Measuring the low-emissions economy in Australia

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accenture

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Executive summary

The clean energy transition is accelerating

Global action on climate change is translating into changing patterns of economic activity. Responding to policy signals and rising expectations from investors, customers, employees and other stakeholders, economic activity is shifting towards lower emissions goods and services around the world.

To meet ambitious global climate goals over the coming decades, energy production systems will decarbonise, energy use will become more efficient, emissions from industrial processes, agriculture and waste will decline, and emissions will be increasingly stored in the landscape.

Australia's economy is changing

In Australia, the climate and energy transition is leading to a shift to low-carbon production and consumption across many sectors of the economy.

Patterns of employment and trade are changing, new industries are emerging and existing industries are evolving.

Employment in renewable energy has increased by 120% over 10 years.[1] Australia's exports of lithium, a key component of batteries for electric vehicles, have more than tripled in the last five years.[2]

We lack comprehensive data on the low-emissions economic transition in Australia

There are disparate datasets from public and private sources that shed light on certain aspects of the low-emissions transition in Australia, but the overall coverage is still limited.

There is some official data on aspects of the low-emissions economy, such as the Australian Bureau of Statistics' estimates of employment in renewable energy activities. But other official statistics generally do not distinguish between high- and low-emissions economic activities, and information from companies and industry groups gives only a partial picture.

We lack comprehensive data that provides a complete picture of the low-emissions economy.

Measuring the low-emissions economy would help us manage the transition

Improving our understanding of low-emissions economic activity would provide useful insights into Australia's transition, including the extent to which we are capturing the new economic opportunities the transition presents.

Better data on the low-emissions economy would help decision-makers assess the effectiveness of policies, identify employment trends and understand the impact across industries and regions.

Better data would help to inform decisions by policymakers, businesses, education and training providers, employees and the community.

We can learn from international efforts to measure the low-carbon economy

Measures of the low-emissions economy are relatively new around the world, though they spring from a longer history of measuring the green economy or green growth.

The United Kingdom's Office of National Statistics has produced estimates of the low-carbon and renewable energy economy since 2015, covering employment, turnover and trade in 17 sectors.

The UK example, along with other examples from the United States and Canada and insights from Europe and the ABS's renewable energy employment estimates, can help to inform a fresh approach to measuring the low-emissions economy in Australia.

Developing a low-emissions economic data series involves defining a scope and choosing an appropriate measurement method

Approaching the measurement of the low-emissions economy as a two-step process ensures a coherent definition of the scope of economic activity to be captured, and a clear set of desired outputs and methods for collecting the data.

Our approach should capture activities across the economy that have a purpose of reducing emissions

The activities covered by a measure of the low-emissions economy in Australia could include products across the economy that *contribute substantially to* and *have a purpose of* reducing our emissions.

The framework could be conceptually aligned with official greenhouse emissions reporting categories to ensure that all relevant low-emissions activities are covered, and be extended to capture closely related activities.

Activities along the value chain of an industry could be included. For example, in the battery industry, upstream activities like lithium mining could be included, through to downstream activities like servicing and maintenance of installed batteries.

Measuring not only the supply but also the use of low-emissions goods and services would capture another important part of the low-emissions economy.

A range of economic indicators could be valuable to decision-makers

Indicators such as output and employment provide foundational insights into the state of the low-emissions economy. Other indicators such as value-added, trade and investment are also valuable for decision-makers.

Presenting relevant economic indicators broken down by industry and region would give decision-makers important insights into where activity is occurring in the low-emissions economy in Australia.

Australia's approach to measuring the low-emissions economy should take into account goals such as timeliness and relevance and seek to maximise the coherence of the data with other official statistics, including by drawing on concepts and methods used in other series.

A staged approach may be appropriate to developing Australia's measurement

Australia's approach could begin with narrower coverage of priority information about the low-emissions economy and scale up to a more comprehensive study over time.

There is a patchwork of existing public and private data sources of varying quality. Initial estimates of the low-emissions economy could be drawn from existing information, then supplemented over time with a new survey, subject to cost and resource considerations.

A new survey of the low-emissions economy would provide detailed information about economic indicators of interest. Surveys are costly to administer, demanding on respondents' time and resources, and are subject to sample error, but they are widely relied on for estimates of economic activity.

Beyond introducing a new survey, reforms to statistical classifications would also help to embed measurement of the low-emissions economy into existing statistics. Standard industry and occupational classifications form the basis of many official statistical series. Modernising these classifications to better recognise new low-emissions activities would allow existing statistical series to incorporate more granular information about the low-carbon transition.

Sources: 1. Australia Bureau of Statistics (2020), *Employment in Renewable Energy Activities*; 2. Department of Industry, Science, Energy and Resources (2021), *Resources and Energy Quarterly*

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01

Measuring low-emissions economic activity will help us manage our economy through the transition

Data on the low-emissions economy can inform policymakers, businesses and the community about the progress of the transition

Area impacted by transition	Role of data on the low-emissions economy	Questions
Economic	▪ To measure the extent to which Australia is capturing new economic opportunities that are and will arise as a result of the transition, including export opportunities ▪ To understand the extent to which low-emissions economic activity will be able to offset the decline in high-emissions industries ▪ To measure the effectiveness of government policies and investments in developing the low-emissions economy	What portion of the economy does the low-emissions economy currently contribute to? Is employment growth in low-emissions sectors exceeding job losses in other parts of the economy?
Social	▪ To ensure that there is a just transition towards a low-emissions economy which provides citizens with opportunities for decent work[1] ▪ To understand how the opportunities in the low-emissions economy are distributed across regions and industries	Which occupations are in demand in the low-emissions economy? Which regions have seen growth in the low-emissions economy?
Environmental	▪ To measure whether there is sufficient activity in the low-emissions economy to support the degree of emissions reduction necessary for an effective transition	What is the total scale of activity across the entire low-emissions sector? Which industries are purchasing the inputs they will need to transition from the low-emissions economy?

Data on the low-emissions economy will inform stakeholders across government, the private sector and NGOs about how our economy is transitioning and what we need to do to prepare.

There is significant global momentum behind efforts to transition to low-emissions economies. In 2015, 196 parties adopted the Paris Agreement to align on strategies to reduce greenhouse gas emissions.[2] There have also been domestic efforts to reduce emissions. To date, all Australian state and territories have declared net zero emissions targets.[3] For example, the NSW Government's *Net Zero Plan* outlines strategies for the state to reach net zero emissions by 2050.[4]

Significant growth is expected in low-emissions activities within the next few decades to support these emissions reduction efforts. This transition towards a low-emissions economy will have economic, social and environmental impacts on all stakeholders. Data on the low-emissions economy will provide stakeholders with valuable insights that will allow them to best manage the transition.

Similar data series have been used internationally to inform key stakeholders. In the UK, the low-carbon and renewable energy economy (LCREE) survey has been used to support the UK Green Jobs taskforce by informing policies which create green jobs and address skill gaps.

Sources: 1. UNFCCC (2020) '*Just Transition of the Workforce, and the Creation of Decent Work and Quality Jobs*'; 2. UNFCCC (2015) '*Paris Agreement*'; 3. Climate Council 2021, '*What does net zero emissions mean?*'; 4. NSW Department of Planning, Industry and Environment (2020) '*Net Zero Plan (Stage 1: 2020-2030)*'

There is a history of measuring economic activity related to the environment, but measures of the low-emissions economy are new

The history of attempts to understand the relationship between the economy and the environment spans more than 30 years, beginning with the first mention of 'green economy' in 1989. More recent approaches have focused on measures of low-emissions activity, however this area is less mature.

A low-emissions measure follows a lineage of previous attempts that have isolated specific environmental activities within the broader economy. These measures have sought to produce measures to inform policy and drive the transition towards a more environmentally responsible future.

Economic activity related to the environment has only consistently been measured in the last two decades. The measurement of economic activity specifically related to 'low-emissions' or 'low-carbon' economic activity is even more incipient – this has not been measured consistently until the UK ONS's Low Carbon and Renewable Energy Economy (LCREE) survey, first released in 2015.

Date	Milestone	Context
1989	'Green economy' was mentioned for the first time	▪ The term was coined in the 1989 report[1] for the UK government to advise the alternative definition to sustainable development, and the economic progress made towards it. Green economy however is only used in the title, and not referred to anywhere else in the report.
1992	UNFCCC with low carbon development concept adopted at Rio *Earth Summit*	▪ The concept of low carbon development is first introduced in the UNFCCC[2] as a term to describe forward-looking national economic development strategies that encompass low-emission economic growth
1993	UN releases its first handbook on a system of Integrated Environmental and Economic Accounting ('SEEA 1993')	▪ UN releases the first iteration of its 'Handbook of National Accounting: Integrated Environmental and Economic Accounting'.[3] This was the first comprehensive attempt to account for environmental assets and measure interrelationships between the economy and the environment. This was later developed to include a measurement of the Environmental Goods and Services Sector (EGSS).
2005	Concept of green growth introduced[4]	▪ The term emerged from the Fifth Ministerial Conference on Environment and Development (MCED) after discussions between governments and other stakeholders from Asia and the Pacific, in which there was a consensus to move beyond sustainable development.
2011	Mainstream adoption of green economy	▪ The UNEP published their report[5] in preparation for Rio +20. This includes a definition of 'green economy' which has widely been accepted.
2012	US BLS estimated employment in "Green Goods and Services" jobs in the USA	▪ The US Bureau of Labor Statistics[6] estimates that 2.4% of total employment in the United States in 2010 were "Green Goods and Services" jobs. These jobs are in businesses that "produce goods and provide services that benefit the environment or conserve natural resources".
	Recognition of green economy	▪ Governments agreed at the Rio +20 conference[7] to recognise the green economy as an important tool for sustainable development
	Green economy defined in measurable way	▪ SEEA developed a practical definition[8] of the environmental activities that could be used to measure the size of the 'green economy'
2015	UK begins Low Carbon and Renewable Energy Economy (LCREE) survey[9]	▪ The UK Office of National Statistics conducted the first low carbon and renewable energy survey which surveyed businesses engaged in activity across 17 LCREE sectors
	ABS begins reporting investment in renewable energy activities	▪ The ABS produces a measurement[10] for the number of direct full time equivalent (FTE) jobs in the renewable energy sector

Sources: 1. Quality of Life Policy Group (1989), *Blueprint for a Green Economy*; 2. UNFCC (1992), *What is the United Nations Framework Convention on Climate Change?*; 3. UN (1993), *Handbook of National Accounting: Integrated Environmental and Economic Accounting*; 4. ESCAP (2021), *Environment and Development: Green Growth*; 5. UNEP (2011),Towards a Green Economy; 6. US Bureau of Labor Statistics (2012) *Employment in Green Goods and Services 2010*; 7. UN 2012, *Rio+20 Policy Brief*; 8. UN (2012), *System of Environmental-Economic Accounting 2012*; 9. UK Office of National Statistics (2021), *Low Carbon and Renewable Energy Economy (LCREE) Survey QMI*; 10. Australian Bureau of Statistics (2020), *Employment in Renewable Energy Activities*

Data on the low-emissions economy is one of several types of data needed to guide Australia's emissions reduction efforts

Measurement of the low-emissions economy is one of several types of data that are relevant to the low-emissions transition. It is important to understand and define its role relative to these other data types.

The range of data is differentiated by whether the data is economic data, emissions and energy data or a hybrid of both; and the level at which the data is measured – either economy-wide, organisational or product-specific. Economic data is often expressed in terms of jobs in full-time equivalent (FTE), or in monetary units (for example, output in millions of dollars). On the other hand, emissions and energy data are usually expressed in physical units (for example, tCO_2e), and hybrid data uses a combination of physical and economic units.

Each type of data is useful for addressing different parts of the low-emissions transition. Distinctly, a measurement of the low-emissions economy is most useful for measuring the economic value of opportunities that arise from the transition. In contrast, for example, the National Greenhouse Gas Inventory can be used to track a country's progress to zero emissions and measure the effectiveness of policies that attempt to reduce emissions. Corporate ESG performance data can be used to inform investors of the environmental and social impact of potential investments. Appliance energy efficiency data can be used to inform household purchasing decisions.

Sustainable finance taxonomies

Sustainable finance taxonomies such as the EU Sustainable Finance Taxonomy are lists of economic activities that are designated as eligible for sustainable finance. The EU taxonomy covers economic activity related to climate change mitigation and adaptation, the circular economy, water and marine resources, pollution control and biodiversity.

Taxonomies are not themselves measurement frameworks, but policymakers want to ensure that investment is flowing into sustainable economic activities, and so taxonomy categories can inform what data is collected by statistical agencies. For example, in Europe, policymakers are considering using national statistics to measure economic activity in the specific activities listed in the taxonomy.[2]

Exhibit 1: Examples of different types of data relevant to emissions reduction

Levels of measurement	Economic data (usually measured in $ or FTE)	Hybrid data (usually measured as ratios or in a mix of units)	Emissions and energy data (usually measured in tCO_2-e or MWh)
Economy-wide	Measurement of the low-emissions economy	Economic-environmental data (e.g. SEEA[1]) Industry emissions intensity data	National GHG inventories (e.g. Australia's National Inventory Report)
Organisational	Company-level marginal abatement cost data	Corporate ESG performance data	Company emissions and energy reporting data (e.g. under the NGER scheme)
Product	Technology cost data	Lifecycle emissions intensity data	Appliance energy efficiency data

Notes: 1. SEEA refers to the System of Environmental-Economic Accounting; 2. Accenture stakeholder interviews

There are several international examples that could inform Australia's approach to measuring the low-emissions economy

International efforts to measure the relationship between the economy and the environment are yet to converge on a common approach. Examples differ in scope, ranging from measures of economic activity relating to renewable energy only through to broad coverage of environmental goods and services. Measurement of the low-emissions economy is emerging but there are few examples to date.

This report focuses on seven international approaches that attempt to measure the economic value of environmental activity.[1] These approaches are outlined in Exhibit 2. While these measurements do not purport to measure the 'low-emissions economy', they form a representative cross-section of international attempts to measure the economic value of activities with positive environmental impacts. These international approaches can inform the development of a credible, and where possible internationally consistent, measurement of the low-emissions economy in Australia.

There is significant diversity in these international measurements across several dimensions. For example, these approaches vary in their scope. The USA BLS approach has a broad scope, capturing any activities with an environmental benefit. The AU ABS study is narrow in scope, only covering activities related to renewable energy.

These approaches also vary in their outputs: some only measure employment, some also measure the monetary value of activity. Further, some are annual official government approaches, while others are one-off measurements prepared by non-government organisations. This diversity can generate a breadth of insights for an Australian approach.

Exhibit 2: Overview of the seven international approaches selected for analysis

Broader: term captures more environmental activities

"Low-emissions economy"

Narrower: term captures fewer environmental activities

Short title[2]	Full title of data series or report	Years of publication	Outputs	Govt approach?
USA BLS	Green Goods and Services	2012 – 2013	Employment	Government
USA Brookings	Sizing the Clean Economy	2011	Employment, export, wages	Non-government
UK ONS EGSS[3]	Environmental Goods and Services	2015 – present (annual)	Employment, output, exports	Government
UK ONS LCREE	Low-carbon and Renewable Energy Economy	2015 – present (annual)	Employment, turnover, # of businesses, imports, exports, acquisitions, disposals	Government
Canada CEC	Missing the Bigger Picture	2017	Employment, GVA, investment	Non-government
AU CEC/UTS	Clean Energy at Work	2019	Employment	Non-government
AU ABS	Employment in Renewable Energy Activities	2015 – 2020 (annual)[4]	Employment	Government

Notes: 1. The list of seven international approaches selected for analysis in this report is not exhaustive. However, it does cover many of the most credible international approaches 2. Short titles are used throughout this report. 3. The UK ONS is one of over 30 national statistical agencies that reports EGSS in alignment with Eurostat's methodology. Each of these countries uses a slightly different measurement approach. The UK ONS EGSS is used as a representative from this group.
Sources: A list of sources referred to for these seven international approaches are included in Appendix p44. 3. The AU ABS was last released in 2020. The next release date is unknown.

Developing a low-emissions economic data series involves defining a clear scope and choosing an appropriate measurement method

Approaching the measurement of the low-emissions economy as a two-stage process ensures the measurement has a clear definition for the scope and associated economic activity, as well as a clear set of desired outputs and methods for collecting them.

1.  **Defining a scope**

Key questions:

- *What activities should be considered low-emissions?*
- *What activities are relevant to the low-emissions economy?*

Chapter 2 discusses the first stage of producing an economic data series on the low-emissions economy; defining what should be included in scope. A low-emissions economy measurement seeks to isolate activities that play an intentional and significant role in reducing greenhouse gas emissions. There are a number of straightforward low-emission activities, such as renewable energy production and afforestation, that would be likely to easily fall within the scope. However, questions arise as to whether activities that happen to be lower-emitting than other comparable activities, such as the use of a fuel efficient petrol car, should be included in the definition. The role of activities that support or enable other low-emissions activities also need to be considered. Chapter 2 provides a possible framework to determine consistent inclusions and exclusions across the economy.

2.  **Choosing a measurement method**

Key questions:

- *What are the desired data outputs that will maximise benefit to users?*
- *What data collection methods could be used to produce the outputs?*

Chapter 3 addresses the second stage of producing an economic data series on the low-emissions economy; determining what specific measures of these activities are most desirable for users and how these outputs can be collected. There are many economic variables, from employment to investment, that may be informative to tracking the state of the low-emissions transition. Different data sources, such as administrative data or company reports, may be suitable data sources for certain metrics, such as employment, but not for others, such as investment. Once a set of priority economic variables are selected, a suitable data source can be validated. Chapter 3 outlines a set of suitable priority economic variables and evaluates Australia's data collection opportunities.

02

The scope of Australia's low-emissions economy could include products across the economy that contribute substantially to and have a purpose of reducing our emissions

Defining the scope of the low-emissions economy involves deciding what is *low emissions* and determining what concept of the *economy* is appropriate

To understand the concept of the 'low-emissions economy' and develop a framework for its consistent application, it is useful to break the phrase into its component parts and consider each separately. First, which activities can be considered 'low-emissions'; and secondly, what is the most appropriate concept of the 'economy' to apply?

What activities should be considered *low-emissions*?

A primary consideration is **determining a meaningful threshold** for when an activity is 'low-emissions'. Some activities, such as afforestation, are performed primarily for the purpose of reducing emissions. Other activities, such as carshare services, are not undertaken substantially for the purpose of reducing emissions, though they may have that effect. While a definition could reasonably include the former option, a choice must be made as to whether, or how to, include the latter. While the inclusion of the latter option would likely expand the coverage of the definition, it may also include a vast range of activities that would not typically be considered 'low-emissions'.

A definition of 'low-emissions' should also account for **changes in what could credibly be considered 'low-emissions' as the economy decarbonises over time**.

For example, a vehicle that is relatively energy efficient today may be considered relatively energy inefficient in ten years, as engine technology continues to improve. This may favour the consideration of a dynamic threshold of 'low-emissions' which evolves in tandem with changing standards. However, a dynamic threshold for 'low-emissions' trades off the ability to accurately compare measurements of the low-emissions economy over time, which may otherwise be achievable through a static threshold.

These factors highlight only two of a number of trade-offs that must be considered defining the 'low-emissions' threshold.

What concept of the *economy* should be applied?

There are different concepts of the economy that we can apply in constructing a definition of the low-emissions economy. One consideration is **whether the 'economy' should include all processes and behaviours that contribute to lower emissions**. This could potentially encompass a vast range of activities performed in a private capacity, for example, a reduction in the fertiliser or the drafting of an internal 'green' company policy. Another alternative is to **restrict the 'economy' only to traded goods and services**; for example, the manufacture of solar cells or the provision of technical advisory services. A further option is to **include public and non-profit sector goods and services**, which are typically provided at no direct cost to consumers.

The choice of the types of activities that should be captured by the 'economy' necessarily involves **compromises between conflicting desirable qualities**. An expansive concept of the 'economy', which may include all low-emissions processes, may be difficult to measure. Conversely, a restrictive concept of the 'economy' which only includes goods and services with an observable market value may offer a less complete picture of low-emissions economic activity in Australia.

The concept of the 'economy' should also consider **the extent to which activities in a value chain of a low-emissions activity should be included**. While final products are the focus of measures such as GDP, intermediate production is a significant source of economic activity. However, not all intermediate inputs to a low-emissions final product contribute equally to the low-emissions economy. For example, the refined battery chemicals or wind turbines are exclusively produced as intermediate inputs into low-emissions final products. However, screws are a generic intermediate good to some low-emissions final products but also used widely across the economy. A definition must decide whether, or how to, include these intermediate inputs.

The concept of the 'economy' should also consider whether it should reflect only the supply of low-emissions goods and services, or whether it should be extended to capture the use of these goods and services.

Five dimensions of quality should inform an Australian definition of the low-emissions economy

Fundamentally, the definition selected for the 'low-emissions economy' has to be of sufficient quality to be accepted and used by stakeholders. There are five dimensions of quality that should be considered, outlined in Exhibit 3.

The definition will ultimately be used to develop a list of products or activities that should be measured. To ensure that this list has comprehensive **coverage** across the wide range of activities that could exist in Australia, a systematic approach to definition could consider all the possible ways in which Australia could reduce its emissions and the economic activities associated with those.

To ensure that this definition is **credible**, an Australian approach could ensure that its categories are derived from internationally recognised classification systems, such as the UNFCCC IPCC inventory segments.

A **comparable** Australian definition could, as far as possible, align itself with definitions used by similar international approaches.

An Australian definition could also emphasise its **relevance to Australia** by prioritising the inclusion of distinctive features of the Australian low-emissions economy.

Lastly, the definition could provide for **measurability** by ensuring that it is specific and clear and is focused on activities for which there is an observable economic value.

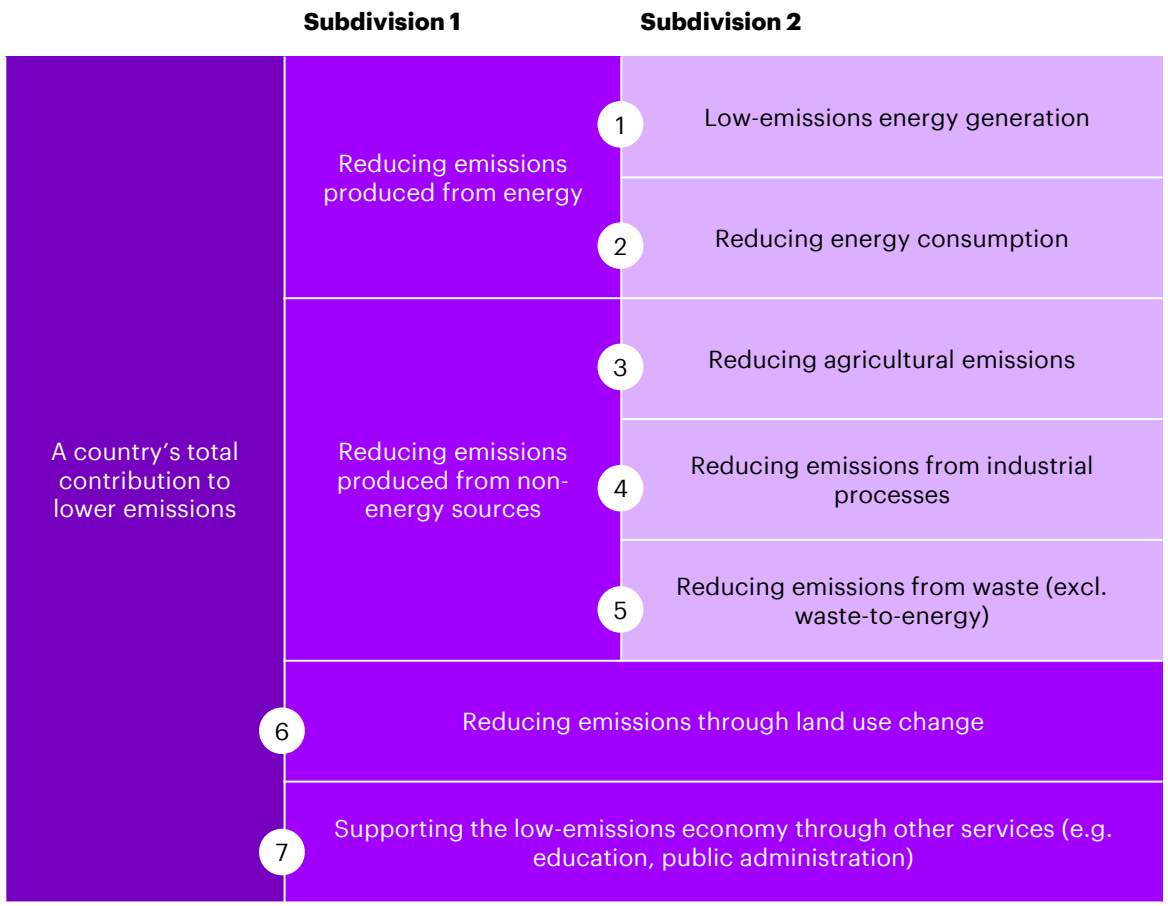
The development of a definition invariably involves a series of compromises between these dimensions. For instance, a definition that is highly relevant to Australia may include products or activities that reflect distinctive patterns of industry in Australia but are not widely included internationally, limiting the comparability of the definition. An awareness of these compromises ensures that a definition can articulate both its applications and limitations.

Exhibit 3: Dimensions of quality that should inform a definition

Dimensions of quality	Description
Coverage	The definition should cover a comprehensive range of low-emissions activities.
Credibility	The definition should be widely accepted by a range of different users as the reliable source of information on the Australian low-emissions economy.
Comparability	The definition should allow for comparison between low-emissions industries in Australia and peer countries.
Relevance to Australia	The definition should capture distinctive aspects of Australia's emissions profile.
Measurability	The definition should be specific and clear and focus on activities for which economic value can be meaningfully measured.

Australia's definition could be aligned with official emissions categories to ensure that it considers all low-emissions activities

Exhibit 4: Seven channels for emissions reduction



There are seven main channels through which emissions could occur and therefore in which the low-emissions economy could exist. Exhibit 4 shows how Australia's total contribution to emissions reductions can be decomposed into these seven channels.

Channels 1 to 6 align to IPCC sectors 1 to 5 in Australia's National Inventory Report under the UNFCCC.[1] The UNFCCC National Inventory Reports have been widely adopted internationally to catalogue greenhouse gas emissions.[2]

Channels 1 and 2 are ways in which emissions can be reduced from the production and use of energy. '*Generating energy from low-emissions source*' includes activities that directly generate energy (e.g. solar farms) and activities that enable the use of energy from low-emissions sources (e.g. battery storage). '*Reducing energy consumption*' refers to activities that consume less energy than equivalent alternatives, regardless of the source of energy consumed (e.g. energy efficient lighting).

Channels 3 to 6 are ways in which non-energy emissions can be reduced. These channels broadly align with IPCC sectors 2 to 5.

'*Reducing agricultural emissions*' includes the use of feedstock additives that reduce livestock emissions, '*Reducing emissions from industrial processes*' includes the production of low-clinker cement, '*Reducing emissions from waste*' could include nitrogen removal from wastewater,[3] and '*Reducing emissions through land use change*' includes afforestation.

Note that '*Reducing emissions from waste*' excludes waste-to-energy, as this is covered by Channel 1, and that '*Reducing emissions through land use change*' includes both terrestrial and marine sinks ('blue carbon').

Channel 7, '*Supporting the low-emissions economy through other services*' are services that create an environment which supports the other six channels but are not direct inputs into these channels. For example, public administration services from the Clean Energy Regulator are included under this channel, However, engineering advisory services to support the development of a solar farm would be included under Channel 1.

While these seven channels are collectively intended to cover the range of ways in which emissions can be reduced, an approach may choose to prioritise the measurement of some channels in the early stages of its development.

Sources: 1. Department of Industry, Science, Energy and Resources (2021) *National Inventory Report 2019*; 2. UNFCCC (2009) *UNFCCC Resource Guide for Preparing the National Communications of Non-Annex I Parties*; 3. De Haas (2018) *Greenhouse Gases from Wastewater Treatment Systems*

Existing international approaches focus on energy emissions and 'other low-emissions services'

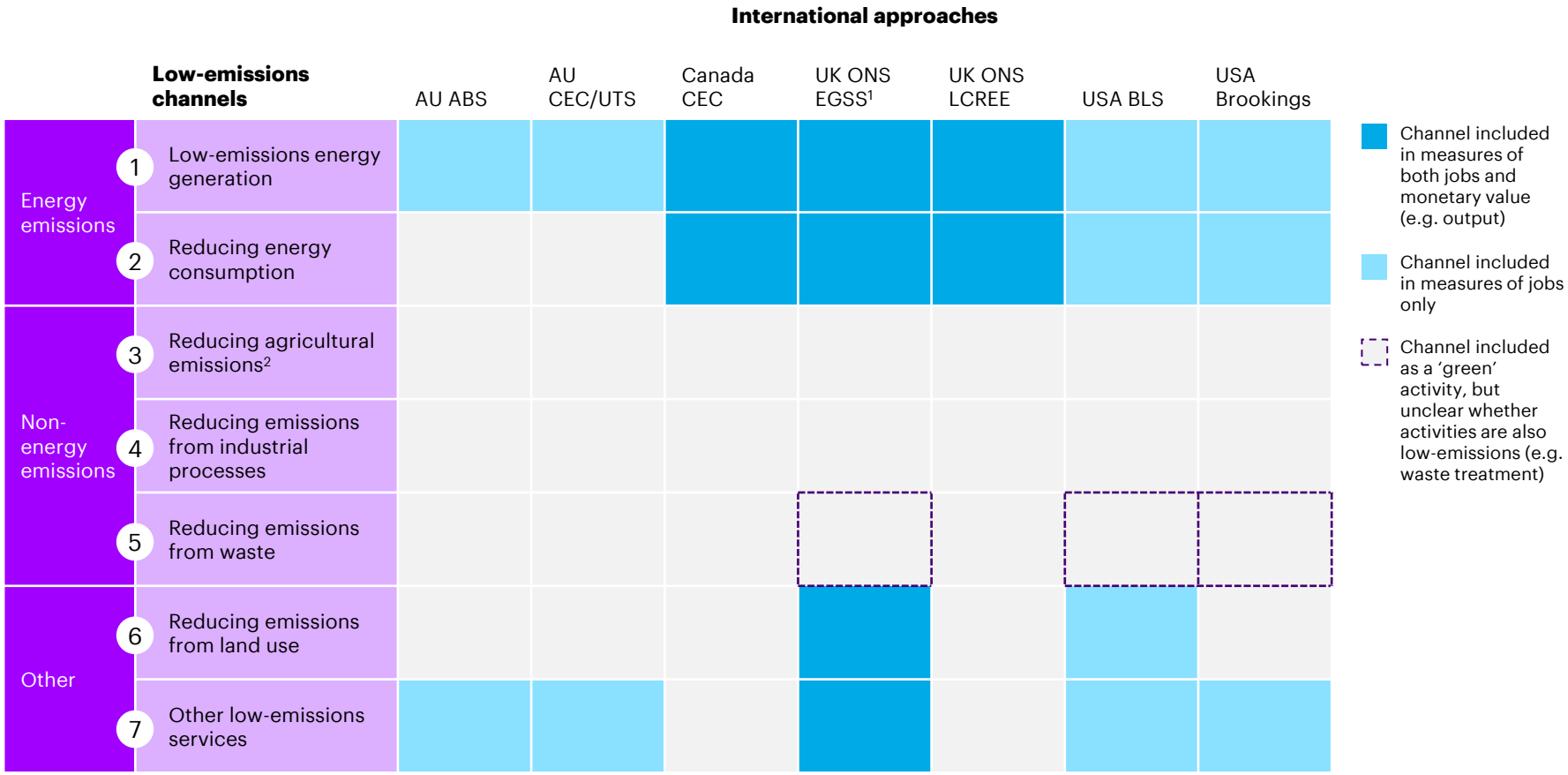
Exhibit 5 presents the inclusion of the 7 low-emission channels across international approaches. Three channels for emissions reduction are widely measured in other international approaches:

- Low-emissions energy generation
- Reducing energy consumption
- Other low-emissions services.

An approach that is internationally comparable would likely capture these three channels.

The two energy-related channels are most widely covered by international approaches. '*Other low-emissions services*', which includes government administration, education and advocacy, is also widely included internationally. However, it is noteworthy that most approaches only measure employment in this channel. This observation may be explained by the fact that the two energy channels are generally comprised of tradeable products with an observable price (which can be used as a metric of monetary value). However, products in the '*Other low-emissions services*' channel are generally provided by the public sector at a zero price. It may nonetheless still be practical to measure the output generated by activities in this channel by measuring the total labour expenses of relevant employers of organisations that provide these services.

Exhibit 5: Low-emissions channels covered by selected international approaches



Notes: 1. The UK ONS EGSS aligns its definition of EGSS with that outlined in Eurostat's EGSS Handbook. Eurostat documents have been used to supplement ONS documents to determine the definition used by the ONS EGSS. 2. The UK ONS EGSS, USA BLS and USA Brookings all included 'organic agriculture' in their definition. This was not considered part of the '*Reducing agricultural emissions*' channel for the purposes of Exhibit 5.

The threshold for what is considered 'low-emissions' may need to change over time in response to declining average emissions intensity

An Australian approach needs to consider two interrelated definitional considerations about the level of emissions. How should 'low-emissions' be defined to ensure that it only includes activities that make a meaningful contribution to emissions reductions? And how should the definition respond to changes to what could plausibly be considered 'low-emissions' throughout the transition process?

What should the be threshold for 'low-emissions'?

All activities have some level of emissions on a lifecycle basis. Whether an activity can be considered 'low-emissions' could depend on its purpose and its emissions relative to substitute products.

For example, solar PV could credibly be considered 'low-emissions'. First, a primary purpose for the production of solar PV is to reduce emissions by substituting for more emissions intensive electricity generation. Second, the lifecycle emissions are *substantially* lower than prevailing sources of energy generation in Australia (namely coal, which accounts for about 75% of electricity generation).[1]

It is less clear whether some other activities should be included. For example, electronic billing does not have a primary purpose of reducing emissions. Further, while electronic billing may produce lower emissions than traditional billing, it does not contribute substantially to reduced emissions.

Australia's definition should apply a threshold to distinguish between activities that are credibly 'low-emissions' and activities that incidentally reduce emissions. One method used internationally to identify relevant activities is to only include products that have a primary purpose of reducing emissions. Exhibit 6 shows an international example of two potential methods.

Exhibit 6: Thresholds used internationally to identify relevant activities

Method	Example
Primary purposes	UK ONS EGSS: Only includes activities for which an 'environmental purpose' is a main purpose of production.
External standards	USA Brookings: Includes activities that *significantly* increase energy efficiency identified using certifications or credible third-party standards (e.g. DOE/EPA Energy Star, LEED certifications).

How should the definition respond to a decline in Australia's emissions over time?

'Low-emissions' is a relative concept – an activity could be considered 'low-emissions' if it produces lower emissions than its functional substitutes. However, as the economy as a whole reduces its emissions over time, the threshold for what could credibly be considered 'low-emissions' may also change.

There are clear limitations of a static definition that defines an immutable list of low-emissions activities. For example, cars that are presently considered energy-efficient may not be considered as such when assessed against the energy efficiency standards that prevail in several decades' time. A static definition may therefore result in a definition that is overly expansive.

For instance, improvements in the overall energy efficiency of consumer goods in the economy may mean that the definition could eventually include *all* new cars. Such a definition may be of limited utility for key user groups.

However, frequent updates to the activities included in the definition can also detract from the utility of the measurement by undermining the continuity of the time series. The list of activities included in an Australian approach should therefore be updated with a frequency that balances the need to reflect evolving understandings of 'low-emissions' throughout the transition, with the maintenance of continuity of the data series over time.

Sources: 1. Geoscience Australia, *Energy – Overview*; Accenture stakeholder consultations

Some emerging activities require careful consideration of their suitability for inclusion as in the 'low-emissions' economy

There are many emerging activities that could conceivably be considered 'low-emissions'. However, for each of the following three classes of activities, an Australian approach should carefully consider whether its inclusion to the definition would be consistent with user needs for the low-emissions data series.

Low-emissions activities that are a component of a broader activity

Key question: *Should the whole activity or only the low-emissions component be included in the definition?*

Examples of low-emissions components

- Electric vehicle ('EV') batteries in an EV
- Use of insulation in an energy-efficient building

Some energy-efficient activities are only distinguishable from their 'standard' counterparts due to the inclusion of particular energy-efficient components. For example, an EV could be considered low-emissions due to the inclusion of a battery, enabling use of low-emissions sources of energy.

Some international approaches[1] include the broader activity in their measurement (e.g. the production of the whole EV). This choice could significantly affect the measured value of the economy because, for instance, the value of an EV is substantially higher than the value of an EV battery.

However a threshold that specifies the proportion of a broader activity that must be low-emissions for the entire activity to be considered low-emissions would be arbitrary. The inclusion of the broader activity may also risk misrepresenting the additional employment and output generated by low-emissions activities. Australia may therefore wish to consider including only the value of the low-emissions component in its definition.

Activities to reduce embedded emissions

Key question: *Should the production of goods or services using energy from low-emissions sources but that do not otherwise contribute to emissions reduction be included in the definition?*

Examples of activities to reduce embedded emissions

- Production of 'green' steel
- Production of 'green' cement

Some activities aim to reduce the embedded emissions in products, such as 'green' steel (i.e. they are produced using energy from low-emissions sources). However, practical challenges may arise if such activities are included in a definition of the low-emissions economy.

First, a threshold that specifies the level of embedded emissions that a product must contain to be considered 'low-emissions' is likely contested and arbitrary. In many cases, it may also be difficult to verify the provenance of energy used in production, hence challenging to identify products that fall below the threshold.

Second, the consumption of energy from low-emissions sources does not itself reduce emissions. Rather, emissions abatement occurs through the low-emissions generation of energy.

Third, as the economy decarbonises, it may be expected that *all* goods and services will contain lower embedded emissions. However, a definition that includes all goods and services is unlikely to be useful for key user groups.

Transitional activities

Key question: *Should activities that may not be aligned with long-term net zero goals be included in the definition?*

Examples of transition activities

- Liquified natural gas
- Fossil fuel-derived hydrogen without CCS

Some activities, such as the use of liquified natural gas for energy generation, may assist a high-emissions economy transition to a lower-emissions economy. However, the same activities may produce a relatively high level of emissions in an economy that is late in its transition. This situation is complicated by the fact that a low-emissions economy could export these fuels or technologies to a high-emissions economy to help the latter economy with its transition.

A definition could plausibly change over time in response to changes in the landscape of the low-emissions economy. However, stakeholders[2] have indicated that it is much harder to remove an entire class of activities from an environmental definition than it is to update a threshold within a class (e.g. updating the threshold for energy efficiency). An Australian definition should carefully consider whether to include 'transitional' activities as it may be difficult to remove them as they become less desirable.

Notes: 1. For example, the UK ONS EGSS, following Eurostat guidance, includes the full cost of the broader product. See also USA Brookings, Canada CEC and UK ONS LCREE.
Source: 2: Accenture stakeholder interviews

Determining the concept of the economy to be applied involves deciding the types of activities included and how intermediate inputs are treated

The concept of the 'economy' applied to 'low-emissions' activities should be both tractable and meaningful. This involves two key considerations: first, the types of economic activities (i.e. products with clear outputs or processes) that should be included; second, the extent to which intermediate inputs should be included.

What economic activities should be included?

Products with clear outputs are available for purchase or provided by the public or non-profit sector. The economic value of these products are usually easily observable. The value of outputs produced by the private sector can be observed through their market price, while the value of outputs provided by the public or non-profit sector can be observed through wages. The economic value of these products can be measured through several variables including employment, output, trade and investment.

In contrast, **processes** or behaviours are performed in a private capacity and cannot generally be exchanged for value. It is difficult to measure the economic value of processes because they are typically tangential to the usual activities of employees within a firm. It is conceivable to measure employment attached to such processes, as demonstrated by the US Bureau of Labour Statistics' proposed (albeit never implemented) green 'processes' measurement. However, without an easily observable metric of economic value, it is challenging to measure the output, trade and investment of these processes.

What intermediate inputs should be included?

Products that **directly contribute to emissions reductions** could credibly be included in the definition of the low-emissions economy. However, this may limit the definition to only, for example, the generation of renewable electricity, excluding the manufacturing of the technologies that are used in generation. An Australian approach should consider whether intermediate inputs to products that directly reduce emissions should also be included.

Some of these inputs are **specialised**. This means that they are predominantly used as inputs to low-emissions final products.

Other inputs are **generic**. This means that, while some of that input may eventually be used in a product that directly reduces emissions, the input could also be used in a wide variety of applications that are not low-emissions. Exhibit 8 provides examples of both types of inputs.

The class of generic inputs is potentially vast, and could include many products that would not intuitively be considered 'low-emissions'. Some international approaches explicitly exclude generalised inputs. For instance, USA Brookings only includes intermediate inputs that use 'skills or technologies that are *uniquely* applied to 'clean' final products.

Exhibit 7: Examples of products with clear outputs and processes

Products with clear outputs	Processes
▪ Installation of a wind turbine ▪ Provision of financial services from the Clean Energy Finance Corporation ▪ Manufacture and installation of energy efficient lighting	▪ Developing a internal company energy efficiency policy ▪ Reducing fertiliser use ▪ Use of efficient lighting in an office building

Exhibit 8: Examples of generic and specialised intermediate inputs

Generic intermediate inputs	Specialised intermediate inputs
▪ Screws used in a wind turbine ▪ Non-specialised accounting services	▪ Refined battery chemicals used in a battery energy storage system ▪ Project-specific engineering advice

Including specialised stages along the value chain of low-emissions activities would better represent the diversity of economic activity

Activities that supply low-emissions goods and services have value chains which lay across multiple industries, not all of which contribute inputs that are specific to the overall activity. An approach could focus on industries producing specialised inputs to these activities.

Exhibit 9 shows illustrative value chains for five potential low-emissions activities, where these value chains have been organised by industry. Each value chain consists of a series of intermediate inputs which engage different industries. Exhibit 9 excludes inputs that are clearly not specialised to the activity, such as mining bauxite for large-scale batteries, because aluminium is widely used outside the low-emissions economy.

An approach could choose which intermediate inputs within a low-emission activity should be included in the definition of the low-emissions economy. A review of industries that are included by international approaches may be useful for two reasons. First, determining whether enough of an industry's output is used in a low-emissions final product to be considered 'specialised' is not always straightforward. International approaches may indicate whether it is credible for a particular input to be considered 'specialised'. Second, an Australian approach may choose to prioritise the measurement of intermediate inputs that are widely measured internationally to ensure that it is internationally comparable.

Exhibit 9: Illustrative production value chains for five potential low-emissions activities

Not relevant to activity

		Industries[1]								
		Materials	Goods production			Services				
Activity	Associated channel	Agriculture or mining	Manufacturing	Utilities	Construction	Trade	Finance and insurance	Professional services	Public admin and education	Other services (maintenance)
Large-scale battery storage	Low-emissions energy generation	Mining lithium[2]	Manufacturing battery cells	Operating a large-scale battery	Installing a battery	Retailing large-scale batteries	Financing battery projects	Providing technical advice on batteries		Maintaining a large-scale battery
Energy efficient lighting	Reducing energy consumption		Manufacturing LED lighting		Installing energy efficient lighting	Retailing energy efficient lighting	Financing LED installation projects	Providing technical advice on LEDs		Maintaining energy efficient lighting
Government administration of regulations	Other low-emissions services								Provision of govt regulatory services	
Feed additives	Reducing agricultural emissions	Farming of plant inputs to feed additives	Processing and production of feed additives			Retailing feed additives		Providing agronomy services		
Afforestation	Reducing land use emissions	Nursery activities; performing afforestation						Providing technical advice on land use		

Notes: 1. Exhibit 9 uses ANZSIC divisions as industries, which is the highest-level classification in ANZSIC. This aligns with the use of ANZSIC industries in a several ABS data series including the National Accounts. Some ANZSIC categories omitted as they have little relevance to these products. 2. An explanation of why lithium may be considered a 'specialised input' for batteries is in the Appendix p49.

The low-emissions economy could be framed as the supply and use of low-emissions goods and services

Understanding the supply (or production) of low-emissions goods and services can inform stakeholders of the economic opportunities that are, or could be, generated by the low-emissions economy. This could be complemented by data on the use (or consumption) of low-emissions activities. By understanding who is consuming low-emissions products and how patterns of consumption are changing over time, an economy can be better placed to support the growth of industries that produce low-emissions goods and services.

1. Supply of low-emissions goods and services

Measuring the supply of low-emissions goods and services is critical to an understanding of the economic value generated by low-emissions activity.

The supply of low-emissions (or 'green') goods and services is widely measured by international approaches. This may reflect the relative ease in which supply data can be collected. For example, business that manufacture energy efficient lighting can be easily identified through administrative records. In contrast, it may be more difficult to identify businesses or households that use energy efficient lighting.

2. Moving from 'supply' to 'supply and use'

While the use of low-emissions (or 'green') goods and services is not widely measured internationally, it would allow stakeholders to understand the broader flow of products through the economy.[1]

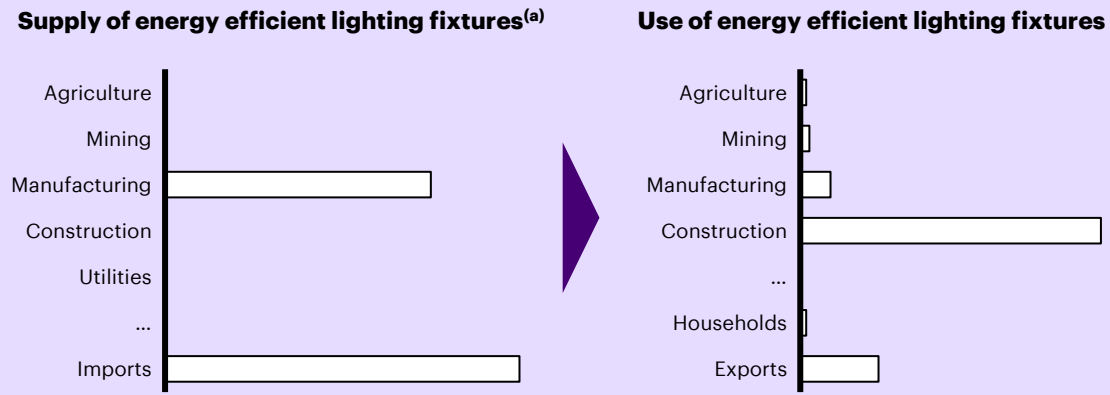
A 'supply and use' approach to the low-emission economy could be particularly powerful because it could facilitate the development of *input-output tables* which could be used to analyse interactions between the low-emissions economy and the broader Australian economy.

Because a 'supply and use' framework would quantify low-emissions activity consistently with other economic statistics (such as the National Accounts), this series could be used as a basis for estimates of other economic variables such as trade or investment. The ABS has previously developed 'supply and use' estimates in its tourism and transport satellite accounts.[2]

Additionally, because supply and use are interrelated, data on 'use' can inform stakeholders on how best to support the development of the low-emissions economy. For example, an understanding of the patterns in the usage of low-emissions electricity could indicate the need for investment or incentives to support the continued growth of activities that generate and store electricity from low-emissions sources.

However, the current absence of any data on 'use' may could reflect the difficulty in tracking the consumption of goods and services. Given the relative ease of measuring the production of low-emissions goods and services, one reasonable option for a country wishing to measure the low-emissions economy could be to initially generate a 'supply' data series and develop this into a 'supply and use' series over time.

Exhibit 10: Illustrative output from a 'supply and use' data series



(a) Supply excludes intermediate inputs to energy efficient lighting fixtures.

Sources: 1. Accenture stakeholder interviews; 2. Australian Bureau of Statistics, *Australian National Accounts: Tourism Satellite Account*; Australian Bureau of Statistics: Australian Transport Economic Account: *An Experimental Transport Satellite Account*

03

Australia's measurement of the low-emissions economy could draw on a variety of primary and secondary data sources

A measurement approach involves considering the data outputs to be produced and the availability of suitable data sources

The choice of a measurement approach involves two considerations. First, an approach should consider the types of data outputs that are of greatest interest to potential users. These user requirements can be used to design a desired data output. Second, an approach should consider the types of data sources that can be used to construct the desired data output.

1 Choosing desirable data outputs

Key question:

How should the final data output be designed to maximise its benefit for its users?

The first stage of developing a data collection strategy involves determining the types of features in a data output that are of most interest to key users, such as policymakers, business communities, researchers and the general public. These features include the types of *variables* included (e.g. employment or output), the *attributes* included (e.g. breakdown by industry) and the level of granularity of the data.

2 Choosing suitable data sources

Key question:

What data sources should be used to construct the desired data outputs?

Once the desirable data outputs have been chosen, the second stage involves evaluating the possible data collection strategies that may be suitable to construct these outputs. Within this stage, methods used by existing international approaches serve as examples for how differing data collection methods correspond to the resultant quality of the data. Broadly, data collection strategies fall into secondary data only, primary data only, or a combination of the two. Where available, secondary data should be evaluated before primary data is considered. In industries or channels without available secondary data, primary data sources such as surveys or industry consultations could be considered to supplement data gaps.

Key terms

- ***Economic variable***: Economic characteristic to be measured, such as employment or value-added.
- ***Attribute:*** Feature according to which economic variables it can be disaggregated. For example, the low-emissions measurement of employment could be disaggregated by product or by industry.

International approaches have produced data on a variety of economic variables including employment, output and trade

There are a range of key economic variables that could be included in a measurement of the low-emissions economy. International approaches commonly collect employment and output, as well as GVA, trade, and investment.

The foundational economic variables of employment and output are likely of interest to the widest audience because they can provide general and easily understood insights into the level of low-emissions economic activity. In particular, the inclusion of employment data would be consistent with international approaches (see Exhibit 11). Further, employment and output variables can also be combined to calculate the productivity of the low-emissions economy.

Several national statistical agencies have highlighted that there is strong user interest in data on Gross Value Added (GVA). Unlike output, GVA isolates the economic contribution of an industry by subtracting the cost of inputs. GVA therefore better represents the economic contribution of a specific industry than output. An accurate estimate of GVA in the low-emissions economy would be difficult to produce in the short-term, as it would require a large amount of detailed data on the profitability of firms in each activity. A rougher estimate of GVA could be generated in the interim by relying on the industry GVA data available in the Australian National Accounts.[1] This would involve an assumption that returns within *low-emissions* industries are similar to returns in that industry overall.

Trade and investment data can give further insights into specific aspects of the low-emissions economy. In particular, trade data may be of particular interest to Australian data users given Australia's distinctive upstream position in global value chains.

Exhibit 11: Economic variables produced by each international approach

	Economic variable	AU ABS	AU CEC/UTS	Canada CEC	UK ONS EGSS	UK ONS LCREE	USA BLS	USA Brookings
Foundational	Employment	✓	✓	✓	✓	✓	✓	✓
Foundational	Output or revenue				✓	✓		
Additional	GVA			✓	✓			
Additional	Trade				✓	✓		✓
Additional	Investment			✓				

Sources: Australian Bureau of Statistics, *Australian National Accounts (Table 6)*

Low-emissions data could be disaggregated by four key attributes: by activity, industry, region and occupation

An economic variable (e.g. employment) can be disaggregated by attributes such as activity, industry, region and occupation. Disaggregating totals can provide more valuable insights to decision makers to provide information on specific products or sectors. Policies and business decisions are targeted to certain products, industries, regions or occupations and as such, it is important to provide data that can track these variables.

There are four attributes that are likely to be relevant to a low-emissions economic data series:

1. **Low-emissions activity**
2. **Producer's industry**
3. **Region**
4. **Occupation**

Measures of economic variables can be disaggregated by attributes to improve the granularity of insight obtained from the collected data. Each disaggregation provides a unique insight into the low-emissions economy.

Disaggregating the data by **low-emissions activity** highlights the types of products or technologies that will become major drivers of the low-emissions economy. Alternatively, disaggregating the data by **producer's industry** can track whether industries are expanding or declining during the transition. Additionally, disaggregating the data by **region** can reveal disparities between states or metro/regional areas in economic opportunities. Lastly, disaggregating the data by **occupation** may point towards the skills required for jobs during the transition. Occupation data is difficult to obtain since businesses often hire employees across a broad range of occupations.

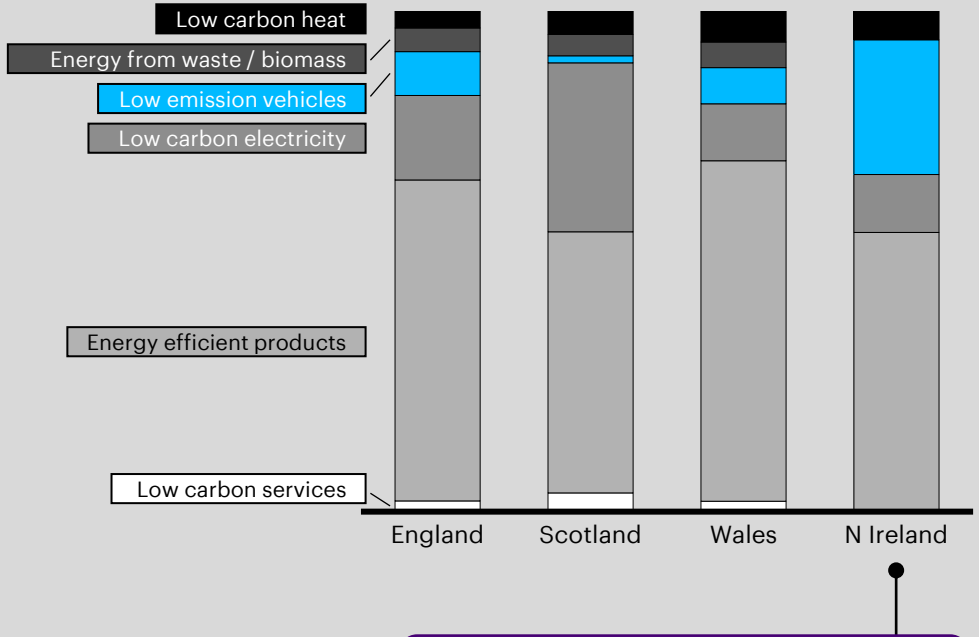
Disaggregating by two attributes simultaneously provides greater granularity and more nuanced insights. Exhibit 12 illustrates this opportunity in LCREE where the economic variable employment has been disaggregated by two attributes of interest: country and product.

While disaggregating the data by attributes of interest can increase data granularity, it can also increase the statistical uncertainty of estimates. Further, disaggregating by several attributes may lead to increasingly small samples sizes. Confidentiality considerations may prevent publishing subdivisions with few data points.

Exhibit 12: Example of analysing LCREE employment data by country and low-emission activity

LCREE employment by country and activity[1]

Percentage of total FTE in each country, 2019



Illustrative insight: Low emission vehicles generate a relatively large proportion of low-emissions employment in Northern Ireland.

Source: 1. Office of National Statistics (2021) *Low Carbon and Renewable Energy Economy Estimates*

International approaches have commonly used activities, industries and regions to disaggregate data

Exhibit 13: Attributes analysed by each international approach

	Attribute	AU ABS	AU CEC/UTS	Canada CEC	UK ONS EGSS	UK ONS LCREE	USA BLS	USA Brookings
Foundational	By low-emissions activity	✓	✓	✓	✓	✓		✓
Foundational	By industry		✓[1]		✓	✓	✓	
Additional	By region	✓	✓			✓	✓	✓
Additional	By occupation		✓					✓
Additional	Intersections between variables	▪ Activity / region				▪ Activity / region ▪ Activity / industry	▪ Industry / region	

Disaggregating data by low-emissions activities and industries may be of particular interest to users that wish to gain an understanding of how different businesses contribute to the low-emissions economy. A disaggregation by region can reveal how the economic activities and benefits of the transition are distributed across the country, while a disaggregation by occupation can provide valuable insights into the specific jobs and skills requires to support the low-emissions economy.

The use of low-emissions activities and industries as key attributes may be particularly attractive because this information can be readily collected from businesses. Some of this information may already be available through administrative data or existing ABS business surveys. Additionally, the *intersection* of these two attributes can be used to triangulate specific parts of value chains that contribute most to the economy. This is explored in more detail on the following page.

Given the diversity of business characteristics across Australian states, and between regional and metropolitan areas, disaggregating by region may also be of interest to users. However, meaningful data on the region in which low-emissions activity occurs may be more challenging to collect. This is because business registration data, which is a key source of information on business location, may not be where the activity occurs. For instance, a mining business may be registered in NSW, but most of its activity occurs in WA.

It is also challenging to collect data on low-emissions activity by occupation. This is because activities often span multiple occupations, and emerging low-emissions occupations may be challenging to categorise using traditional occupational classifications such as ANZSCO.

Notes: 1. AU CEC/UTS collects data by stage in the value chain (e.g. development, manufacturing, installation) rather than industry. These stages approximately align with industries.

Intersecting two attributes of interest can reveal insights not observed by applying a single attribute

Exhibit 14: Illustrative: low-emissions output disaggregated by low-emissions activity and industry

		Industry					
		Agriculture	Mining	Manufacturing	Utilities	Construction	...
Low-emissions activity	Solar PV	-	-	$x	$x	$x	...
	Hydropower	-	-	$x	$x	$x	...
	Battery storage	-	$x	$x	$x	$x	...
	Onshore wind	-	$x	$x	$x	$x	...
	...	...	...	...	...	...	...

Output *Higher* *Lower*

Illustrative insights:

*Lithium mining inputs to battery storage contributes significantly to the low-emissions economy. As lithium spodumene is exportable, this presents a significant **export opportunity** for Australia.*

*The construction of solar PV is a significant part of the low-emission economy. While construction is not typically exportable, an increase in this contribution over time may indicate the need for more **skills and investment** in this area*

The disaggregation of the outputs measurement by industry and low-emission activity attributes reveals nuanced insights for industry and trade policy through isolating the outputs of specific goods or services across the value chain.

Disaggregating by low-emissions activity only provides insight into the size of the market broadly however is not able to distinguish between different parts of the activity's value chain. This may obscure the varying export potential and skills needed at each part of the value chain.

Disaggregating by both activity and industry allows a user to triangulate the economic value and potential of different parts of the value chain for different low-emissions activities. For example, Exhibit 14 illustrates the potential for a low-emissions data series to capture the key industries responsible for output within each activity. This insight can inform where investment or skill generation may be beneficial to service a growing industry within a low-emissions value chain.

There are a range of primary and secondary data sources that could be used to measure the desired outputs

After determining the form of data outputs that best serve the needs of users, an Australian measurement approach should then develop a strategy for selecting data sources that can be used to construct those data outputs. An Australian approach could draw upon a variety of primary and secondary sources of data.[1]

For a particular study, **primary data** is data that is collected for the purposes of that study. For example, a new survey that was designed to measure part or all of the 'low-emissions economy' would be a primary data source. Primary data could also take the form of interviews or focus groups (for example, with business owners or experts), which can be used to inform assumptions where data is otherwise difficult to collect.

Secondary data is pre-existing data that was not collected for the purposes of that study. Some secondary data comes from government departments and agencies. For example, the ABS prepares the Australian Industry data, which could be used to estimate the relationship between output and employment in each industry.[2] Some government agencies may have administrative data. This data was prepared by the agency in their ordinary course of business, but could provide data points that are useful for the measurement of the low-emissions economy. For example, the Australian Energy Market Operator, a quasi-governmental regulator, releases data on the capacity of existing and proposed energy generation projects. This could potentially be used to estimate the low-emissions economy as it relates to generation from low-emissions sources.

Other secondary data sources come from non-government sources. Supranational agencies, such as the International Energy Agency, may be valuable sources of data on low-emissions energy activities. An Australian approach could also use industry certifications such as the Green Building Council Australia's (GBCA) Green Star Project Directory either as a source of data or a benchmark for what an industry may consider 'low-emissions' or 'energy efficient'. For smaller industries, an Australian approach could also use data on projects, employment or revenue that may be available in company reports and websites.

Each data source has unique characteristics that affect the desirability of their use. These qualities are outlined on the following page.

Exhibit 15: Examples of data sources that could be used to measure the low-emissions economy

Category		Data sources
Primary data		New surveys
		Interviews with industry / experts
		Direct collection and observation
Secondary data	**Government sources**	Existing data series from a national statistical agency
		Administrative data from government departments / agencies
		Government reports
	Non-government sources	Data from supranational agencies
		Industry surveys
		Industry reports
		Industry certifications (e.g. GBCA Green Star Project Directory)
		Proprietary research (e.g. IbisWorld)
		Company reports and websites

Sources: 1. See generally, Australian Bureau of Statistics, *Statistical Language – Data Sources*; Australian Bureau of Statistics, *Statistical Language – What are Data?*; 2. Australian Bureau of Statistics, *Australian Industry*

Australia should consider the usefulness, cost-effectiveness, timeliness, repeatability and credibility of various data source options

Exhibit 16: Evaluation of primary and secondary data against key dimensions of quality

Dimensions of quality	Definition	Primary data (e.g. survey)	Secondary data: Govt	Secondary data: Non-govt
Usefulness	A data source is useful if it can provide granular and highly relevant data that meets the needs of users.			
Cost-effectiveness	A data source is preferred if it is less resource-intensive for all relevant parties (e.g. survey commissioners and survey respondents).			
Timeliness	A data source is preferred if there is a shorter time lag between the reference period and the time when the data is reported.			
Repeatability	A data source should be repeatable in future years to allow for comparisons against a baseline.			
Credibility	A data source should be widely accepted by a range of users as the reliable source of information.			

There are five key dimensions of quality for a data source: usefulness, cost-effectiveness, timeliness, repeatability and credibility. An Australian measurement approach should assess the unique qualities of each data source to determine whether it is suitable for credible measurement. Exhibit 16 provides a general assessment of primary and secondary data sources against key dimensions of quality.

Primary data for a measure of the low-emissions economy is any data specifically collected for this purpose.[1] A key advantage of primary data is that it can be designed to best align with user needs for the data series. For example, a survey specifically designed for the low-emissions economy can target questions in such a way that it captures the desired variables (e.g. employment) and attributes (e.g. industry) at an appropriate level of granularity. Primary data collection is also generally repeatable given sufficient resources to collect primary again in later years.

A key disadvantage of primary data is its high cost. Surveys are often resource-intensive for not only survey commissioners, but also for survey respondents.[2] Additionally, national statistical agencies are often constrained in terms of time and staffing, so it may not be feasible for these agencies to run additional surveys.[2] Some surveys also involve a considerable time lag between the reference period and the time when the data is released. For example, the UK ONS LCREE and the US BLS surveys reported data two years after the survey's reference period. This can detract from the utility of the data, especially in an area of potential growth like the low-emissions economy. Further, the credibility of a survey can be limited by a low sample size or a low amount of measured activity.

The desirability of **secondary data** is highly variable. While some secondary data may be highly relevant and useful for the measurement of the low-emissions economy, other secondary data may require significant assumptions to be used.[3] The timeliness and repeatability of secondary data is also variable, as it depends on the speed and frequency at which this data is published. However, the repeatability of government secondary data is likely to be higher given that government agencies tend to report data more consistently and frequently than non-government sources.

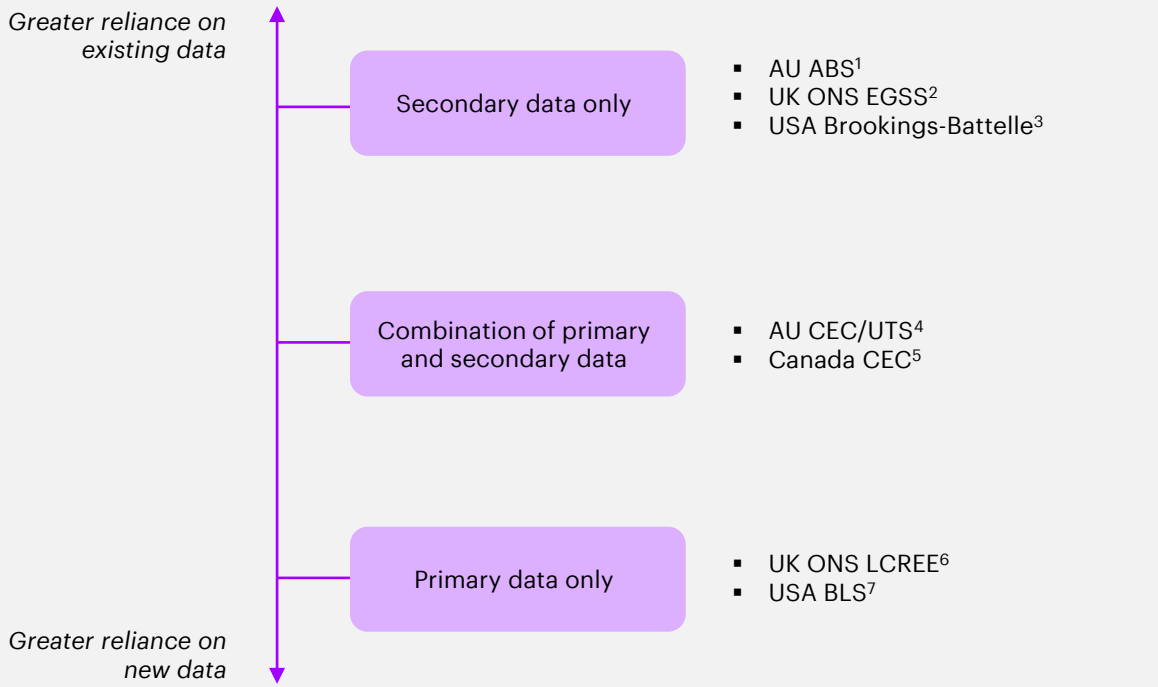
Because secondary data is pre-existing, it is highly cost-effective. An Australian approach could therefore prioritise the use of secondary data where it is useful, timely, repeatable, and credible, and consider supplementing this with primary data where there is no appropriate secondary data.

While an Australian approach should assess the quality of each *individual* data source, it should also assess whether the suite of sources used is coherent as a whole. This is addressed later in this report.

Notes: 1. This report will primarily consider surveys, as this is likely the most useful and credible primary data source. 3. Some highly relevant administrative data may not be available for use, for example, due to legislation and confidentiality concerns. See *Australian Bureau of Statistics* (2011) *Common Issues with Acquiring Administrative Data*
Sources: 2. Accenture stakeholder interviews

International approaches have adopted one of three data collection models: secondary data only, primary data only or a combination

Exhibit 17: Data collection models used in other approaches



There is no internationally agreed upon method of producing measurements for the low-emissions economy. The current range of methods fall along the spectrum from solely relying on existing secondary data through to producing new primary data.

Some international approaches use **secondary data only**. For example, the UK ONS EGSS primarily draws upon other ONS data series (e.g. UK National Accounts, Supply-Use Tables) and government administrative data to estimate GVA and employment in the Environmental Goods and Services Sector.[2] Other approaches, such as the AU ABS Renewable Employment study supplemented government data with non-government data such as company annual reports.[1]

Other approaches use a **combination of primary and secondary data**. For example, the AU CEC/UTS study uses a survey to estimate the ratio of employment to new renewable energy installations. Survey data is combined with secondary data on the quantity of new installations to estimate renewable energy sector employment.[4]

It is worth noting that neither of the studies that have been selected for analysis in this report use a combination of primary and secondary data are conducted by national statistical agencies. However, there are some official approaches outside the focus of this report that use a combination data collection model (e.g. Austria, Belgium, Hungary and Poland for their Environmental Goods and Services Sector estimates).[8]

Some international approaches use **primary data only**. For example, the UK ONS LCREE surveys a sample of 24,000 UK businesses to estimate the total value of carbon and renewable energy activity.[6]

The following page shows two case studies of how international approaches have collected and used different data sources. The case studies illustrate how the data source influences the economic variables and attributes of the outputs.

Sources: 1. Australian Bureau of Statistics (2020) *Employment in Renewable Energy Activities, Australia Methodology*; 2. Office for National Statistics (2021) *Environmental Accounts on the Environmental Goods and Services Sector (EGSS) QMI*; 3. Brookings Institution (2011) *Sizing the Clean Economy*; 4. UTS Institute for Sustainable Futures (2020) *Renewable Energy Employment in Australia: Methodology*; 5. Navius Research (2019) *Quantifying Canada's Clean Energy Economy*; 6. Office for National Statistics (2021) *Environmental Goods and Services Sector (EGSS) Methodology Annex*; 7. US Bureau of Labor Statistics (2013) *Extended Technical Note*; 8. Eurostat (2021) *2020 EGSS Quality Reports*

The UK ONS has produced data series using both the 'primary data only' and 'secondary data only' models

Exhibit 18: Methodology of the UK ONS LCREE (example of a 'primary only' model)[1]

Data inputs

- 24,000 businesses surveyed using a stratified sampling method
- 2,300 of these businesses reported LCREE activity[2]

Calculations

1. Proportion of businesses reporting any LCREE activity within a stratum is estimated
2. Responses in each stratum are reweighted to ensure that they appropriately represent non-sampled businesses
3. Reweighted responses are aggregated to generate an estimate of total LCREE activity in each stratum

Data outputs

Economic variables	Attributes
▪ Number of businesses ▪ Turnover ▪ Employment ▪ Imports and exports ▪ Acquisitions and disposals	▪ By country ▪ By industry ▪ By activity and country ▪ By industry and country

Exhibit 19: Methodology of the UK ONS EGSS (example of a 'secondary only' model)[3]

Data inputs

Source	Data sources used	
ONS	▪ Annual Business Survey ▪ Business Register and Employment Survey ▪ Supply-use Tables	▪ Public sector employment ▪ Low-carbon and Renewable Energy Economy
UK Govt Depts	▪ BEIS Digest of UK Energy Statistics ▪ BEIS Energy Trends ▪ BEIS Household efficiency ▪ BEIS Energy generation costs ▪ BEIS Solar PV deployment	▪ BEIS Renewable heat incentive rates ▪ HMRC trade tables ▪ MHCLG UK Housing Survey ▪ Feed-in-tariff annual reports
OECD	▪ OECD-FAO producer price (biofuel)	▪ OECD Classification of Functions of Government

Calculations

The ONS combines available data using a variety of calculations, ratios and assumptions.

For example, the output of biofuel production is calculated by multiplying 'reasonable prices' (based on OECD-FAO biofuel prices) by the quantity of biofuel produced (based on government administrative data).

Data outputs

Economic variables	Attributes
▪ Output ▪ GVA ▪ Employment ▪ Exports	▪ By activity[4] ▪ By industry

Sources: 1. Office for National Statistics (2021) *Low Carbon and Renewable Energy Economy* (LCREE) Survey QMI; 3. Office for National Statistics (2021) *Environmental Accounts on the Environmental Goods and Services Sector (EGSS) QMI*
Notes: 2. 2,300 businesses that were surveyed reported activity in any of the 17 LCREE sectors. 4. 'Activity' includes both the ONS's EGSS activity classifications and the EU classification of environmental protection and resource management activities (CEPA and CReMA).

To develop a new data series, an Australian approach could start by evaluating existing secondary data before assessing the need for new primary data

Since the collection of secondary data is generally more cost-effective than primary data, it is worth assessing the availability and quality of existing secondary data that could form the basis of estimates of the low-emissions economy. In areas of the low-emissions economy where existing secondary data is sparse or of low quality, it could be supplemented with primary data, subject to an assessment of the costs and benefits.

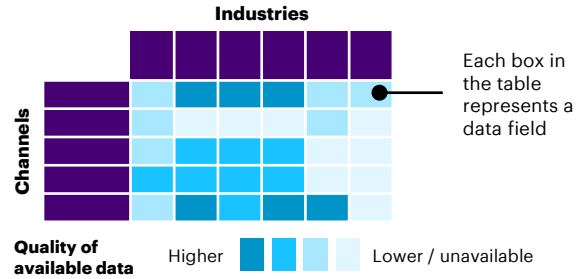
1. Evaluating the availability and quality of secondary data

Given the vastness of activities that could potentially comprise the low-emissions economy, countries are unlikely to have a single high-quality secondary data source that could form the basis of a comprehensive measurement of the economy. The challenge for countries wishing to measure the economy is then to curate a selection of data sources that could be used to measure the low-emissions economy.

The complex inquiry into the availability and quality of existing data sources could be structured by segmenting the low-emissions economy into discrete data fields that potentially could be measured independently. These data fields could be structured around data attributes that are of greatest interest to stakeholders. For example, if stakeholders are particularly interested in low-emissions data that is disaggregated by both low-emissions channels and industry, an approach could segment the low-emissions economy into data fields for each combination of channel and industry.

The approach could then evaluate the availability and quality of secondary data in each of these data fields. This has been completed illustratively in Exhibit 20.

Exhibit 20: Illustrative evaluation of available secondary data for each data field



2. Assessing the need for primary data

An Australian measurement approach has various options for dealing with a lack of available secondary data or low-quality secondary data. When considering its options, an Australian approach should not only consider how the quality of data for individual data fields can be improved, it should also consider whether the overall data collection approach is coherent *as a whole*.

There are three main options for dealing with a data field with low-quality or no available data:

- Exclude the data field from the measurement
- Supplement secondary data with assumptions
- Supplement secondary data with primary data.

An approach could consider excluding the data field from measurement if it is relatively unimportant to users contributes only a small amount to the low-emissions economy. This option could also be considered where a survey is not feasible or too expensive to run, and the use of assumptions would not be credible. The data field could be included in later iterations of the study if, for instance, there is greater user interest in this data point. This approach has been used by the ABS renewables study. Here, the operation and maintenance of large-scale solar infrastructure has been omitted in the 2018-19 study but will be included in the next iteration.[1]

The use of assumptions in combination with low-quality secondary data could be considered where the accuracy of a data field is not of critical importance to data users. This may be preferable where the quality benefits of using primary data instead of assumptions does not outweigh the additional cost of primary data.

Finally, the use of primary data to supplement secondary data may be desirable where users demand highly accurate data on the low-emissions economy such that the use of assumptions would be insufficient to meet their needs. A survey would be a credible option if it is affordable and there is sufficient low-emissions activity that can be measured to facilitate a statistically robust estimate.

Choices about data sources could be also be driven by an assessment of the internal coherence of the overall data collection approach. That is, an approach could prefer data fields in the same low-emissions product or industry to be measured in a consistent way, even if higher-quality data is available for some fields, to ensure that credible comparisons can be made across the entire data series.

Source: 1. Australian Bureau of Statistics (2020) *Employment in Renewable Energy Activities, Australia Methodology*

There are various options for surveys that could supplement available secondary data on the low-emissions economy

To supplement data gaps left by available secondary data, an approach could collect primary data through the use of a survey. Surveys can be designed to target different attributes, such as industries or low-emissions channels.

Surveys are able to collect data where there is no suitable available data or provide a greater granularity of detail where existing data in sufficient for the current purpose. Specifically, they can collect desired attributes such as industry and low-emissions activity during the data collection since there is direct contact with those being surveyed. Surveys can further provide insight into the occupational breakdown and skills requirements across the channels; information that is difficult to collect otherwise. However, producing a new survey is highly labour intensive and accordingly extremely costly to produce. As such, surveys should initially only be completed where no other options are available. In time, surveys could be considered across the remaining channels and industries to gain greater granularity in data.

Several practicalities should be considered for the feasibility of collecting usable primary data. First, the sample of businesses selected is extremely important. Particularly for immature channels and industries in Australia, special care should be taken to ensure the sample includes businesses in these areas. Second, the questions included in the survey should balance the amount of information desired with the associated demand placed on the respondent. As many countries administer a large number of surveys to businesses, the additional burden of a potential new survey should be considered. It is also important that the questions presented to the respondent are clear and direct the respondent to provide the desired information. These practical considerations are not exhaustive but rather suggestive of the concerns that should be addressed if a survey were to be chosen as a data collection method.

Exhibit 21: Illustrations of industry-based and channel-based surveys

Industry-based survey

The industries with the least existing data could be targeted through industry specific surveys to meet the data gaps to be filled by primary data. This approach is advantageous since firms are clearly classified by industry and can be targeted.

Channel-based survey

Multiple channels could be targeted through activity specific surveys. This is more challenging than by industry since it is difficult to target relevant firms. Further, most of the data gaps fall within specific industries and should be targeted accordingly.

04

Australia's approach could start with priority information about the low-emissions economy and expand over time

Australia could start with a simple measurement of parts of the low-emissions economy, before scaling up to a more comprehensive study

A range of objectives for an Australian low-emissions economy data series emerge from the considerations outlined in this report. However, the implementation of an ambitious and full-scale measurement approach likely requires researchers to have significant resources and experience with data on the low-emissions economy.

Not all these objectives would need to be pursued at once – instead, an Australian approach could first undertake a simpler and more limited measurement of the low-emissions economy. This initial measurement could be refined as researchers learn from earlier iterations of the study and expanded as low-emissions activity proliferates.

An Australian approach could select its priorities in three key parts of the measurement process:

- The choice of **low-emissions channels** that are measured
- The choice of **economic variables and attributes** that are provided in the data output
- The range of **data sources** that are used.

1. Priority low-emissions channels

To ensure that it is internationally comparable, an Australian approach could prioritise the low-emissions channels that are widely measured by international approaches. As outlined on page 16, there are three channels that are frequently measured internationally:

- Low-emissions energy generation
- Reducing energy consumption
- Other low-emissions services.

An Australian approach could also prioritise low-emissions channels that reflect distinctive aspects of the Australian economy, and therefore its emissions profile. A detailed analysis of these channels is included on the following page.

2. Economic variables and attributes

There are at least five key economic variables that could be included in an Australian data series on the low-emissions economy: employment, output, GVA, investment and trade.

While all five are valuable in affording an understanding of the low-emissions economy, some of these variables are likely to appeal to a broader group of users. For example, employment is a variable that is well-understood by generalist users, as highlighted by its wide inclusion in international approaches, and could be a prime candidate for prioritisation. Output could also be prioritised as a relatively accessible measure of the overall state of the low-emissions economy.

There are also various data attributes that potential users may find appealing, including disaggregations of the data by activity, industry, region and occupation. An Australian approach could prioritise the inclusion of activity and industry attributes, because the combination of these attributes could be used to triangulate the economic value of distinctive parts of the value chain of different low-emissions activities. This could allow stakeholders to target specific industry areas that may require more support during the transition.

3. Data sources

While the use of primary data sources can potentially produce highly precise insights about the low-emissions economy, it would also require significant resources. A successful survey can take significant time to develop, and requires both researchers and respondents to have familiarity with the concept of the low-emissions economy. A reliable survey also requires a sufficient scale of low-emissions activity in the economy to be measured through sampling, which may not be present at an early stage of the transition.

For these reasons, an Australian approach could initially rely on existing secondary sources as a basis for earlier iterations of the study, and consider whether primary data should be used to fill any gaps in available secondary data. It could then incrementally refine and expand its data collection methods over time. This may involve a greater use of targeted surveys which could be used to expand the scope and improve the accuracy and precision of the data series.

Five key low-emissions channels could initially be prioritised for inclusion in Australia's approach

Australia could consider including channels that reflect distinctive aspects of the Australian economy and therefore emissions profile in addition to widely measured channels. Two channels could be considered particularly relevant to Australia:

- Reducing agricultural emissions
- Reducing land use emissions

From 2014-15 to 2019-20, Australian governments spent $640 million on the research, development, demonstration and commercialisation of low-emissions agricultural and land technologies.[1] This is unsurprising given the importance of agriculture to the Australian economy. Exhibit 22 shows that the agricultural sector contributes a far greater proportion of national CO_2-e emissions in Australia compared to other countries that have developed measurements of the economic value of activities related to the environment. In contrast, Australia's industrial process and waste emissions are not particularly distinctive compared to its international peers.

Additionally, Australia's expansive land mass offers distinctive abatement opportunities through land use change. There is currently a growing active market for land sector carbon abatement, with approximately $1.5 billion in land sector carbon credits (ACCUs) committed for purchase in the April 2021 Emissions Reduction Fund auction.[2]

This system of ACCUs gives a readily observable indication of land use emissions reduction activity in Australia.

Australia's emissions reductions through land use change also has potential for significant expansion. Australian think tank, Beyond Zero Emissions, estimates that its 'Million Jobs Plan land use initiative', which includes the revegetation of 27 million hectares of land, can generate 40,000 ongoing jobs.[4] Future growth is supported by the development of nascent carbon sequestration technologies such as marine permaculture.

Australia could therefore prioritise the following five channels which are either widely measured internationally or reflect distinctive aspects of the Australian economy:

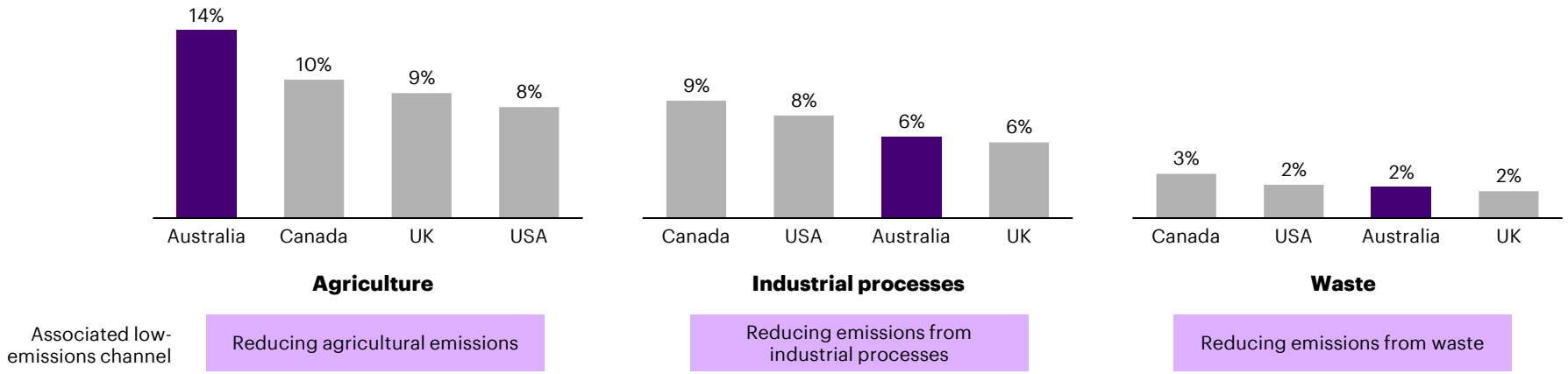
- Low-emissions energy generation
- Reducing energy consumption
- Other low-emissions services
- Reducing agricultural emissions
- Reducing land use emissions

Australia could also consider expanding its definition to include other channels over time as economic activity proliferates in more nascent low-emissions channels. Australia's choice of priority channels for measurement could also be informed by the evolving social, economic and environmental priorities of key user groups.

After selecting priority channels, an Australian approach could then identify specific activities that can be credibly and tractably included under each channel. The subsequent pages outline key factors that Australia could consider when identifying these products.

Exhibit 22: Carbon emissions associated with each channel

CO_2-e emissions by source as a % of total CO_2-e (excluding LULUCF) by jurisdiction, 2014-2018 (5-year average)[3]



Sources: 1. Department of Industry, Science, Energy and Resources (2020) *First Low Emissions Technology Statement*; 2: Clean Energy Regulator (2021) *ERF Auction April 2021*; 3. UNFCCC, *'Time Series – Annex I'*; 4. Beyond Zero Emissions (2020) *The Million Jobs Plan*; Accenture calculations

Australia's definition could begin by including activities that are widely included in international approaches

Providing a list of 'low-emissions activities' that are to be initially included in the definition will ensure it is practical and tractable. Australia's selection of activities that could credibly be considered 'low-emissions' could be informed by a review of international approaches.

Exhibit 23 shows a list of activities that have been included in international approaches for the three channels that are widely measured internationally. A detailed analysis of activity inclusions by international approach is included in Appendix p45-48. An Australian definition may also wish to include other activities that are not included in Exhibit 23 to reflect the composition of the Australian low-emissions economy over time.

For '*low-emissions energy generation*', well-established renewable generation technologies such as solar and wind are most commonly included. Emerging renewable generation technologies such as wave and geothermal are sometimes included. Non-renewable low-emissions generation technologies are less frequently included.

Many international approaches such as UK ONS EGSS and the Canada CEC study have included technologies that enable the use of low-emissions energy sources, such as storage and transfer technologies. It is worth noting that many international approaches include electric vehicles (as a whole) in their definitions. As discussed on the next page, an Australian definition may wish only to include the batteries in electric vehicles. Further, while no international approaches have included 'green' hydrogen fuel,[1] this may reasonably be added as a technology that facilitates the storage of energy generated from low-emissions sources.

For '*reducing energy consumption*', international approaches have most frequently included activities relating to buildings, such as building installations and heating, ventilation and air conditioning.

For '*other low-emissions services*', international approaches have most frequently included government services. In an Australian context, this could include services provided by the Climate Change Authority or the Clean Energy Regulator.

Exhibit 23: Summary of products included in international approaches

Detailed analysis in Appendix p45-48

Low-emissions energy generation
Generation from low-emissions energy sources
Solar PV
Solar thermal
Wind
Hydropower
Bioenergy
Wave
Geothermal
Waste-to-energy
Nuclear
Technologies that enable the use of low-emissions energy sources
Battery storage
Electric vehicles (batteries)
Grid infrastructure

Reducing energy consumption
Energy-efficient building architecture
Energy-efficient building installations (e.g. insulation, double-paned windows)
Energy-efficient heating, ventilation and air conditioning
Energy-efficient lighting
Energy-efficient consumer goods and appliances
Energy-efficient industrial machinery

Other low-emissions services
Public administration
Education
Advocacy

Frequency of inclusion

Higher — Lower

Notes: 1. The AU CEC/UTS study intended to estimate employment in hydrogen generation and storage. It is unclear whether this study will proceed.

Established and emerging activities that reduce emissions from agriculture and land use are candidates for inclusion in Australia's definition

Activities within the agricultural and land use channels are not currently included in any international environmental or low-emissions economic data series. However, Australia could consider established and emerging activities that reduce agricultural and land use emissions as candidates for inclusion. These activities have significant abatement potential and a measurable economic value. An Australian definition could add to these lists as the low-emissions economy in these channels matures.

Established and emerging activities that reduce agricultural emissions

Feed change includes the use of additives that reduce livestock emissions produced during enteric fermentation. These additives can reduce methane emissions from cattle anywhere from 15-80% depending on the type of additive.[1] Australia's livestock is the third largest source of greenhouse gas (GHG) emissions, contributing 70% of agricultural sector emissions and 11% of national GHG emissions.[1] Consequently, feed additives are could be critical to reducing agricultural emissions.

Urease inhibitors are chemical additives that stop or reduce the rate of nitrous oxide produced from urea in manure stockpiles. The agricultural sector is responsible for 73% of Australia's nitrous oxide emissions.[2] Other methods of reducing emissions from manure stockpiles include process changes such as manure stockpile aeration, however process changes are more difficult to measure and quantify economically.

Biogas systems take in agricultural waste and convert it into methane. When the methane is produced, it can either be combusted immediately in a flare to avoid fugitive methane emissions or stored for later use.[3]

Controlled-release fertilisers reduce the amount of nitrous oxide produced by nitrogen-based fertilisers. Other methods to reduce nitrous oxide include process changes such as reducing the use of nitrogen fertiliser or using legume crops or pastures on rotation instead of nitrogen fertiliser.[4]

Established and emerging activities that reduce land use emissions

Afforestation is the establishment of new forests on land not forested and includes both afforestation and reforestation activities. These activities produce natural carbon stocks that sequester carbon dioxide and represent a high opportunity for carbon abatement. These activities are currently recognised by ACCUs and can be used to offset existing emissions.

Biochar is a form of charcoal produced heating organic waste material that when applied to soil increases the soil carbon content and can improve agricultural productivity.[5]

Peatland and wetland hold a significant capacity for carbon sequestration compared to other forms of land. Globally, wetlands cover just 9% of earth's land surface yet are estimated to store 35% of terrestrial carbon.[6] Given Australia's significant coastline, there is substantial opportunity for peatland and wetland restoration as a low-emissions activity.

Exhibit 24: Examples of activities that reduce agricultural emissions

Reducing agricultural emissions
Feed change
Urease inhibitors
Biogas systems
Controlled-release fertiliser

Exhibit 25: Examples of activities that reduce land use emissions

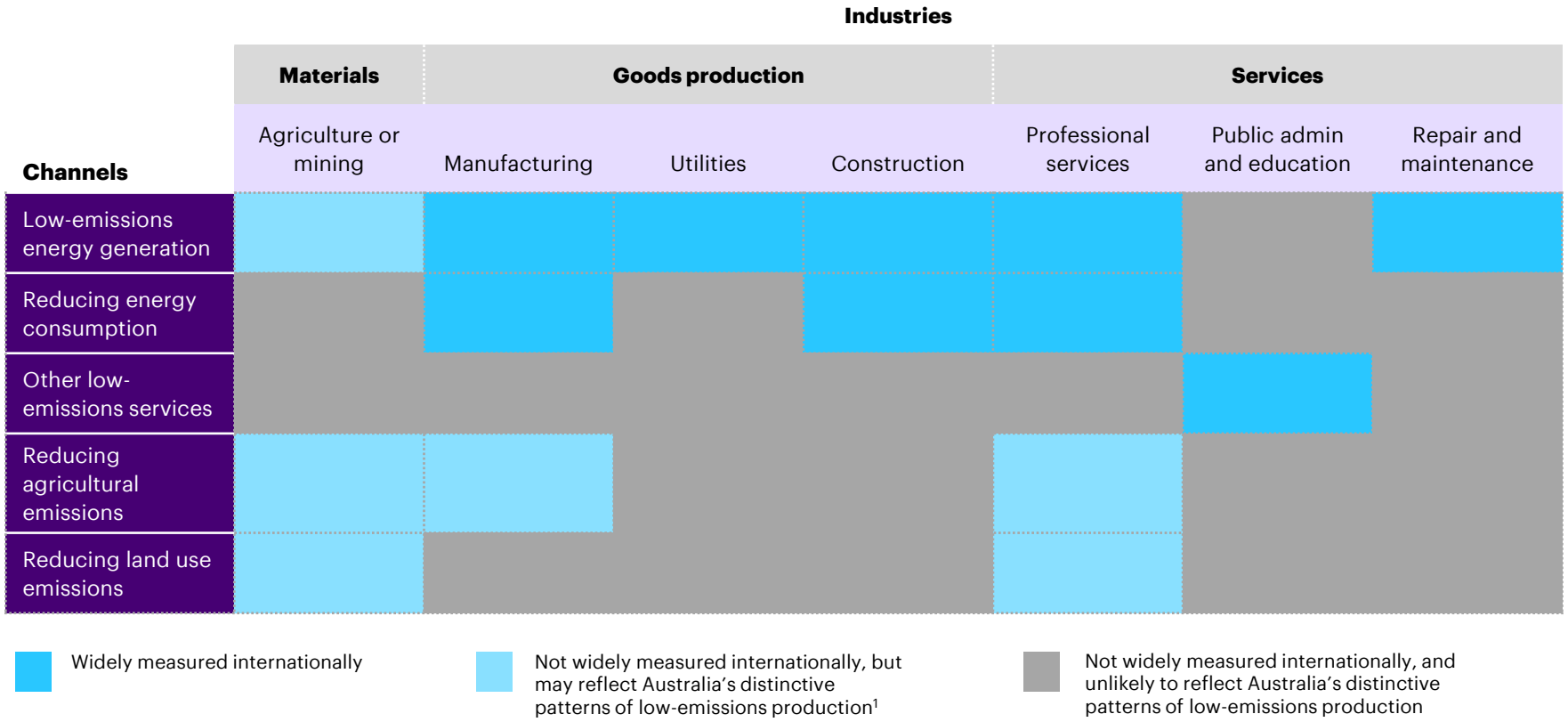
Reducing land use emissions
Afforestation
Biochar
Peatland and wetland restoration

Notes: 3. Methane can also be captured for later use as an energy source in heating or for the cogeneration of heat and energy. The use of methane in this way would fall within the '*low-emissions energy generation*' channel.
Sources: 1: WA Department of Primary Industries and Regional Development (2020) *Carbon farming: reducing methane emissions from cattle using feed additives* 2. WA Department of Primary Industries and Regional Development (2020) *Managing manure to reduce greenhouse gas emissions*; 4. WA Department of Primary Industries and Regional Development (2020), *Reducing nitrous oxide emissions from agricultural soils in Western Australia*; 5. Department of Agriculture, Water and the Environment 2019, *Biochar*; 6. QLD Department of Environment and Science (2020), *Wetlands and the carbon cycle*

The choice of industries could reflect international approaches, supplemented by industries where Australia is distinctive

Exhibit 26: Industries that are widely included internationally, and industries where Australia is distinctive

Detailed analysis in Appendix p45-48



International approaches typically include industry activities in the 'goods production' stage of the value chain, plus professional services such as engineering and design. An Australian approach could prioritise the inclusion of industries that are widely included internationally, supplemented by industries which are particularly significant to Australia.

Exhibit 26 shows the industries that are most frequently included internationally for typical activities in each channel. International comparisons are only available for the three channels that are widely measured internationally.

Second, the exhibit also shows the industries for each channel that otherwise reflect Australia's distinctive patterns of low-emissions production. For example, since Australia is distinctively a net exporter of minerals (in particular, lithium for battery storage), lithium mining could credibly be included as an industry where Australia is distinctive.

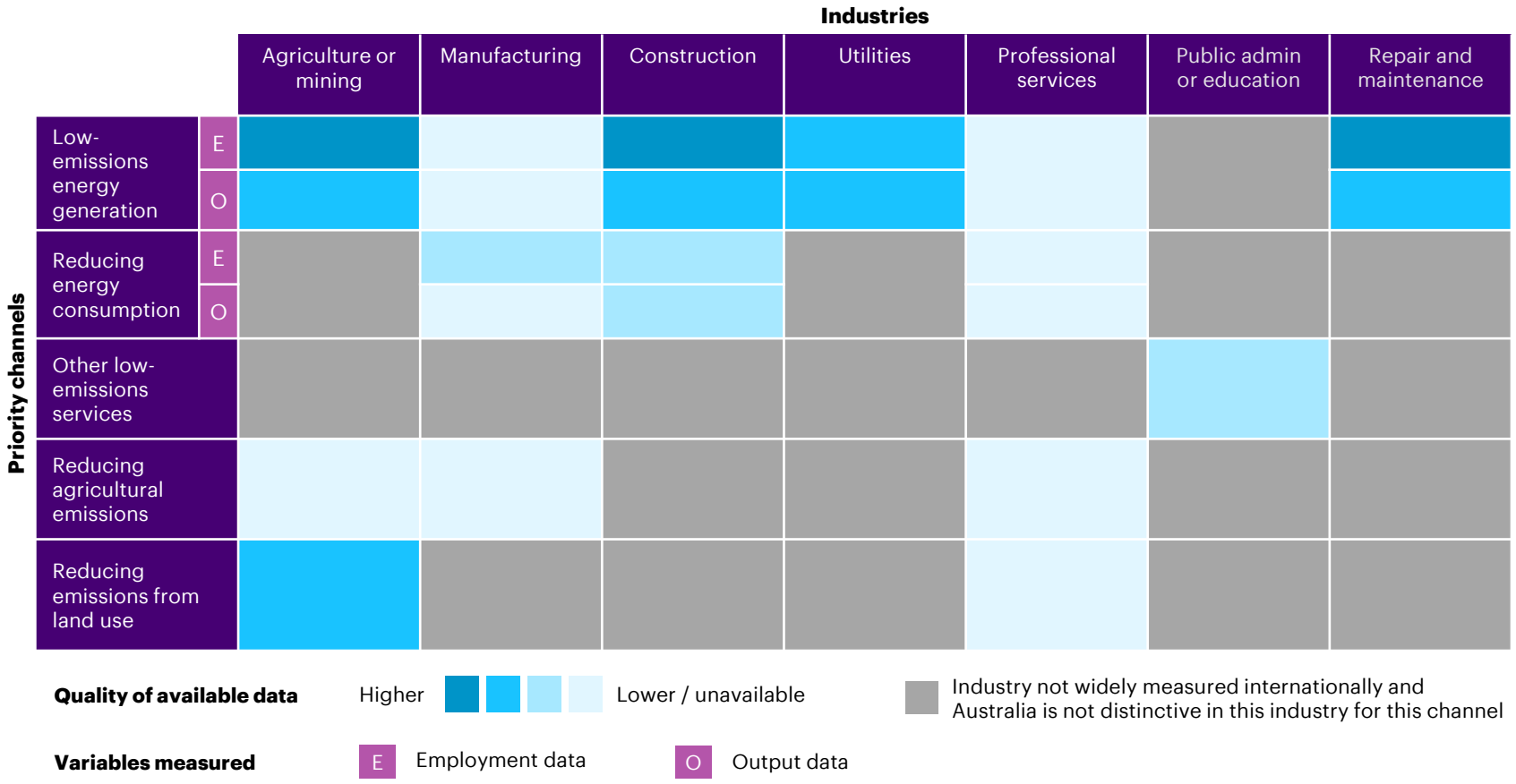
A detailed analysis of the industries that are included internationally is in Appendix p45-48. Also see Appendix p49 for an analysis of lithium mining's potentially distinctive contribution to low-emissions energy generation.

Notes: 1. For *'reducing agricultural emissions'* and *'reducing land use emissions'*, an industry could be considered distinctive to Australia if it could be expected to form a meaningful part of the value chain for a typical activity in this channel. See Exhibit 9 for an illustrative value chain for a typical activity in these channels. The *'Retailing'* industry was excluded because it is widely included in international approaches, even though it may be ostensibly relevant to channels covered in those approaches. See Appendix p49 for an analysis of lithium mining's potentially distinctive contribution to low-emissions energy generation.

There is a patchwork of secondary data sources of varying quality that are available to measure the low-emissions economy

Exhibit 27 : Secondary data availability and quality for priority channels and key industries

Detailed analysis in Appendix p50-52



Sources: 1. Australian Bureau of Statistics, *Labour Account Australia* 2. Australian Bureau of Statistics, *Australian National Accounts (Table 7)*

Secondary data varies significantly in its quality and availability. Most available secondary data that is also high-quality is in the '*Low emissions energy generation*' channel. There is limited secondary data available for the other channels.

Exhibit 27 shows an assessment of the availability and quality of secondary data for each data field, which is segmented by priority channel and industry. The quality of secondary data sources is assessed against four dimensions: usefulness, timeliness, repeatability and credibility. A detailed assessment of the quality of available data sources is in Appendix p50-52.

To develop statistics on employment, a sound approach could use the Australian Labour Account[1] as a starting point. This account provides high quality industry-level labour data that is coherent with other economic statistics produced by the ABS.

It is worth noting that there is very little available secondary data in the manufacturing and professional services industries across all channels. This does not mean that it is not possible to estimate the size of the low-emissions economy in these areas. National Accounts[2] provide estimates for overall output in each industry. These estimates can be used in combination with assumptions (perhaps informed by desktop research) to estimate the proportion of these industries that fall within each low-emissions channel.

A pathway for the development of an Australian approach could consider both near-term priorities and future opportunities

The preceding analysis reveals a potential pathway for the development of an Australian approach. In its initial iterations, an Australian approach could start with its near-term priorities by selecting priority channels, economic variables and data attributes which can be measured using simple data collection strategies. As the level of low-emissions activity increases over time, and researchers and stakeholders gain a greater understanding of the low-emissions economy, an Australian approach could evolve into a more comprehensive measurement of the economy.

Exhibit 28: Potential pathway of an incremental development of an Australian approach

Stage	Near-term priorities	Future opportunities
Definition	Australia's approach could initially target five channels. 1 Low-emissions energy generation 2 Reducing energy consumption 3 Other low-emissions services 4 Reducing agricultural emissions 5 Reducing land use emissions	The definition could be expanded to cover more channels in the future. 6 Reducing emissions from industrial processes 7 Reducing emissions from waste (excl. waste-to-energy)
Data outputs	**Variables**: Employment, output **Attributes**: By product, by industry	**Additional variables**: Investment, trade, GVA, exports **Additional attributes**: By region
Data sources	The available secondary sources for each low-emissions channel should be validated, and primary data could be selected for data gaps where secondary data is insufficient. An Australian approach could consider whether the use of a combination of both primary and secondary data is appropriate.	As researchers gain experience with measuring the low-emissions economy, an Australian approach could refine its data collection methods over time. This could involve an increased or exclusive reliance on targeted surveys as the level of low-emissions activity increases, which could improve the granularity and accuracy of the data series.

Changing standard industry and occupational classifications to capture low-emissions economic activity is an important medium-term reform

An Australian pathway for the development of a measurement of the low-emissions economy is constrained by the way in which business information is classified. The standard industry and occupational classifications of ANZSIC and ANZSCO underlie most national statistics in Australia. However, these standard classifications may struggle to capture the nascent industry activities and occupations that emerge from the transition. An update to these existing classifications would not only improve the quality of measurements of the low-emissions economy, but it would also ensure that these measurements are coherent with other national statistics such as the Labour Account[1] and the National Accounts.[2]

What are industry classification codes?

Standard industry classifications codes provide a standard framework to group businesses that are doing similar productive activities. These group of similar activities are known as industries. Businesses are assigned industries based on their predominant activity.

The Australian and New Zealand Standard Industrial Classification (ANZSIC) is the official industry classification across Australia and New Zealand. ANZSIC forms the basis for standardized collection as well as analysis. It is used by official statistics agencies as well as industry organisations and researchers, and for regulatory, taxation and research purposes[3] to arrange large amounts of data about businesses. Similar to ANZSIC, the Australian and New Zealand Standard Classification of Occupations (ANZSCO) is the official occupation classification across Australia and New Zealand.

ANZSIC was first released in 1993 and later revised in 2006. To remain current, industry classifications need to be periodically evaluated to remain up to date with evolving industries. The benefits of updating industries must be assessed against the cost of changing the underlying categories of statistical collections. The high cost of reworking collections and outputs and revising time series inhibit the ease and ability to revise industry classifications.

ANZSCO was first released in 1986 and has been revised several times in 1997, 2006, and 2003. In 2021, ABS announced a revision to 3 occupations: agriculture, forestry and fisheries, cybersecurity, and naval ship building.[4] These changes are part of a feasibility test to investigate incremental changes to allow ANZSCO to keep up with rapid changes in labour markets. This revision may be valuable in informing future revisions of ANZSIC.

How would changes to classifications help?

The existing standard industry classifications do not distinguish between high- and low-emission economy activities within industries. Explicit low-emissions categories would improve the usefulness of existing national statistics that is categorised according to industry classifications.

Existing industry classifications do not adequately distinguish between high-emission and low-emission activities, or aggregate low-emissions activities too highly. As a result, it is difficult to isolate low-emissions activities because they are often recorded in the same category as the high-emission counterpart activity. For example, all energy generation is aggregated into the same 1- and 2-digit ANZSIC code. All renewable electricity generation is within one 4-digit ANZSIC code, except hydro which has its own. Several national statistics agencies emphasised the shortcomings of existing industry classifications for measuring the low-emissions economy.[5]

Redesigning classifications would involve adding categories that distinguish between low-emission and high-emission versions of the same process or product. For example, one category for low-emission energy generation, distinguished from a second for fossil-fuel energy generation. Several national statistics agencies[1] have discussed the need for explicit categories of low-emission and green activity to effectively measure and track this activity.

The process of redesigning the standard industry classification approach is a significant and lengthy project, often taking 10 years from redesign to being reflected in new statistics.

Changing industry classifications presents challenges for long-running time series that use these categories for reporting. Given the number of data series that rely on these classifications, changes are made infrequently.

Notes: 1. Australian Bureau of Statistics (2021), *Labour Account Australia*; 2. Australian Bureau of Statistics (2021), *Australian National Accounts*
Sources: 3. Australian Bureau of Statistics (2021), *Updating ANZSCO commences in March 2021*; 4. Australian Bureau of Statistics (2008), *Australian and New Zealand Industrial Classification (ANZSIC), 2006*; 5. Accenture stakeholder interviews

05

Appendix

Seven international measurements of economic activity related to the environment have been referred to throughout this report

Exhibit A1: Sources for seven international approaches referred to in this report

Approach	Main sources
AU ABS	Australian Bureau of Statistics (2020) *Employment in Renewable Energy Activities, Australia* Australian Bureau of Statistics (2020) *Employment in Renewable Energy Activities, Australia Methodology*
AU CEC/UTS	Clean Energy Council (2020) *Clean Energy at Work* UTS Institute for Sustainable Futures (2020) *Renewable Energy Employment in Australia: Methodology* UTS Institute for Sustainable Futures and Clean Energy Council (2020) *Renewable Energy Jobs in Australia 2020 (Stage One)*
Canada CEC	Clean Energy Canada (2019) *Missing the Bigger Picture* Navius Research (2019) *Quantifying Canada's Clean Energy Economy*
UK ONS EGSS	Office for National Statistics (2021) *Environmental Goods and Services Sector (EGSS) Estimates* Office for National Statistics (2021) *Environmental Accounts on the Environmental Goods and Services Sector (EGSS) QMI* Office for National Statistics (2021) *Environmental Goods and Services Sector (EGSS) Methodology Annex* Eurostat (2016) *Environmental Goods and Services Sector Accounts (Handbook)* Eurostat (2016) *Environmental Goods and Services Sector Accounts (Practical Guide)*
UK ONS LCREE	Office for National Statistics (2021) *Low Carbon and Renewable Energy Economy, UK: 2019* Office for National Statistics (2021) *Low Carbon and Renewable Energy Economy (LCREE) Survey QMI*
USA BLS	US Bureau of Labor Statistics (2013) *Green Goods and Services Occupations* US Bureau of Labor Statistics (2013) *Extended Technical Note*
USA Brookings	Brookings Institution (2011) *Sizing the Clean Economy* Brookings Institution (2011) *Methodological Appendix for Sizing the Clean Economy: A National and Regional Green Jobs Assessment*

International approaches have generally included established and some emerging renewables as low-emissions energy sources

Exhibit A2: Detailed analysis of products that are included in international approaches

Products in *'Energy from low-emissions sources'*

Channels	Energy from low-emissions sources											
	Low-emissions energy sources									Technologies that enable the use of low-emissions energy sources		
	Established renewables				Emerging renewables			Other low-emissions energy				
Products	Solar PV	Solar thermal	Wind	Hydropower	Bioenergy	Wave	Geothermal	Waste-to-energy	Nuclear	Battery storage	EVs / EV batteries	Grid infrastructure
Approaches: AU ABS	✓	✓	✓	✓	✓	✓	✓			✓		✓
AU CEC/UTS	✓	✓	✓	✓	✓					✓		✓
Canada CEC	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
UK ONS EGSS	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓
UK ONS LCREE	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
USA BLS	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	
USA Brookings	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Frequency of inclusion Higher Lower

International approaches have also included a variety of products in the ‘Reducing energy consumption’ and ‘other low-emissions activities’ channels

Exhibit A2: Detailed analysis of products that are included in international approaches

Products in *‘Reducing energy consumption’* and *‘Other low-emissions activities’*

	Channels	Reducing energy consumption						Other low-emissions activities		
	Products	Energy-efficient building structures	Energy-efficient building installations	Energy-efficient heating, ventilation and a/c	Energy efficient lighting	Energy-efficient consumer goods and appliances	Energy efficient industrial machinery	Public administration	Advocacy	Education
Approaches	AU ABS	*Channel not included in approach*						✓	✓	
	AU CEC/UTS	*Channel not included in approach*						✓		
	Canada CEC	✓	✓	✓	✓	✓	✓	*Channel not included in approach*		
	UK ONS EGSS[1]	✓	✓	✓	✓			✓	✓	✓
	UK ONS LCREE	✓	✓	✓	✓			*Channel not included in approach*		
	USA BLS	✓	✓	✓	✓	✓		✓	✓	✓
	USA Brookings	✓	✓	✓	✓	✓		✓		✓

Frequency of inclusion Higher Lower

Notes: 1. The UK ONS EGSS follows the methodology outlined in Eurostat’s EGSS Handbook. This does not provide an exhaustive list of inclusions in *‘reducing energy consumption’*, but includes any goods that are more resource-efficient that equivalent substitutes. This table records those inclusions which are explicitly mentioned in Eurostat’s EGSS Handbook.

For ‘energy from low emissions sources’, international approaches have frequently included utilities, construction and professional services

Exhibit A2: Industries included in international approaches[1]

Industries in *‘Energy from low-emissions sources’*

Channel	Energy from low-emissions sources									
	Materials		Goods production			Services				
Industries	Agriculture	Mining[2]	Manufacturing	Utilities	Construction	Trade	Finance and insurance	Professional services	Public admin and education	Other services (maintenance)
Approaches										
AU ABS				✓	✓	✓		✓		✓
AU CEC/UTS				✓	✓		✓	✓		✓
Canada CEC			✓	✓	✓			✓		
UK ONS EGSS				✓	✓			✓		✓
UK ONS LCREE			✓	✓	✓		✓	✓		✓
USA BLS			✓	✓	✓			✓		✓
USA Brookings				✓	✓			✓		

Frequency of inclusion Higher Lower

Notes: 1. Industries were either explicitly mentioned in the report or data series, or inferred from the list of products included and supporting documentation. 2. However, mining inputs (particularly lithium) could be considered distinctive to Australia’s transition. See page 47.

For ‘reducing energy consumption’, some international approaches have included manufacturing, utilities, construction and professional services

Exhibit A2: Industries included in international approaches

Industries in *‘Reducing energy consumption’* and *‘Other low-emissions services’*

	Channel	Reducing energy consumption									
		Materials		Goods production			Services				
	Industries	Agriculture	Mining	Manufacturing	Utilities	Construction	Trade	Finance and insurance	Professional services	Public admin and education	Other services (maintenance)
Approaches	AU ABS	*Channel not included in approach*									
	AU CEC/UTS	*Channel not included in approach*									
	Canada CEC			✓	✓	✓			✓		
	UK ONS EGSS			✓	✓	✓			✓		
	UK ONS LCREE			✓	✓	✓			✓		
	USA BLS			✓	✓	✓			✓		✓
	USA Brookings			✓	✓	✓			✓		

Note on Other low-emissions services

All international approaches that include the ‘*Other low-emissions services*’ channel only include the ‘*Public admin and education*’ industry under this channel.

Frequency of inclusion Higher Lower

Lithium is expected to be primarily used as an input to battery storage, and lithium mining is arguably an industry where Australia is distinctive

Lithium is a critical input in battery storage.[1] Exhibit A6 shows that, according to International Energy Agency projections consistent with the Paris agreement, by 2040, over 90% of global lithium demand will be for 'clean' technologies such as batteries.[1] Lithium could therefore credibly be considered to be a specialised input to low-emissions final products in the near future.

Other minerals are also expected to be critical to the transition to a low-emissions economy. For instance, cobalt is another key input to battery storage. By 2040, almost 70% of cobalt is expected to be used in low-emissions technologies.[1, 4] Australia should also consider whether other minerals could be considered to be specialised inputs.

While mining inputs are not widely included in international approaches, Australia could consider including lithium and other critical mineral inputs in its definition of the 'low-emissions economy' to reflect the distinctive contribution that Australia's mining industry could make to global decarbonisation. The potential inclusion of these inputs would likely better reflect Australia's distinctive upstream role in the global production of *low-emissions* goods and services (see Exhibit A4).

Australia's lithium mining industry could play a particularly significant role in Australia's low-emissions economy. According to data from the WA Department of Mines, Industry Regulation and Safety,[2] Australia produces almost half of all lithium that is produced globally.

Exhibit A3: Projected proportion of lithium used in 'clean' final goods

Percentage of total global lithium demand, IEA projections[1]

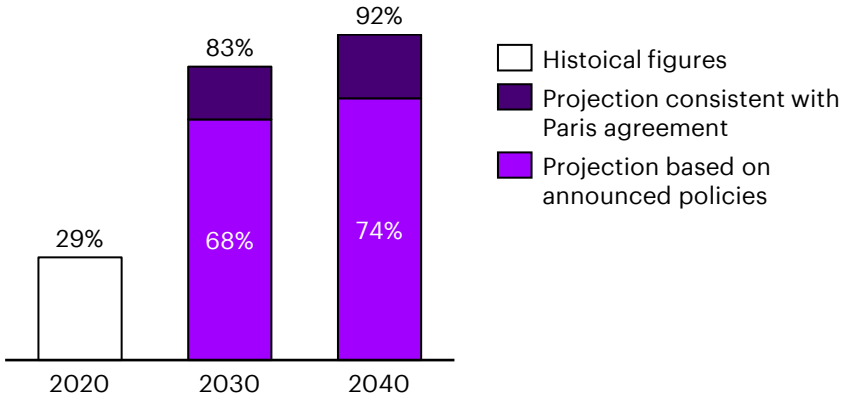
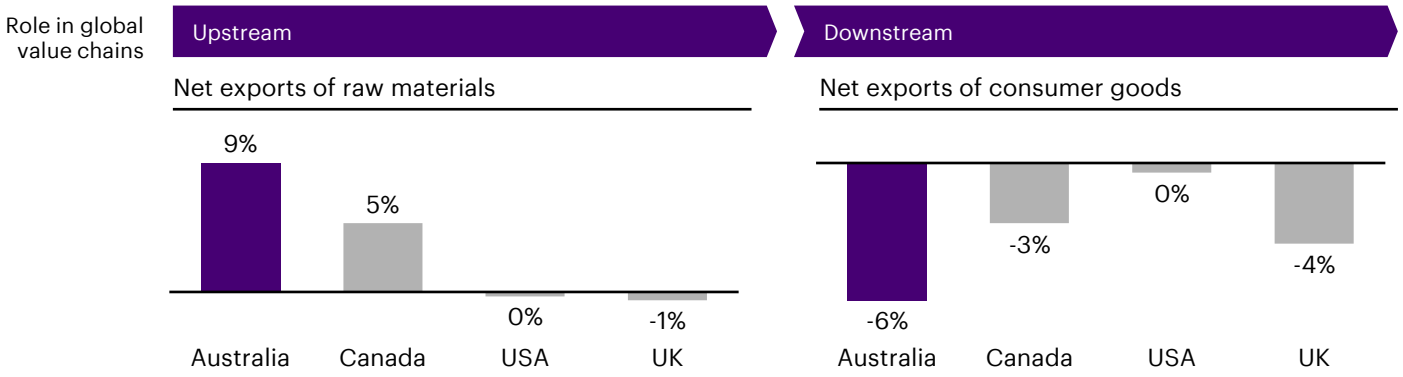


Exhibit A4: Net exports of raw materials and consumer goods for selected countries

Net exports as a percentage of GDP, 2018[3]



Sources: 1. International Energy Agency (2021) *The Role of Critical Minerals in Clean Energy Transitions*; 2. WA Department of Mines, Industry Regulation and Safety, *2020 Economic Indicators Resource Data*; World Bank, *World Integrated Trade Solution*, World Bank, *DataBank*, Accenture calculations
Notes: 4. IEA projection consistent with the Paris agreement.

There is high-quality secondary data available for most industries in ‘energy from low-emissions sources’

Exhibit A5: Assessment of quality for selected secondary data sources

Data fields in *‘Energy from low-emissions sources’*

Channel	Industry and evaluation of overall data quality for data field	Relevant data sources	Assessment of quality of individual data sources
Energy from low-emissions sources	Mining	WA Dept of Mines (DMIRS), employment by mineral (lithium)	DMIRS releases data on employment in mining in WA by year and month. This data is granular, and records employment by mineral (including lithium) and mine site. Since all Australian lithium is mined in WA, this data source covers all lithium mining employment in Australia
		WA Dept of Mines (DMIRS), exports (other)	DMIRS releases annual data on WA exports by mineral, including an ‘other’ category which includes lithium. Assuming that lithium mined in Australia is primarily exported (can be verified with other sources), this figure can be combined with other figures to triangulate an estimate of lithium mining output. DMIRS cites itself as a data source for lithium production, so it may have unpublished data on lithium output.
		USGA (lithium)	USGA releases annual data on the quantity of lithium mined by country, in tonnes. This can be combined with pricing data to estimate the value of Australian lithium mining output.
	Manufacturing	*Lack of available data for this data field*	
	Construction	ABS Employment in Renewable Activities	The ABS currently releases employment figures for renewable energy activities inclusive of design, construction, operation and maintenance. This is a credible and reliable source that reports across several industries within the channel.
		CEC project tracker	The CEC releases data on large-scale renewable energy generation projects that have been completed or are under construction. This figure can be combined with estimates of the relationship between output or employment with installed capacity.
	Utilities	AEMO generation information	AEMO releases monthly data on installed capacity of energy generation and storage in the NEM. This figure can be combined with estimates of the relationship between output or employment with installed capacity.
		ABS Energy Account (physical supply)	The ABS releases annual accounts on the supply and use of energy resources, by energy source. This could be used to determine the proportion of all energy generated that is low-emissions. This proportion can be combined with other data.
	Professional services	*Lack of available data for this data field*	
	Maintenance	ABS Employment in Renewable Activities	As above.
		CEC project tracker	As above.

Quality of available data *Higher* *Lower* *Different for employment and output data (see Exhibit 27)*

There is some lower quality data available across most industries for 'reducing energy consumption'

Exhibit A5: Assessment of quality for selected secondary data sources

Data fields in *'Reducing energy consumption'*

Channel	Industry and evaluation of overall data quality for data fields	Relevant data sources	Assessment of quality of individual data sources
Reducing energy consumption	Manufacturing	EEC Energy Efficiency Employment in Australia report (2019)	The EEC's estimate is applies the energy efficiency employment survey results from the US Department of Energy to Australia. It takes the proportion of workers in several US industries that are engaged in energy efficiency activities, and applies this proportion to comparable Australian industries to generate an estimate of the number of workers engaged in energy efficiency in Australia. The report includes a limited number of occupations which broadly fall within the manufacturing, construction and professional services industries.
	Construction	EEC Energy Efficiency Employment in Australia report (2019)	As above.
		GBCA Green Star Project Directory	The GBCA releases values for total number of buildings certified. This provides a baseline value but is not exhaustive for all energy reduction construction.
		Energy Efficiency Certification Scheme	The EEC maintains a list of certified professionals that have the skills and experience to delivery Integrated Building Energy Retrofit projects. This can be used to develop a lower bound on employment in the management of energy efficiency retrofit projects.
		NABERS energy efficiency ratings	NABERS operates a voluntary energy efficiency ratings scheme for buildings over 1000sqm. NABERS maintains a database of ratings. This could be used as part of an employment factors approach to estimate construction and audit jobs in energy efficient buildings.
		Commercial Building Disclosure (CBD) dataset	The CBD program requires the disclosure of energy efficiency information for commercial office spaces over 1000sqm. This dataset could be used as part of an employment factors approach to estimate construction and audit jobs in energy efficient buildings.
	Professional services	EEC Energy Efficiency Employment in Australia report (2019)	As above. This report gives an estimate of employment in professional services such as mechanical engineers and technicians.
		NABERS energy efficiency ratings	As above. To calculate audit jobs in energy efficient buildings, one would need information on the ratio between NABERS audits and employment, which may be difficult to source.
		Commercial Building Disclosure dataset	As above. To calculate audit jobs in energy efficient buildings, one would need information on the ratio between CBD audits and employment, which may be difficult to source
	Maintenance	*Lack of available data for this data field*	

Quality of available data *Higher* *Lower* *Different for employment and output data (see Exhibit 27)*

There is limited secondary data available for most industries for three of the low-emissions channels

Exhibit A5: Assessment of quality for selected secondary data sources

Data fields in *'Other low-emissions services'*, *'Reducing agricultural emissions'* and *'Reducing land use emissions'*

Channel	Industry and evaluation of overall data quality for data fields	Relevant data sources	Assessment of quality of individual data sources
Other low-emissions services	Public administration and education	Environmental govt department reports (labour expenses)	The environmental government department reports are a reliable baseline for professionals working in the low-emissions space. This source is not however exhaustive of all employment in the low-emissions services.
Reducing agricultural emissions	Agriculture	*Lack of available data for this data field*	
	Manufacturing	Emissions Reduction Fund program register (Reducing Greenhouse Gas Emissions by Feeding Dietary Additives to Milking Cows)	This source records the number of Emission Reduction Fund projects that add eligible additives to milking cows to reduce methane emissions. This could be used as part of an employment factors approach to estimate jobs in the production of eligible additives for milking cows.
	Professional services	*Lack of available data for this data field*	
Reducing land use emissions	Agriculture	IBISWorld report: Forestry Support Services in Australia	IBISWorld releases employment and output data for the 4-digit ANZSIC, Forestry Support Services. This includes forest reafforestation, forest plantation and conservation activities.
	Professional services	*Lack of available data for this data field*	
Data that can be used in ratios across all channels	*All*	National Accounts	National accounts are released at extremely high levels and do not provide any channel specific data. However, they can provide very rough splits for channels in the low emissions economy once ratios are applied using ANZSIC divisions.

Quality of available data *Higher* *Lower*

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