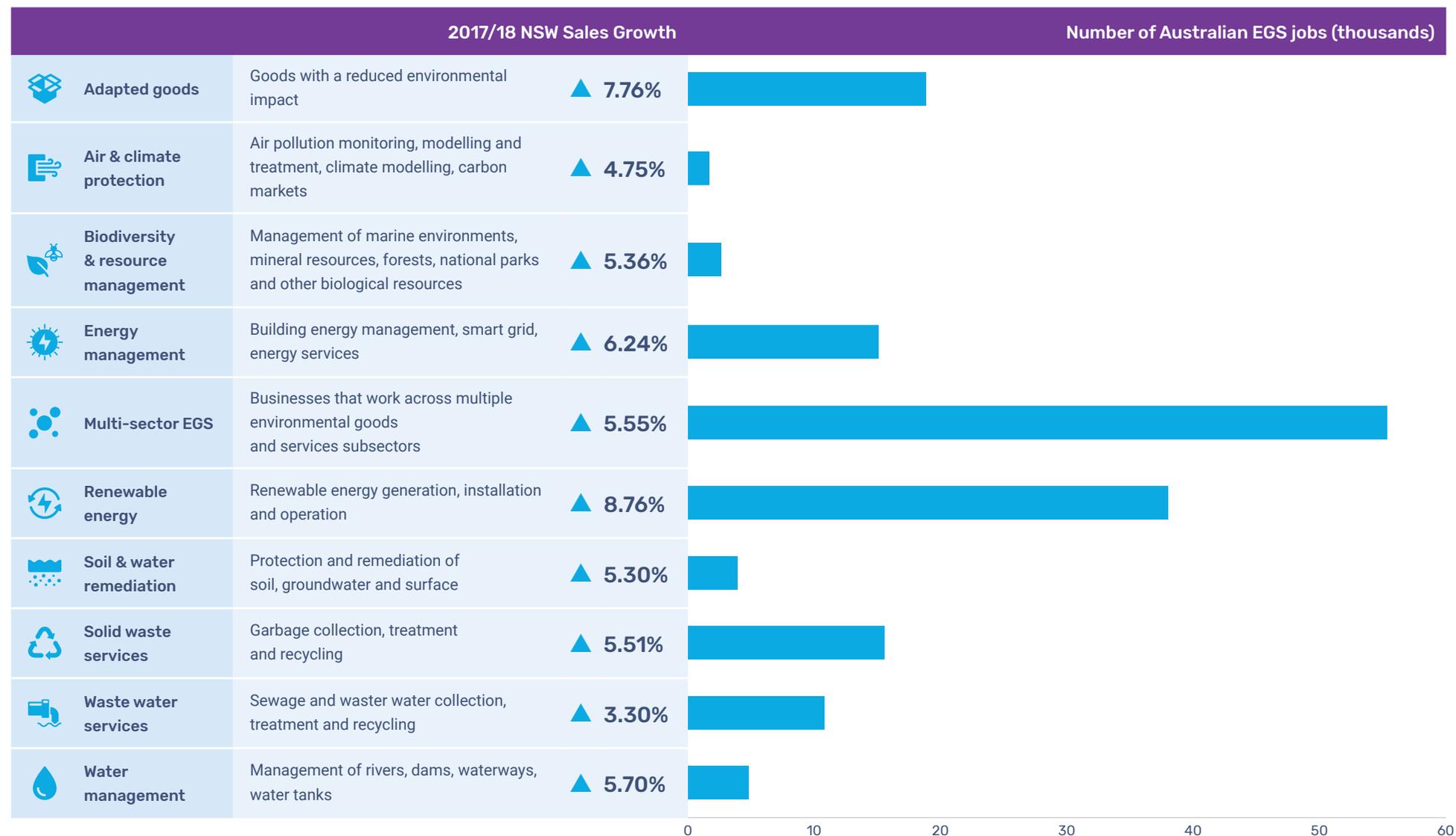
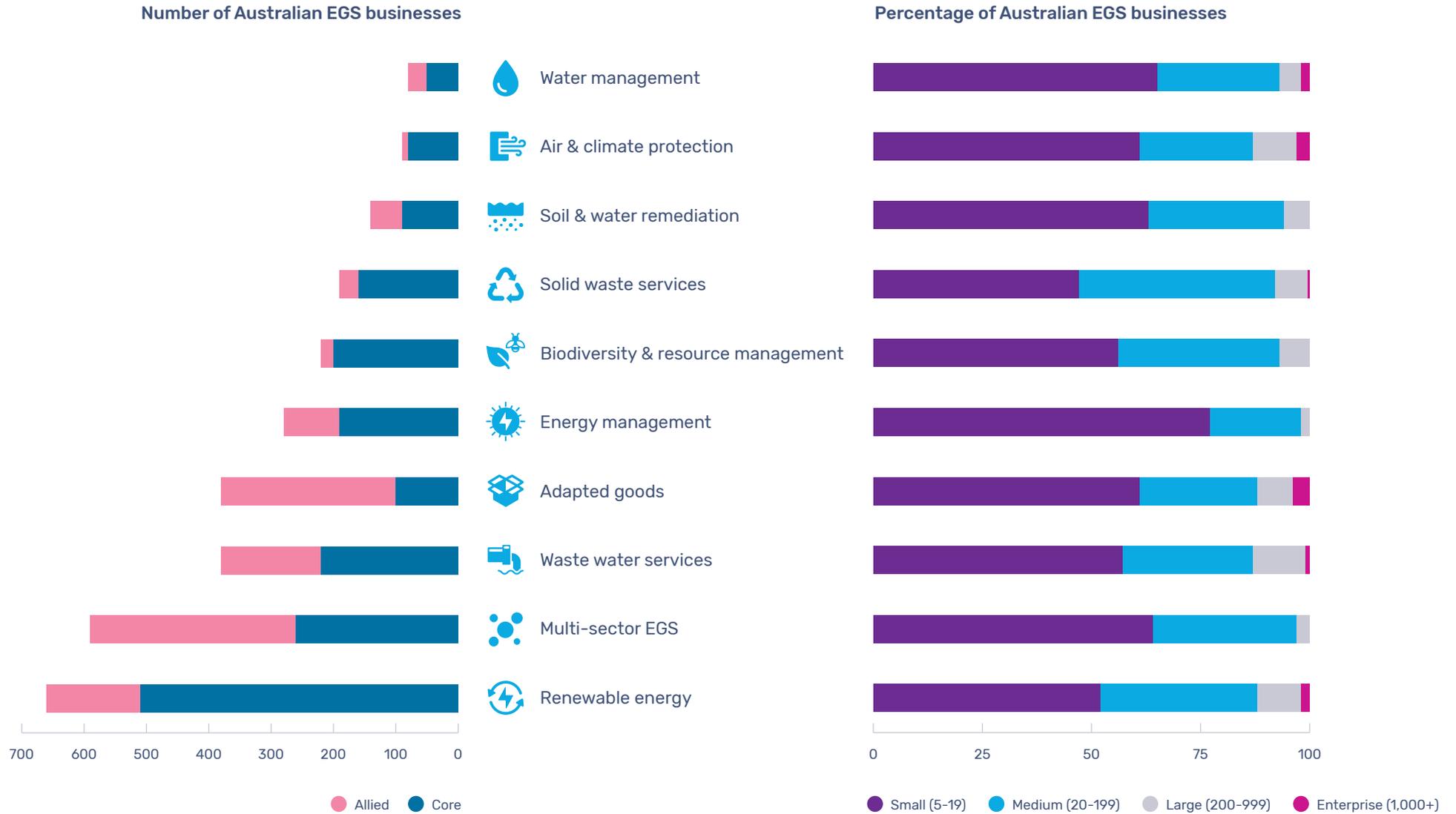


Figure 3

Australian EGS businesses, subsectors and jobs



2

NSW's competitive advantage in EGS

NSW has globally competitive advantages and natural physical advantages in EGS. Australia is renowned internationally for its clean natural environment and attracts almost nine million international visitors each year, with more than half visiting NSW.²⁷ Among the top five activities that international travellers engage in are sightseeing, going to the beach and visiting national and state parks.²⁸ Australia's clean air and water, highly liveable cities and outdoors-focused lifestyle has helped to build a well-known international reputation for environmental performance.

2.1

The sector is diverse and NSW is home to a large share of innovative EGS businesses

Analysis of a sample of over 3,300 EGS organisations found that the Australian EGS sector is made up of 10 diverse subsectors.²⁹ Multi-sector EGS is the largest group, employing 33% of the workforce, typically in large engineering and environmental consultancies.³⁰

Types of organisations in the EGS sector include research institutes (1.6%) and industry associations and non-profits (6.3%), but the majority are small businesses (61%).³¹ Interestingly the sector has a larger representation of medium firms (31%) than is typical, and its large business cohort (7.3%) includes 25 organisations with over 2,000 staff.³²

NSW is home to 43% of Australia's EGS businesses (but is only a third of the Australian economy) and 44% of its 'innovative' EGS businesses, which is double the share of the next strongest state.³³ Innovative EGS companies are identified as those that have a strong digital business model, active partnerships with research institutions or technology companies and a global marketing focus or recognition of excellence in innovation awards.³⁴

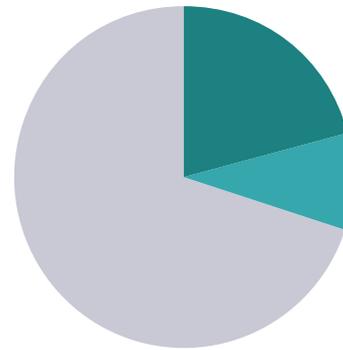
Figure 4
The EGS sector in NSW

The NSW EGS sector

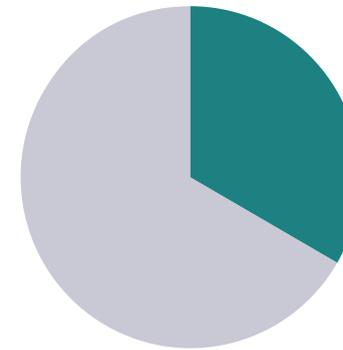
152,000 jobs

\$43.9bn in domestic sales

\$3bn in exports



21-30%
of EGS organisations are
in **regional NSW**



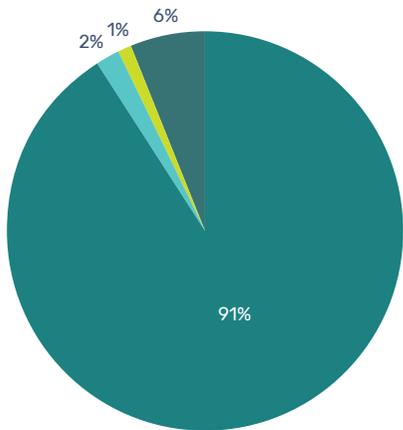
~1/3
of EGS organisations are
in **renewable energy**

Top regions by subsector

	 Adapted goods	 Air & climate protection	 Biodiversity & resource management	 Energy management	 Multi-sector EGS	 Renewable energy	 Soil & water remediation	 Solid waste services	 Waste water services	 Water management
1	Hunter Riverina Murray	North Coast	North Coast	Hunter	Hunter	Hunter	Hunter	Central Coast	Hunter	Hunter North Coast
2	Illawarra Shoalhaven	Hunter	Riverina Murray Hunter	Illawarra Shoalhaven	North Coast	North Coast	Riverina Murray	Hunter	Central West North Coast	Central West & Orana
3	Central Coast North Coast	Central Coast	New England & Northwest	North Coast Central Coast	Illawarra Shoalhaven	Illawarra Shoalhaven	Southeast & Tablelands North Coast	Illawarra Shoalhaven North Coast	Illawarra Shoalhaven	Riverina Murray Illawarra Shoalhaven

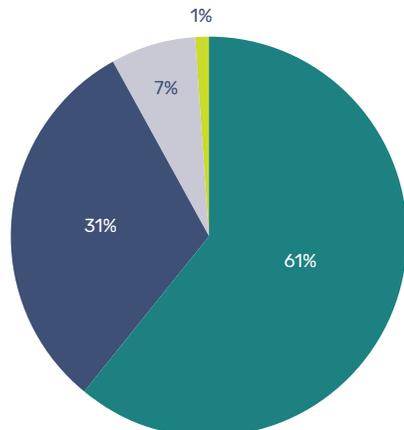
Figure 5
EGS businesses breakdown

Australian EGS organisations by type



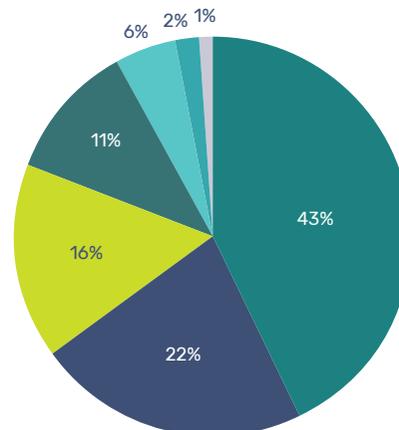
- Business
- Education/research
- Government
- Associations

Australian EGS businesses by size



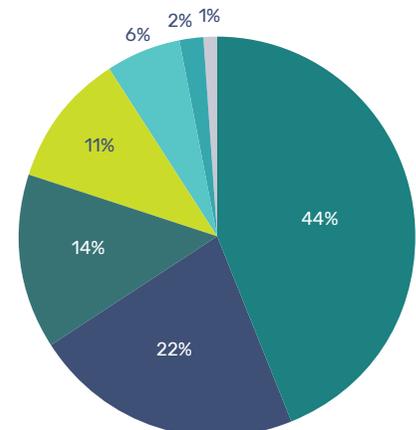
- Small (5-19)
- Medium (20-199)
- Large (200-999)
- Enterprise (1,000+)

Australian EGS businesses by state



- NSW
- VIC
- QLD
- SA
- ACT
- TAS

Innovative Australian EGS businesses by state



- NSW
- VIC
- QLD
- SA
- ACT
- TAS

2.2 NSW EGS research capabilities

The state has particular strengths in recovery and recycling, water and wastewater treatment, building technologies, cleaner manufacturing, processes and materials, and renewables.

NSW is home to the top 10 global researchers in the fields of building simulation (University of Wollongong), membrane science (UNSW and UTS), environmental remediation (University of Newcastle), desalination (UTS), solar cells (UNSW) and rechargeable battery technology (University of Wollongong & University of Sydney) (see Table 2). They also have a greater proportion of top 10 researchers than neighbouring states. NSW universities received at least \$35 million in EGS research grant funding last year, and 17% of the patents they registered since 2014 were for EGS innovations.³⁵

NSW EGS researchers are working in private research and development (R&D) labs, university departments and Cooperative Research Centres that link established research strengths with industry partners. There are currently more than 60 university-led research centres across the state that target environmental issues in different subsectors (see Appendix 1).

In Sydney, UNSW's Sustainable Materials Research and Technology Centre is driving the roll-out of microfactories, which use patented technology to extract reusable resources from waste streams. The University of Newcastle's Global Centre for Environmental Remediation is developing effective and affordable approaches to contamination science and land clean-up, while the University of New England Institute for Rural Futures is working with the NSW Environmental Trust to find cost-effective solutions to deliver environmental water to the state's wetlands and rivers.

Table 2
Selected NSW university research / industry collaboration and alumni

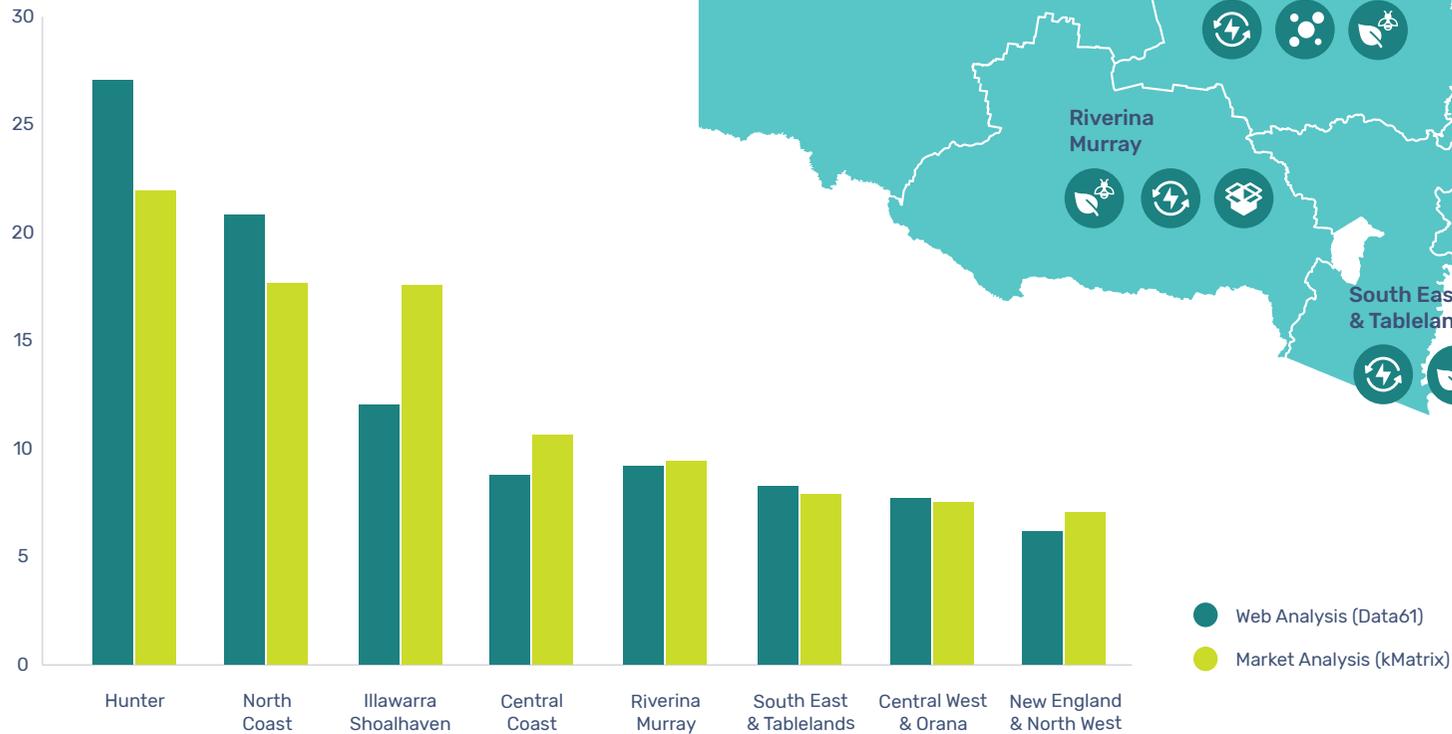
Strength	Example commercial partnerships / spinouts	Alumni ³⁶
Photovoltaics University of NSW	<ul style="list-style-type: none"> Partnership with Greatcell Solar on third generation solar photovoltaic (PV) technology that uses perovskite solar cells to develop an ultra-thin, highly efficient layer of solar energy cells that can be applied to multiple building surfaces. 	886 alumni (since 1974*) 55% working in NSW
Rechargeable batteries University of Wollongong	<ul style="list-style-type: none"> Partnership with China's Tianneng Battery Group to develop next generation high-energy-density lithium-ion batteries. Launched AquaHydrex, which is partnering with ARENA on power-to-gas trials to store excess renewables in gas grid. 	120 alumni (since 1994*)
Water filtration University of NSW	<ul style="list-style-type: none"> Launched the Memtec low-pressure water microfiltration company that sold in 1998 for \$600m 	504 alumni (since 1973*)
Water treatment UTS	<ul style="list-style-type: none"> Launched the Aerofloat mechanically simple compact wastewater treatment technology company in 2009. 	197 alumni (since 1979*) 80% working in Australia
Environmental remediation University of Newcastle	<ul style="list-style-type: none"> Launched Innova Soil Technology company for the safe, reliable and efficient treatment of hydrocarbon-contaminated soils. 	363 alumni (since 2005*) 85% working in Australia

*Year a world-leading researcher in that topic commenced at the university
Source: CSIRO Data61 analysis 2018

Figure 6
The EGS sector in regional NSW

2,000+
 Regional businesses

Distribution of regional EGS businesses



Top subsectors by region

- Adapted goods
- Multi-sector EGS
- Biodiversity & resource management
- Renewable energy
- Solid waste services
- Waste water services



Note: Number of businesses identified in the Far West region was too low to allow statistically valid analysis of subsector strengths.

2.3 NSW Government initiatives

The NSW Government delivers a range of regulations, policies and programs that either work directly with the EGS sector, or more broadly support innovation, entrepreneurship and commercialisation, often in partnership with universities.

Under the NSW Innovation Strategy, relevant innovation initiatives are being delivered by the Department of Finance, Services and Innovation and the Department of Industry, with additional startup support from Jobs for NSW. The Jobs for NSW policy to support tradeable sectors with the potential to become globally competitive and create large numbers of resilient jobs identifies environmental technologies as a priority for NSW.³⁷

On the environment side, the NSW Environment Protection Agency (EPA) has both regulatory and program functions, particularly in the waste sector, including funding that is earmarked for innovation. The Office of Environment and Heritage (OEH) administers business-facing programs under the Climate Change Fund and the Environmental Trust, and an extensive range of environmental grants and initiatives that directly or indirectly engage with the EGS sector.

NSW EGS businesses and innovators also have access to Commonwealth and local government innovation and environmental funding streams, and this list expands again when university-led initiatives are considered.

2.3.1 NSW EGS best practice policies are boosting innovation and energy efficiency

NSW has a number of internationally recognised best practice policies in EGS, which have enhanced its strong industry base and driven local innovations.³⁸ This is particularly apparent in the NSW-run National Australian Built Environment Rating Scheme (NABERS)³⁹ and the energy efficiency and energy management sector under the white certificate Energy Savings Scheme (ESS).⁴⁰

NABERS is globally renowned for delivering deep cuts in commercial building energy use. NABERS relies on close collaboration and information-sharing with industry, and has seen the growth of service and technology innovations that improve NABERS ratings, including building management system hardware and software, and portfolio management tools.

The ESS created a competitive market and provided financial incentives for suppliers and manufacturers to develop innovative products and services that deliver energy savings at least cost. NSW is now leading the world in the widescale adoption of efficient lighting, with a vertically integrated market structure and innovative products developed by Australian manufacturers that have captured significant market share from established multinationals.⁴¹ Similarly, the NSW Biodiversity Offsets Scheme has created a regulatory environment that rewards innovation in the biodiversity and landscape management sector.⁴²

3

Applying international EGS experience to NSW

Analysis of a broad range of international environmental policies and NSW initiatives⁴³ shows that programs successful in delivering both environmental benefits and innovation share some common attributes. The lessons from international experience have identified factors that are vital to optimise NSW's competitive advantage in the EGS sector.

3.1 International experience

Successful programs work closely with the market to create investment certainty, overcome coordination failures and build demand for innovative EGS products. They have evolved their approach from just setting rules that curtail environmentally damaging activity, to changing market conditions so as to motivate end users to seek out innovations to improve their environmental performance (see Appendix 2 for a shortlist of the 35 most successful international programs).

These international programs send strong market signals that clearly communicate policy intent and also often play a brokering role in drawing together innovators and market actors. The strongest signals are financial and come in the form of market-based instruments such as white certificate schemes, or economic incentives including differential licence or registration fees based on levels of environmental pollution.

3.2 The role of government

Government regulation and policy significantly shape the activity of the EGS sector, and the rate of new business entries closely follows large-scale policy initiatives.⁴⁴

A review of international best practice found that government interventions that deliver significant economic and environmental benefits, and support innovation in industry sectors of strategic interest are those that:

- support commercialisation through sector-specific funding streams and programs that draw in co-investment and outline incentives for researchers to collaborate with business
- address co-ordination failures by cultivating strong connecting networks that share information and encourage deep collaboration
- stimulate demand through trade promotion and competitive public procurement
- create the right business climate through pro-innovation regulatory reforms
- make a long-term policy commitment to the sector while fostering industry leadership, so that most of the effort comes from the market.⁴⁵

The rationale for government action to support any innovation in the market is diverse, ranging from ensuring the supporting infrastructure is in place so that the innovation ecosystem can thrive, to addressing investment deficits by investing in basic research and incentivising private investment—directly or indirectly (Table 3).

For example, persuasive or light-handed government measures may include providing clear information that increases demand for EGS, such as credible environmental rating schemes. More direct measures could include regulations that can be effective in driving innovation to meet new environmental standards.

Government also has a role in correcting information (for example, coordination) failures by helping research institutions to innovate, fostering highly networked innovation ecosystems and enhancing their visibility and brand identity.⁴⁶

As a major consumer, governments can also send financial signals by demanding EGS products directly through competitive procurement policies. As a policy developer, government can create investment certainty by setting realistic, measurable and long-term environmental targets, with dedicated funding where it maximises social welfare.

Table 3**Focus of successful EGS programs⁴⁷**

Focus	Activities	Examples
Build networks at scale	Large industrial communities recover, reprocess and reuse unwanted or underused resources under a unified brand	UK's Industrial Symbiosis Network
Develop niche markets	Focus on emerging areas of competitive advantage and create commercialisation and testing hubs	Belgium's bio-based Economy Hub
Drive domestic demand	Government commissions environmental goods and services to provide demand for innovations	EU's Green Public Procurement Directive
Fund outcomes	Businesses compete for funding to achieve environmental outcomes on flexible criteria	UK's Industrial Energy Efficiency Accelerator USA's Clean Fuels Program
Set standards	Create benchmarks of performance and minimum performance standards, and set incentives for action	NSW (Australia-wide) NABERS ratings Germany's KfW-Effizienzhaus Japan's Top Runner scheme
Send price signals	Polluter pays regulation together with insurance partnership incentivises reduced pollution with lower insurance premiums	EU's Environmental Liabilities Directive

3.2.1**The common elements of the most successful international initiatives provide a framework to address local barriers**

The value of international reviews is to understand and adapt relevant approaches where applicable and apply their insights and experience to the local context. The high-level lessons from environmental programs that successfully drive local innovation include:

- understand what works and disseminate and replicate lessons through the market
- know the market and engage with the actors that can bring about the desired change
- create the space for market-led actions through a clear mandate, funding support and long-term signals
- broker adoption of innovation at scale, with local relevance to provide the strongest support for market delivery.

3.3

Key success factors for the NSW EGS sector

Our research identified three factors that are vital for NSW to optimise its research and industry strengths, and capitalise on market opportunities in the EGS sector:

1 Networks and collaboration

strong relationships between universities, industry and end users

2 Importance of markets

Investment confidence and market demand

3 Scaling for export

International demand for EGS products and services

3.3.1

Networks and collaboration

The NSW EGS sector is highly diverse, comprising researchers, startups, businesses and end users working across a range of different subsectors. The IPC's research identified a lack of formal networks for linking innovators, businesses and end users in the sector. In most instances of successful research-industry collaboration, the relationship came from personal connections rather than formal structures, or the collaboration was with overseas universities. This lack of connectivity within the NSW EGS ecosystem is hampering collaboration and innovation efforts.

This is also reflective of a broader cultural issue about enterprise and university collaboration; Australia is ranked 32nd for university–industry collaboration in the 2018 Global Innovation Index,⁴⁸ a trend that is mirrored in NSW.⁴⁹ Stakeholders report a lack of standardised benefit-sharing agreements for universities and businesses to work together to commercialise innovations.

A lack of network connections is also felt by private sector actors. Some large end user firms reported an appetite to work with local startups but struggled to find suitable candidates. Others had trouble integrating new innovations into existing supply chains. This is compounded by the issue of market credibility—at each step in the supply chain the intermediary must be convinced of the value of the product before stocking it. While at the customer end, the seller must be both willing and able to supply the material for a similar price as traditional materials.

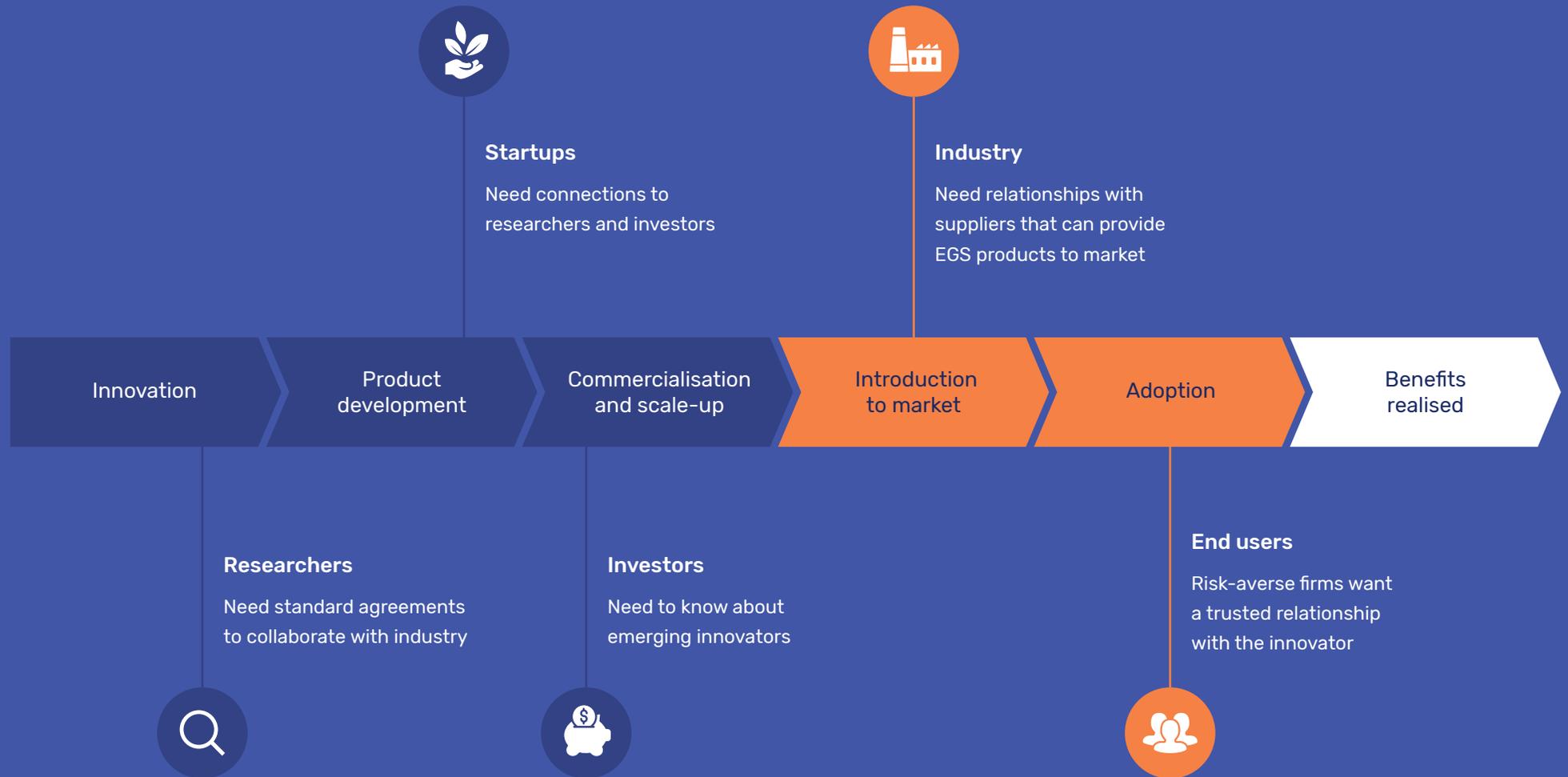
In more mature sectors, such as agriculture, institutions and initiatives (including the Commonwealth's Rural Research and Development Corporations or the NSW Department of Primary Industry's Global Agtech Ecosystem) do the work of linking the needs of end users to the efforts of researchers and entrepreneurs. The comparatively young EGS sector in NSW lacks similar pathways for demand-driven innovation. It has a range of existing research and industry hubs within discrete environmental specialties, but these are not well connected or well coordinated across the EGS ecosystem.

3.3.1.1

International examples

Successful international innovation networks make connections in ways that overcome information barriers and broker the institutional and professional connections that build a strong sector ecosystem. These networks also sustain innovation over the long-term. They are able to catalyse significant private investment and can be a cost-effective way for governments to fund local, commercially supported R&D and market uptake of innovations.

Figure 7
Networks and collaboration in the innovation lifecycle



There are many international approaches to innovation hubs and networks, which can range from loosely connected virtual communities to well-staffed, well-funded R&D laboratories. For instance, the US-based innovation powerhouse Manufacturing USA runs 14 research institutes, including one for Clean Energy Smart Manufacturing.⁵⁰ These bring industry, academia and government into collaborative arrangements, and have to date leveraged US\$1.8 billion in private investment from US\$860 million in government funding.⁵¹

The international Isle Technology Approval Group is funded by end users and links innovators to large utility customers to test, pitch and trial new technologies in a demand-driven, innovation environment.⁵²

The circular economy

International research on circular economy programs shows there are economic, social and environmental benefits to bringing together disparate parties through a product's life cycle.

The UK's National Industrial Symbiosis Programme (NISP) is a business-led circular economy program with over 15,000 participating micro, small, medium and multinational corporate businesses from every industry sector. It has generated £2.4 billion in new sales revenue and waste disposal and input cost savings, from an initial government investment of £27 million.⁵³ In turn, this has created or safeguarded 10,000 jobs over six years.⁵⁴ These figures only include direct savings and sales in the first year of the material exchange, and not the ongoing

benefits or the economic impact of any positive environmental effects.

The NISP model has been replicated in 21 countries worldwide. The program establishes mutually profitable links between companies so that unwanted or underused resources (including energy, waste, water and logistics) are recovered, reprocessed and reused by others. It originated as three pilot schemes in Scotland, West Midlands and Yorkshire & Humberside in 2003. Their success provided a clear evidence base to the Department for Environment and Rural Affairs, who, in 2005, awarded International Synergies £27 million over three years to roll out the program across all nine English regions.⁵⁵

The Scottish Institute for Remanufacture (SIR) was established in 2015 to accelerate the move to a circular economy through product remanufacture, reconditioning, repair and reuse. SIR funds collaborative projects between universities and businesses, enabling companies to increase reuse, repair and remanufacture. The Scottish Government estimates that over 19,000 people are employed

in remanufacturing, contributing £1.1 billion to annual economic activity.⁵⁶ By 2020, this sector has potential to bring an additional £620 million.⁵⁷

3.3.1.2

NSW Government initiatives

A range of innovation networks are currently enhancing the EGS sector in NSW.

NSW Circular Economy Policy

The EPA is developing a NSW Circular Economy Policy based on international best practice approaches, which provide a framework for implementing product life cycle initiatives. The policy looks to embed circular economy principles in NSW public and private sector decision-making and mindsets. These principles include minimising the use of finite resources, decoupling economic growth from resource consumption, designing out waste and pollution, and creating new and reclassified circular economy jobs.

Through more efficient use of the resources already flowing through the economy, NSW can improve resource productivity without the need for any additional inputs. Just as the sharing economy provided new value opportunities for car and property owners, the circular economy offers businesses the chance to monetise waste streams and excess capacity. By creating new markets in secondary resources, a strong circular economy will also reduce the state's reliance on export markets in recyclable waste, creating capacity within the country to fulfil its own needs, and potentially exporting its services to others.

NSW Circular Economy Innovation Network

Established by the Office of the NSW Chief Scientist and Engineer, this will harness and strengthen work by state and local governments, businesses and researchers. It aims to improve connectivity, address supply chain gaps and support technology development and businesses looking to scale up. It will build on existing networks and knowledge hubs in NSW that focus on collaboration between the state's research institutions and business models to successfully drive private investment in research. It will do this by bringing together researchers, industry and government.

NSW Energy and Resources Knowledge Hub

The hub brings together businesses, research organisations and industry associations to share and direct research to meet industry needs through collaborative projects.

NSW Smart Sensing Network

Sensing technology experts in academia, industry and government are working together to develop collaborative and innovative solutions to environmental and infrastructure sensing and monitoring challenges.

The Cyber Security Network and Defence Innovation Network

These networks operate on similar models to undertake quality research for the safety of the state's electronic and physical future. They have a clearly defined objective, a focus on collaboration between the state's research institutions and business models that drive private investment in research.

3.2.2

Importance of markets

A major challenge facing innovators in the NSW EGS sector is proving the environmental credentials of their product to a sceptical market and providing the right market signals.

Market Credibility

This lack of confidence reduces demand for EGS as well as the appetite for investment in businesses in the sector. Both of these factors contribute to difficulties for innovators seeking to bring a novel product to market.

The lack of such standards is particularly problematic for companies with no track record of successful implementation at scale. It is also challenging for those focused on business-to-business sales, where the level of investment required is typically far higher than for business-to-consumer sales, and the risk appetite is far lower, particularly in regulated industries. This leads to low capital attraction with end users unwilling to invest in untested innovations.

Most stakeholders report that while consumers are increasingly considering sustainability when making purchases, they lack access to the information they need to be confident in their decision and are wary of 'greenwashing'. With few exceptions (such as the NABERS ratings for building environmental performance and GECA for a narrow range of products) it was noted that there is no broadly accepted credible, independent authority or other testing protocol for verifying a product's environmental claims.

Market signals

Innovation relies on a stable investment environment, and investment in environmental technologies is highly sensitive to the politics of the day.

EGS innovators also experience barriers within regulations designed to protect the environment, particularly on the issue of recycled materials. While it is not common for regulations to be identified as directly prohibiting new technologies, the severity of penalties for non-compliance in regulated industries was seen to contribute to the culture of risk-aversion among end users. The effect of this culture on market demand is seen as a major barrier to the uptake of potentially transformative innovations.

Research found that an authoritative anchor customer, such as government, is extremely valuable to the success of new-to-market innovations.⁵⁸ It provides an initial customer base and cash flow, as well as a level of credibility to environmental claims, which is a critical market signal for future customers.

Figure 8

The importance of market credibility in the innovation lifecycle

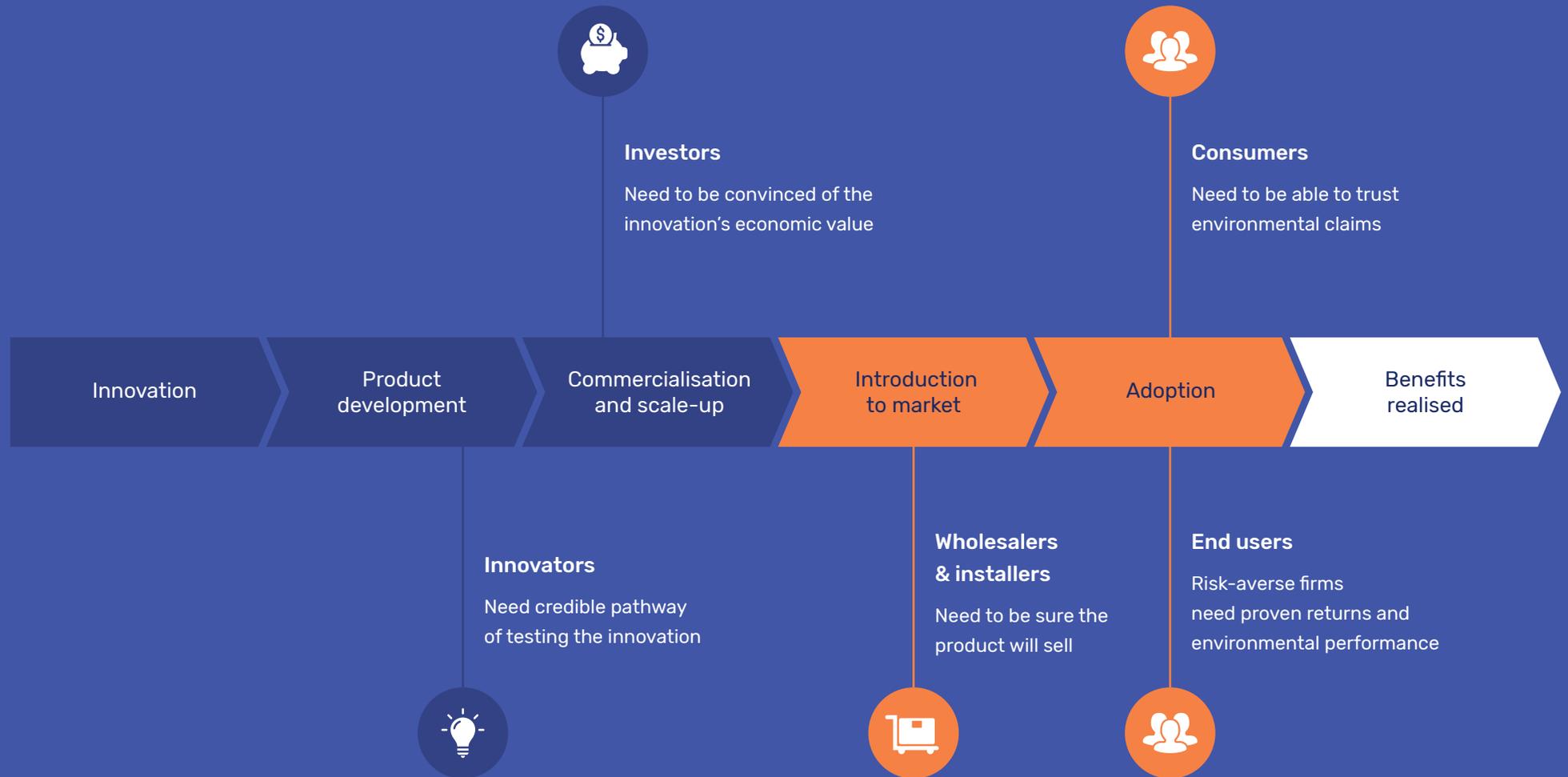
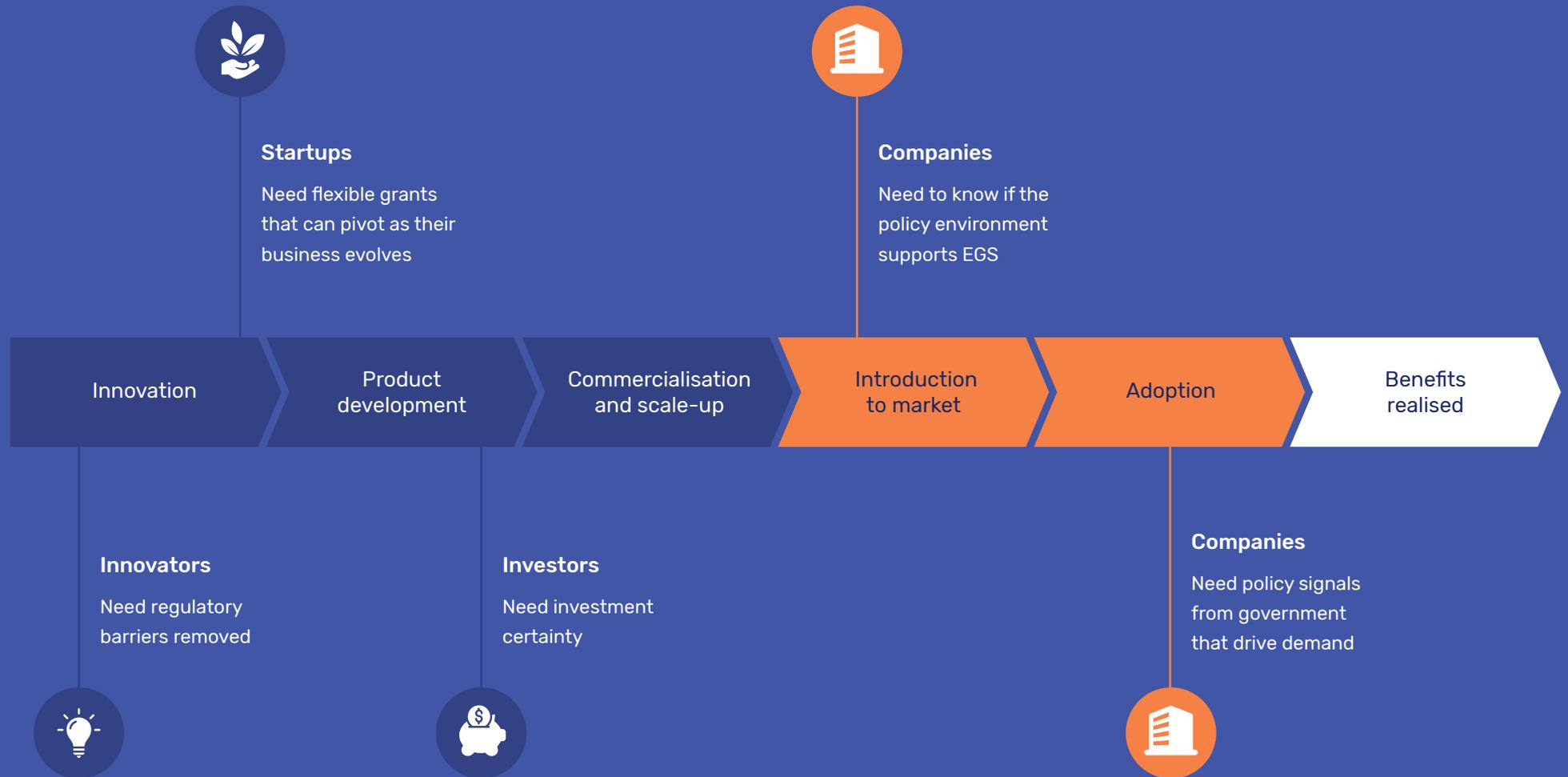


Figure 9

The importance of market signals in the innovation lifecycle



3.2.2.1

International examples

Sustainable procurement practices can drive demand and improve credibility

There are numerous examples of environmental and life cycle assessments in public sector procurement that deliver reductions in operating costs and help to drive market transformation.

The 2010 IT procurement policies of Stockholm County Council mandated 20% better energy performance than existing energy star standards, use of recycled plastics, and zero lead, mercury, PVC or halogenated flame retardants.⁵⁹ Bids were assessed on total cost of ownership and environmental criteria. Most suppliers were unable to meet all the requirements, but the policy was the catalyst for rival suppliers to change their practices. The initial contract resulted in savings to the council of hundreds of thousands of euros in reduced energy and disposal costs.⁶⁰

The EU's Green Public Procurement Policy (GPP) provides clear and ambitious environmental criteria for products and services, and can be a major driver for innovation, providing industry with incentives for developing green products and services. It requires public authorities to procure goods, services and works that have a reduced environmental impact throughout their life cycle when compared to others with the same primary function. The average financial impact has been a 1% reduction in costs, with any higher purchasing prices for EGS products compensated by lower operating costs.⁶¹

At the national level, most EU member states have now published GPP National Action Plans. These outline a variety of actions and support measures for green or sustainable public procurement. Studies indicate that GPP has on average led to a 25% reduction in CO₂, with construction, gardening, paper and textiles attaining the highest reduction percentages.⁶²

Financial rewards to provide strong market signals

Innovation challenges: can help catalyse and focus research and innovation efforts by offering the market a financial reward to successfully deliver a particular outcome. They are a call to action aimed at accelerating research, development and demonstration in innovation areas that could make a significant contribution to economic, environmental and social objectives.

Innovation challenges are increasingly used by public and private sectors to seek ambitious solutions to intransigent problems, though the concept has a long history of success. As far back as 1919, the \$25,000 Orteig Prize drove millions of dollars (in current terms) into aviation R&D, culminating in the world's first transatlantic flight in 1927.

The US Defence Advanced Research Projects Agency (DARPA) issues challenges to spur innovation that supports the USA's defence priorities.⁶³ Previous challenges have included autonomous vehicles and disaster response robots. The current grand challenge is seeking solutions to ensure continued access to the increasingly crowded electromagnetic spectrum for consumer and military applications. There are now numerous innovation challenge platforms such as InnoCentive, XPRIZE and Challenge.gov that focus the efforts of thousands of innovators across the world.

Competitive grants: collaborative relationships within and between businesses and researchers are important and productive components of successful innovation ecosystems. They must be based on mutual trust, and this cannot be quickly manufactured. Co-funding from governments can catalyse and broker new relationships, lowering the barriers to their formation and reducing the financial risk involved in adopting new ways of working together.

An example of a successful competitive grant is the US Government's Tech-to-Market's Innovative Pathways Funding Opportunity, which facilitates more efficient pathways for clean energy technologies to reach market in North America. The government provides US\$7.8 million for 11 projects,⁶⁴ such as:

- **Incubatenergy**

Supported over 500 companies, collectively raised more than US\$1 billion in follow-on funding and generated US\$330 million in revenue. The national network has also supported the creation of nearly 3,000 direct jobs.⁶⁵

- **Powerhouse**

An incubator and accelerator company that has supported 42 companies and generated \$52 million in revenue, raised US\$287 million in capital, and employed 386 people.⁶⁶

- **Clean Energy Trust**

Has to date awarded over US\$3.7 million in funding to 33 clean energy start-ups, which have raised an additional US\$112 million in follow-on funding, and created over 300 jobs.⁶⁷

Elsewhere, the European Institute of Innovation and Technology (EIT) RawMaterials program was initiated in 2008 and is funded by the European Commission (€2.7 billion between 2014 and 2020).⁶⁸ Its goal is to find new solutions to secure the supplies and improve efficiencies of processing raw materials (extraction, processing, recycling and reuse). It is the largest program of its kind in the world (4% of EU GDP) and unites more than 120 partners—academic and research institutions as well as businesses—from more than 20 EU countries.⁶⁹ Entrepreneurs, startups and SMEs have access to funding opportunities and support through partner networks and collaboration activities. These include matchmaking, networking, product/process validation, acceleration and upscaling, education, business creation and support and internationalisation.

3.2.2.2

NSW Government initiatives

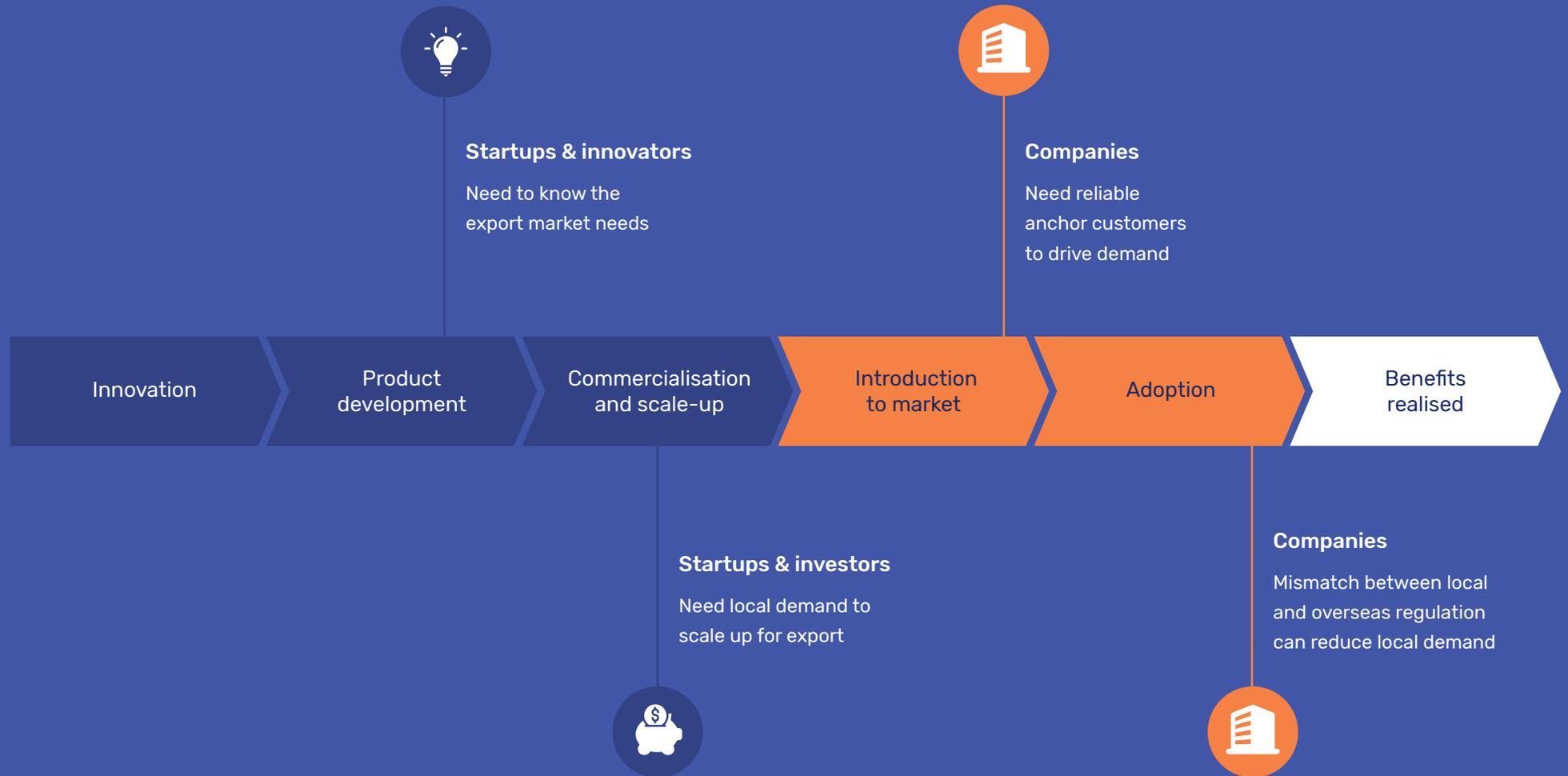
The NSW Government Resource Efficiency Policy was introduced in 2014 with specific resource efficiency requirements for purchases relating to energy, water, clean air and waste management. The most recent public report (2016-17) shows that 76% of agencies report their activities; the report does not provide a breakdown of specific compliance with each action.⁷⁰

The NSW Government also provides a mechanism for 'innovation procurement', where agencies can engage a supplier through direct negotiation on short-term contracts up to \$1 million to do proof-of-concept testing or outcomes-based trials. This has not yet been extensively used for any procurement type.

The NSW Government spends \$20 billion a year procuring goods and services.⁷¹ The core mandatory requirement in the NSW procurement policy framework is for procurers to assess value for money. This includes consideration of costs over the period the goods or services are to be used. It does not explicitly consider the full cost of operation and disposal, or the monetised ecological costs of the product, which are difficult to calculate.

Figure 10

Domestic demand in the innovation lifecycle



3.2.3

Scaling for export

EGS innovators are keenly aware of the demand for NSW EGS in overseas markets, but many face difficulties getting to the scale needed to exploit those opportunities. This is particularly the case for new-to-world, or new-to-market innovations for which anchor customers and testimonials provide critical proof of the value proposition to potential customers. Australian environmental regulations are generally more permissive than European markets, so domestic markets do not demand the same level of environmental performance. This prevents innovators reaching the level of turnover required before they can make the investments in manufacturing and other infrastructure needed to service high demand international markets.

3.2.3.1

International examples

Clear market signals about the importance and value of EGS to the economy and the environment are important. Environmental goals can be more effectively achieved by changing market conditions and providing incentives for businesses to work with the market. Growing local market demand for EGS products also helps providers to scale up to meet overseas demand.

The global market in environmental goods (excluding services) is expected to reach US\$3 trillion by 2020,⁷² and much of the growth in demand comes from our key trading partners. Sustainability and environmental quality are increasingly prominent concerns in international trade, particularly as living standards improve in developing economies. Through international agreements and environmental legislation, regulated environmental standards are becoming a feature of global markets and represent a commercial opportunity for businesses in NSW.

3.2.3.2

NSW Government initiatives

The EGS subsectors where NSW has the greatest strengths—such as building technologies, with domestic sales of \$3.4 billion and growth of 10.7% in 2017-18—have been driven by local environmental regulatory schemes such as the NABERS building efficiency rating scheme.

These are recognised as being best practice when working with markets to encourage innovation and deliver environmental outcomes. Advocating the international adoption of such schemes could facilitate the growth of new export markets for the NSW innovators that develop and deliver EGS under these schemes.

4

Appendices

4.1 Appendix 1

Environmental research centres in NSW universities

University of Sydney

Sydney Environment Institute
 Australian Centre for Climate and Environmental Law
 Sydney Institute of Agriculture
 Marine Studies Institute
 Australian Research Council (ARC) Centre of Excellence for Translational Photosynthesis
 Bushfire and Natural Hazards CRC
 Centre for Wind, Waves and Water
 Centre for Future Energy Networks
 Waste Transformation Research Hub
 Planetary Health Platform
 Centre for Sustainable Energy Development
 Centre for Excellence in Advanced Food Enginomics
 Integrated Sustainability Analysis Group
 Carbon, Water and Soil Research Group
 Australian Centre for Field Robotics (ACFR)
 Interoperability for Extreme Events Research Group
 The Warren Centre for Advanced Engineering
 ARC Training Centre for the Australian Food Processing Industry

University of NSW

ARC Centre of Excellence for Climate System Science
 ARC Research Hub for Green Manufacturing
 Australian Centre for Advanced Photovoltaics
 Australian Water Recycling Centre of Excellence
 National Centre for Groundwater Research and Training
 National Centre of Excellence in Desalination Australia
 Water Research Australia
 Centre for Ecosystem Science
 Centre for Energy and Environmental Markets
 Centre for Marine Bio-Innovation
 Centre for Sustainable Materials Research and Technology
 Climate Change Research Centre
 Connected Waters Initiative
 Water Research Centre
 Advanced Environmental Biotechnology Centre
 Sydney Institute of Marine Science
 Cooperative Research Centre (CRC) for Greenhouse Gas Technologies
 CRC for Low Carbon Living
 Australian Energy Research Institute
 UNSW Global Water Institute

Macquarie University

Centre for Environmental Law
 Marine Research Centre
 Centre for Green Cities
 Species Spectrum Research Centre
 Planetary Research Centre
 Centre for Energy and Environmental Contaminants

University of New England

Institute for Rural Futures
 Centre for Invasive Species Solutions
 SMART Farms

University of Newcastle

Newcastle Institute for Energy and Resources
 Centre of Excellence for Geotechnical Science and Engineering
 Priority Research Centre for Organic Electronics
 CRC for Contamination Assessment and Remediation of the Environment
 Invasive Animals CRC
 International Centre for Balanced Land Use
 Global Centre for Environmental Remediation
 NSW Institute for Frontier Geoscience
 Centre for Plant Science
 Centre for Water, Climate and Land
 Centre for Water Security and Environmental Sustainability

University of Wollongong

Centre of Atmospheric Chemistry
 Australian Centre for Cultural Environmental Research
 Australian National Centre for Ocean Resources and Security
 Engineering Materials Research Strength
 GeoQuest Research Centre
 Centre for Environmental Informatics

University of Technology Sydney

C3 (Climate Change Cluster)
 Centre for Clean Energy Technologies
 Centre for Compassionate Conservation
 Centre for Technology in Water and Wastewater
 Deep Green Biotech Hub
 Institute for Sustainable Futures
 Materials and Technology for Environmental Efficiency
 Centre for Autonomous Systems

Western Sydney University

Hawkesbury Institute for the Environment
 Global Centre for Land-based Innovation
 Bushfire and Natural Hazards CRC

Charles Sturt University

Graham Centre for Agricultural Innovation
 Institute for Land, Water and Society

Southern Cross University

Forest Research Centre
 National Marine Science Centre
 Centre for Coastal Geochemistry
 Marine Ecology Research Centre

4.2 Appendix 2

International best practice EGS programs

Initiative	Description
Biodiversity	
Agricultural subsidy (Switzerland)	Eligibility for farm support payments depends on adherence to environmental legislation. If a farmer contravenes these laws, they can be fined, and payments can be withheld. Farmers can also receive additional payments for extensive ecological crop production or organic production.
Impact Mitigation Regulation (Germany)	Requires the preservation of the existing ecological situation where new development occurs. Habitat banks are land purchased by government (with a known ecological value) and are available for developers to purchase to compensate for impacts of economic development.
Results-based Agri-environment schemes (EU)	A robust framework for education campaigns, as well as monitoring and evaluation. Farmers are able to receive payment for their involvement in successful conservation practices.
Doctrine and guidelines on the mitigation hierarchy (France)	A 'polluter pays' approach that imposes a cost on the activities that cause adverse impacts to biodiversity, with a no-net-loss (NNL), and ideally, net gain of habitats.
Provincial wildlife population monitoring program plan (Canada)	Aims to collect long-term trend data to evaluate the effectiveness of forest management in maintaining wildlife. The data will inform future requirements for improving the management of natural resources.

Initiative	Description
Clean Air	
Tech-to-Market's Innovative Pathway's Funding Opportunity (USA)	Funds mechanisms that facilitate more efficient pathways for clean energy technologies to reach market.
The Top Runner Program (Japan)	Mandatory energy efficiency standards for a variety of appliances, equipment, and automobiles. It uses the most efficient model currently on the market (the 'Top Runner') as its benchmark and stipulates that all products in that category must meet a weighted average standard of the benchmark within four to eight years.
SunShot (USA)	A 10-year federal government R&D funding program (2011–2021). Its aim is to drive innovation, catalyse growth in the solar industry, and help drive down costs throughout the marketplace.
KfW-Effizienzhaus (Germany)	A voluntary national energy rating scheme for existing homes. The scheme is attached to a finance mechanism, with the amount and terms of the funding increasing based on improved building performance relative to the baseline minimum standard of new houses in Germany (EnEV).
Energiesprong – Stroomversnelling (Sweden)	A disruptive market mechanism to cost-effectively improve the energy performance of older social housing up to minimum standards.
Smartway Program (USA)	A voluntary public-private program that is comprised of partnerships, financial incentives, policy and technical solutions, and research and evaluation projects that find new ways to optimise the transportation networks in a company's supply chain.
Clean Fuels Program (USA)	Provides grants to fund cooperative partnerships that are used to co-sponsor projects intended to demonstrate the successful use of clean fuels and zero or low-emission transport technologies.
KWS 2000 (Netherlands)	Agreements with government and industry to meet targets. Industry supported to adopt new technology and processes through grant funding for new technologies and practices that could be applied sector-wide.
Super Truck (USA)	A five-year matched grant funding program targeting emissions reductions in the road freight sector.
Industrial Energy Efficiency Accelerator (UK)	A technology-neutral competition for companies that have existing or near-market innovative technologies for energy efficiency or emissions reduction.
Pro-Lite (EU)	A specialist procurement advisory agency initiated and funded by the EU to provide guidance for public-sector authorities on ways of consolidating their lighting procurement power to create economies of scale, support innovative procurement solutions and drive European economies.

Initiative	Description
Contaminated Sites	
Environmental Liabilities Directive (EU)	Establishes a strict framework for the prevention and remedying of environmental damage. It is based on the polluter pays and precautionary principles, and focuses on preventing and mandating the remediation of any environmental damage (including loss of environmental services).
EPA Green Remediation Focus (USA)	Develops and promotes innovative clean-up strategies that restore contaminated sites to productive use, reduce associated costs, and promote environmental stewardship.
State Coalition for the Remediation of Dry Cleaners (USA)	An information sharing hub, it advances practices used for drycleaner site remediation by documenting technical information about best practice.

Miscellaneous

Manufacturing USA (USA)	Provides funding for advancing manufacturing innovation. Structured into discrete 'institutes' that bring together industry, academia and government to work in specific advanced manufacturing technology areas, such as the Clean Energy Smart Manufacturing Innovation Institute.
Green Public Procurement (EU)	A process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured.
Innovation Platform and PIANOo (Netherlands)	A centralised procurement advisory body for all Dutch national government departments and municipal authorities. This body has developed criteria and practical instruments to implement Sustainable Public Procurement (SPP).
OkoKauf Wien (Austria)	Ecological criteria applied to procurement procedures.

Initiative	Description
Waste	
National Industrial Symbiosis Programme (UK)	Establishes mutually profitable links between companies so that unwanted or underused resources (including energy, waste, water and logistics) are recovered, reprocessed and reused by others.
German Resource Efficiency Programme (Germany)	A detailed framework that sets out a long-term roadmap for the nation to make natural resource extraction and use more sustainable.
The Green Dot (Germany)	A packaging waste labelling and industry contribution scheme. The Green Dot indicates to consumers that the manufacturer has met their obligations to take back and/or to recycle its packaging.
Elretur (Sweden)	Legislation that makes it a producer's responsibility to manage the waste from their electric and electronic equipment at point of disposal.
Bio Base Europe (Belgium)	An innovation and training centre set up to grow the bio-based economy in Europe. It supports the development of technologies that convert biomass into industrial enzymes, fine chemicals, food ingredients, biopolymers, nutraceuticals, bioplastics, biomaterials and biofuels.
The Scottish Institute for Remanufacture (Scotland)	Funds collaborative projects between universities and business, enabling companies to increase reuse, repair and remanufacture in their manufacturing operations.
Smart Specialisation Strategy (Slovenia)	A platform for concentrating development and investment on areas where Slovenia has the critical mass of knowledge, capacities and competences, and where there is innovation potential.
European Institute of Innovation and Technology (EU)	Enhances innovation in the raw materials sector by sharing of knowledge, information and expertise. Entrepreneurs, startups and SMEs have access to funding opportunities and support through partner networks and collaboration activities.

Water

Imagine H2O (International)	A startup accelerator. It provides early stage technology startup companies with mentorship and introductions to investors, strategic partners, and end-users.
Alliance for Water Stewardship (International)	Develops and administers the International Water Stewardship Standard (the AWS Standard), which provides a globally-applicable framework for major water users to understand their water use and impacts, and to work collaboratively and transparently for sustainable water management.
Water Technology Innovation Blueprints (USA)	Highlights the EPA's initial ideas and plans for advancing technology innovation across various water programs.
Isle Technology Approval Group (International)	Connects innovators with large private and public organisations looking for new technology, giving them a unique opportunity to connect directly with potential customers internationally.

4.3

About the report

This report is based on findings from a research project commissioned by the NSW Innovation and Productivity Council (IPC). Preliminary economic analysis of the NSW environmental goods and services (EGS) sector by GHD in 2017 indicated that the global EGS market and innovation within the NSW EGS sector was strong, and that the sector had a high potential for innovation-led growth. CSIRO Data61 were engaged to build a data-rich profile of the EGS sector across Australia using web-based data collation, linguistic analysis and machine learning to identify EGS businesses and their specialities, employee size and other characteristics. KMatrix undertook detailed market analysis of the sector and its regional strengths. The IPC Secretariat worked with The Strategy Group to understand the market drivers and barriers to innovation in this sector. A policy review by Common Capital of international best practice EGS initiatives and the suite of existing NSW EGS and innovation programs provided the basis for identifying the specific opportunities explored in this report.

This project has been overseen by an IPC subcommittee, with support from a NSW Government advisory group of representatives from key agencies.

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References and citations

- 1 World Intellectual Property Organisation 2014, 'Renewable Energy: New Study Shows Patenting Growth', https://www.wipo.int/pressroom/en/stories/green_tech.html
- 2 kMatrix (2018) *NSW Final Report – Low Carbon and Environmental Goods and Services Sector (LC) EGSS*
- 3 Idcommunity (2017) 'New South Wales – Industry sector of employment', <https://profile.id.com.au/australia/industries?WebID=100>
- 4 kMatrix (2018) *NSW Final Report – Low Carbon and Environmental Goods and Services Sector (LC) EGSS*
- 5 <https://www.treasury.nsw.gov.au/nsw-economy/nsw-economic-dashboard>
- 6 Eurostat (2016) 'Environmental goods and services sector accounts', <https://ec.europa.eu/eurostat/documents/3859598/7741794/KS-GQ-16-011-EN-N.pdf>, pp 18-21
- 7 Broadfoot, A. personal communication, 9 March 2018
- 8 Australian Bureau of Statistics (2017) '8172.0 – Management and Organisational Capabilities of Australian Businesses 2015-16', <http://www.abs.gov.au/ausstats/abs@.nsf/mf/8172.0>
- 9 Ibid, 81720D0006_201516 Management and Organisational Capabilities of Australian Business, 2015-16, Table 2 Environmental management activities undertaken, by innovation status, by employment size, by industry, 2015-16
- 10 Department of Foreign Affairs and Trade, 'Environmental Goods Agreement (EGA)', <https://dfat.gov.au/trade/organisations/wto/negotiations/ega/Pages/environmental-goods-agreement.aspx> – In 2014 Australia joined negotiations on the WTO Environmental Goods Agreement to expand the list of 54 environmental goods on which tariffs were reduced in 2012, Negotiations are ongoing.
- 11 Unpublished analysis by CSIRO Data61 of LinkedIn (2017)
- 12 Eurostat (2018) 'Environmental economy – statistics', https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Environmental_economy_-_statistics; Eurostat (2018) 'Environmental economy – statistics on employment and growth', https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Environmental_economy_-_E2%80%93_statistics_on_employment_and_growth#Employment_by_environmental_domain
- 13 The Telegraph (2018) 'Graphene: the wonder material that could solve the world's water crisis', <https://www.telegraph.co.uk/news/2018/05/03/graphene-wonder-material-could-solve-worlds-water-crisis>
- 14 Organization for Economic Cooperation and Development (OECD) (1999) 'The environmental goods and services industry manual for data collection and analysis', https://unstats.un.org/UNSD/envAccounting/ceea/archive/EPEA/EnvIndustry_Manual_for_data_collection.PDF
- 15 Australian Bureau of Statistics ABS (2015) '4655.0 – Australian Environmental-Economic Accounts – Towards an environmental expenditure account', <http://www.abs.gov.au/ausstats/abs@.nsf/featurearticlesbytitle/9E80135DB8053A73CA257F94001825E2>
- 16 kMatrix (2018) *NSW Final Report – Low Carbon and Environmental Goods and Services Sector (LC) EGSS*
- 17 SGS Economics & Planning (2018) 'Economic performance of Australia's cities and regions', https://www.sgsep.com.au/download_file/view_inline/1803
- 18 NSW Treasury (2018) Budget 2018-19 Half-Yearly Review', <https://www.budget.nsw.gov.au/sites/default/files/budget-2018-12/2018-19%20Half-Yearly%20Review.pdf>
- 19 kMatrix (2018) *NSW Final Report – Low Carbon and Environmental Goods and Services Sector (LC) EGSS*
- 20 The Strategy Group (2017) *Stakeholder engagement with the NSW environmental goods and services sector*
- 21 Australian Trade and Investment Commission, 'Environment and water management to China', <https://www.austrade.gov.au/australian/export/export-markets/countries/china/industries/environment-and-water-management>; Australian Trade Commission, Australian Education and Training – Capability in water', <https://www.austrade.gov.au/ArticleDocuments/5473/Water%20EandT%20Capability%20Statement%20FINAL-Web.pdf.aspx>
- 22 Idcommunity (2017) 'New South Wales – Industry sector of employment', <https://profile.id.com.au/australia/industries?WebID=100>; kMatrix (2018) *NSW Final Report – Low Carbon and Environmental Goods and Services Sector (LC) EGSS*
- 23 Idcommunity (2017) 'New South Wales – Industry sector of employment', <https://profile.id.com.au/australia/industries?WebID=100>
- 24 kMatrix (2018) *NSW Final Report – Low Carbon and Environmental Goods and Services Sector (LC) EGSS*
- 25 <https://www.treasury.nsw.gov.au/nsw-economy/nsw-economic-dashboard>
- 26 kMatrix (2018) *NSW Final Report – Low Carbon and Environmental Goods and Services Sector (LC) EGSS*; Jobs for NSW (2016) 'Jobs for the Future – Adding 1 million rewarding jobs in NSW by 2036', https://www.jobsforNSW.com.au/_data/assets/pdf_file/0020/90740/Jobs-for-the-future-full-report-August-2016.pdf
- 27 Tourism Australia (2018) 'Tourism statistics', <http://www.tourism.australia.com/en/markets-and-stats/tourism-statistics.html>
- 28 Destination NSW (2019) 'Travel to New South Wales – Preliminary Year ended September 2018', <https://www.destinationnsw.com.au/wp-content/uploads/2019/01/travel-to-nsw-time-series-sept-2018.pdf?x15361>
- 29 Unpublished analysis by CSIRO Data61 of LinkedIn (2017)
- 30 Ibid.
- 31 Ibid.
- 32 Ibid.
- 33 Ibid.
- 34 Ibid.
- 35 Unpublished research by GHD (2017) *Sector Focus on Innovation*
- 36 Unpublished analysis by CSIRO Data61 of LinkedIn (2017)
- 37 Jobs for NSW (2016) *Jobs for the Future: Adding 1 million rewarding jobs in NSW by 2036*, Priority 1.1, p 28

- 38 Unpublished research by Common Capital (2018) *Innovation-led growth in the EGS sector*
- 39 NABERS, 'What is your building's impact?', <https://www.nabers.gov.au>
- 40 IPART, 'Energy Savings Scheme', <https://www.ess.nsw.gov.au/Home>
- 41 IPART, 'Overview of the Scheme', https://www.ess.nsw.gov.au/How_the_scheme_works/Overview_of_the_scheme
- 42 NSW Office of Environment & Heritage (2018) 'How does the Biodiversity Offsets Scheme work?', <https://www.environment.nsw.gov.au/biodiversity/schemeprocess.htm>
- 43 Unpublished research by Common Capital (2018) *Innovation-led growth in the EGS sector*
- 44 Unpublished analysis by CSIRO Data61 of LinkedIn (2017)
- 45 Unpublished research by Common Capital (2018) *Innovation-led growth in the EGS sector*
- 46 Ibid.
- 47 Unpublished research by Common Capital (2018) *Innovation-led growth in the EGS sector*
- 48 Global Innovation Index (2018) 'Global Innovation Index 2018', <https://www.globalinnovationindex.org>
- 49 CWTS Leiden Ranking (2018) 'CWTS Leiden Ranking 2018', <http://www.leidenranking.com/ranking/2018/list>
- 50 Manufacturing USA, 'CESMII (Clean Energy Smart Manufacturing Innovation Institute)', <https://www.manufacturingusa.com/institutes/cesmii>
- 51 Manufacturing USA (2016) 'DoD announces award of new advanced tissue biofabrication manufacturing innovation hub in Manchester, New Hampshire', <https://www.manufacturingusa.com/news/dod-announces-award-new-advanced-tissue-biofabrication-manufacturing-innovation-hub-manchester>
- 52 Isle, 'Technology Approval Group (TAG)', <http://www.isleutilities.com/services/technology-approval-group>
- 53 International Synergies, 'National Industrial Symbiosis Programme', <https://www.international-synergies.com/projects/national-industrial-symbiosis-programme>
- 54 Ibid.
- 55 Ibid.
- 56 Scottish Institute for Remanufacture, 'Circular Economy', <http://www.scot-reman.ac.uk/about-remanufacturing/circular-economy>
- 57 Ibid.
- 58 Unpublished research by Common Capital (2018) *Innovation-led growth in the EGS sector*
- 59 European Commission (2012) 'GPP Green Public Procurement – A collection of good practices', http://ec.europa.eu/environment/gpp/pdf/GPP_Good_Practices_Brochure.pdf
- 60 Ibid.
- 61 PwC Sustainability (2009) 'Collection of statistical information on Green Public Procurement in the EU, Report on data collection results', http://ec.europa.eu/environment/gpp/pdf/statistical_information.pdf
- 62 Ibid.
- 63 Congressional Research Service (2018) 'Defense Advanced Research Projects Agency: Overview and issues for Congress', <https://fas.org/sgp/crs/natsec/R45088.pdf>
- 64 gtm (2017) 'DOE seeks to unlock new tech-to-market investment pathways with new \$7.7M grant round', <https://www.greentechmedia.com/articles/read/doe-unlock-new-tech-to-market-investment-pathways-with-7-8-million-grant#gs.TeGj7h1G>
- 65 Office of Energy Efficiency & Renewable Energy, National Incubator Initiative for Clean Energy (NIICE), <https://www.energy.gov/eere/technology-to-market/national-incubator-initiative-clean-energy-niice-0>
- 66 The Guardian (2017) 'Powerhouse: the startup making solar the most accessible energy in the world', <https://www.theguardian.com/sustainable-business/2017/apr/30/powerhouse-incubator-accelerator-solar-energy>
- 67 Clean Energy Trust (2017) 'Clean energy trust invests \$950,000 in Midwest cleantech startups at 7th annual Clean Energy Trust Challenge', <http://cleanenergytrust.org/clean-energy-trust-invests-950000-midwest-cleantech-startups-7th-annual-clean-energy-trust-challenge>
- 68 European Institute of Innovation & Technology (2013), 'EIT plans for 2014 to 2020 adopted by European Parliament', <https://eit.europa.eu/newsroom/eit-plans-2014-2020-adopted-european-parliament>
- 69 EIT, 'EIT Raw Materials', <https://eit.europa.eu/eit-community/eit-raw-materials>
- 70 NSW Government Resource Efficiency Policy (2018) 'Progress Report 2016-17', <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Energy-savings-and-resource-efficiency/nsw-government-resource-efficiency-policy-progress-report-2016-17-180303.pdf>
- 71 NSW Government, 'ProcurePoint – supply2gov', <https://procurepoint.nsw.gov.au/before-you-supply/supply2gov>
- 72 Sustainable Business Australia (2017) 'Current and Future Impacts of Climate Change on Housing, Buildings and Infrastructure', <https://www.apf.gov.au/DocumentStore.ashx?id=d8cbcdd0-a99b-44b5-aa0a-a345fd7d855f&subId=515513>

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