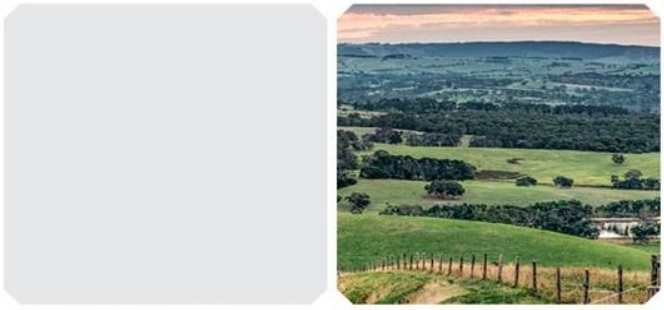
Australian Government
Clean Energy Regulator

Quarterly Carbon Market Report






CLEAN ENERGY REGULATOR

December Quarter 2022

PDR: MS23-001423

The Hon Chris Bowen MP
Minister for Climate Change and Energy
Parliament House
CANBERRA ACT 2600

Dear Minister

I am pleased to submit the December 2022 Quarterly Carbon Market Report (QCMR) as the 2022 calendar year administrative report (the report) for the operation of the Renewable Energy (Electricity) Act 2000 (the Act). The QCMR includes key information and metrics covering the operation of the Act for both the large-scale and small-scale schemes, and investment in renewables over the course of the year. The report is submitted for presentation to the Parliament in accordance with section 105 of the Act.

The report shows a surge in large scale renewable energy investment, a recovery in rooftop solar installations and record renewables generation across the National Electricity Market.

In 2022, renewables developers committed to building 4.3 gigawatts (GW) of new large-scale wind and solar capacity with 60% of this capacity announced in the second half of 2022. This is an almost 50% increase from 2021, and points to renewed investment confidence in Australia's large-scale renewable energy market following clear government ambition and favourable policy settings. This large step up in investment is a critical start to transition our electricity system to 82% renewable energy by 2030 to help meet Australia's legislated 2030 emissions reduction target.

The Clean Energy Regulator approved 2.5 GW of new capacity for large-scale generation certificate (LGC) creation in 2022. This included Australia's largest solar farm, the New England Solar Farm. We expect we will approve a similar level of capacity in 2023. Generation eligible for large-scale generations certificates grew to 44,000 gigawatt hours (GWh), up from 39,000 GWh in 2021, materially exceeding the legislated target of 33,000 GWh.

Rooftop solar PV investment by households and businesses also rebounded strongly in the second half of 2022 with almost 315,000 systems totalling 2.8 GW of installed capacity for the full calendar year, up from the original estimate of 2.3 GW. If this trend continues, households and businesses could install record additional capacity in 2023. Almost 7% of rooftop solar PV systems installed in 2022 included a reported concurrent battery installation, more than double the proportion of reported battery installations in 2021.

2022 was a big year for renewable energy. Across the year, the large and small-scale renewable energy schemes delivered an average of 35% of all electricity in the National Electricity Market (NEM), peaking at a record 42% in the fourth quarter.

Corporate ambition to demonstrate renewable energy use saw a record 7.4 million LGCs cancelled from non-RET demand. This is a 30% increase from 2021.

Overall, 2022 was a positive year for renewable energy. A further step up in investment is needed to both reach 82% share of renewables by the end of the decade and for Australia to be a low emissions hydrogen superpower.

Yours sincerely

Mr David Parker AM
Chair and CEO
Clean Energy Regulator

27 April 2023

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2022 market outcomes and tracking against estimates

Market outcomes

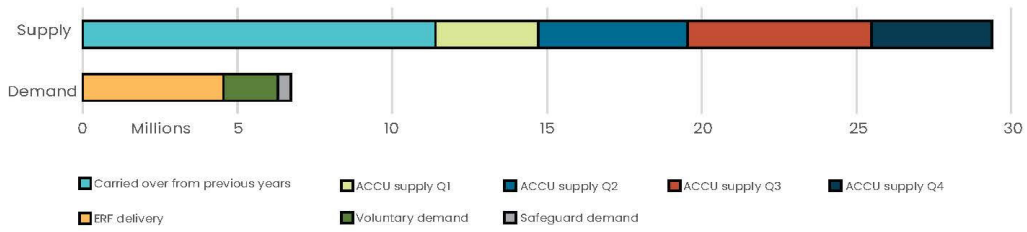
	2022 results	Year on year change	Tracking towards 2022 estimate	2023 preliminary estimates
ACCUs issued	17.7 m	▲ 4%	–	18 m
Renewable capacity approved – LRET	2.5 GW	▲ 6%	–	2.5 GW
Renewable capacity installed – SRES	2.8 GW	▼ 11%	✓	3 GW

Voluntary and state and territory demand

	2022 results	Year on year change	Tracking towards 2022 estimate	2023 preliminary estimates
ACCU cancellation (domestic unit)	1.5 m	▲ 56%	✓	1 m
LGC cancellation (domestic unit)	7.4 m	▲ 28%	–	8 m
CER cancellation (international unit)	15.9 m	▲ 33%		

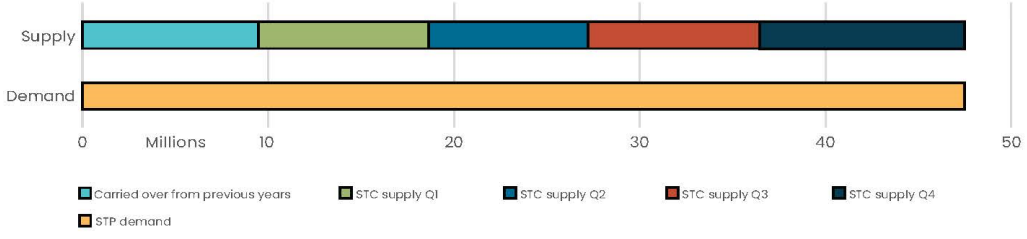
Tracking market dynamics

2022 ACCU market



2022 LGC market

2022 STC market



LIST OF ACRONYMS

ACCU	AUSTRALIAN CARBON CREDIT UNIT	**RPP**	RENEWABLE POWER PERCENTAGE
CER	CERTIFIED EMISSION REDUCTION UNIT	**SRES**	SMALL-SCALE RENEWABLE ENERGY SCHEME
LGC	LARGE-SCALE GENERATION CERTIFICATE	**STC**	SMALL-SCALE TECHNOLOGY CERTIFICATE
LRET	LARGE-SCALE RENEWABLE ENERGY TARGET	**STP**	SMALL-SCALE TECHNOLOGY PERCENTAGE

Report objective

Carbon markets play a key role in Australia's efforts to reduce emissions. The Clean Energy Regulator (CER) has prepared this report to support the effective operation of Australia's carbon markets.

This report consolidates information across the three national carbon markets that CER administers for the December Quarter 2022 (October 2022 to December 2022), providing information on supply and demand trends, and opportunities to inform market decisions.

In accordance with section 105 of the Renewable Energy (Electricity) Act 2000 this report covers the operations of the large-scale and small-scale schemes for the 2022 calendar year for presentation to Parliament.

Detailed information and metrics are available in the following sections:

- 2022 market outcomes and tracking against estimates,
- Executive summary – Strong increase in renewables investment, and
- Chapter 2 State of Total Renewables including 2.A Large-scale generation certificates and 2.B Small-scale technology certificates.

Report disclaimer

All figures are sourced from CER unless otherwise referenced. All statements in this report reflect current policy settings, other than in specific instances where the Australian Government has announced or is consulting on proposed policy changes.

This Quarterly Carbon Market Report (QCMR) represents the views of CER at the date of publication. CER is providing this information to the market to increase market transparency, help identify genuine low-cost carbon abatement opportunities, and assist entities that produce or need to source units and certificates under the schemes CER administers. CER has used its best endeavours to ensure the quality of the information in this document but cannot guarantee its accuracy or completeness. The QCMR is not legal, business or financial advice. You should obtain independent professional advice on your circumstances before making any investment decisions. The information is provided as general information only. Neither CER, nor the Commonwealth of Australia will accept liability for any direct, incidental or consequential loss or damage resulting from the QCMR, or the information provided through the Quarterly Carbon Market report, or the availability or non-availability of the QCMR.

Version history

Version	Date	Changes
1.00	17/03/2023	-
2.00	xx/05/2023	Report objective updated as tabled in the Australian Parliament on date month 2023, in accordance with s105 of the Renewable Energy (Electricity) Act 2000

Executive Summary

An important year for Australian Carbon Credit Units

The 2022 calendar year was a defining year for the Australian Carbon Credit Unit (ACCU) market. Significant developments included the Independent Review of Australian Carbon Credit Units (the Review), the proposed reforms to the Safeguard Mechanism and the fixed delivery milestone exit arrangement for Commonwealth carbon abatement contracts.

The reported generic ACCU spot price varied considerably during the year, starting at $51 and ending at $33.80 with reported spot market trading volume in 2022 about 5 times greater than in 2021.

The Review was released on 9 January 2023. It concluded the current ACCU scheme is essentially sound. The Review made 16 recommendations to enhance confidence in the integrity and effectiveness of the scheme. The Australian government accepted all 16 recommendations in principle.

On 10 January 2023, the Australian government released the proposed design rules for the reforms to the Safeguard Mechanism for consultation. The proposed reforms will require Australia's largest emitting facilities to reduce their emissions in line with Australia's national emissions target (43% below 2005 levels by 2030), to deliver an estimated 205 million tonnes of abatement by the end of the decade compared to emissions without these reforms.

The market responded positively to these events. The reported spot generic ACCU price increased from $34.50 to $38.50 in the following 2 weeks. Reported spot and forward trading volumes were 3.2 million in this 2-week period. This is 2.5 times greater than the previous 2-week volume record.

Other key market highlights for ACCUs in 2022 include:

- 17.7 million ACCUs were issued, up by nearly 700,000 from 2021.
- Project registrations increased by 385 to 1,434.
- 1.5 million ACCUs were cancelled against non-Commonwealth demand, a 56% increase compared to 2021.

Key events for the ACCU market later in 2023 include legislation before parliament on the Safeguard Mechanism reforms and rule changes, as well as ongoing development of the proposed Australian Carbon Exchange. Key dates include:

- 14 February 2023 - contract milestone exit applications due
- 29 and 30 March 2023 - 15th ACCU auction.

Chapter 1 includes important market data on ACCUs, including our estimates for 2023 which suggest modest ACCU supply growth in the short term.

Strong increase in renewables investment

The second half of the 2022 calendar year saw a material increase in investment in wind and solar power stations and rooftop solar:

- 4.3 gigawatts (GW) capacity of wind and solar power stations reached a Final Investment Decision (FID) in 2022. This is up from 2.9 GW in 2021, with 60% of the capacity announced in the second half of the year (H2).

- 2.8 GW of small-scale rooftop solar was installed for the full year. This exceeded our estimate of 2.3 GW earlier in the year.

The CER estimates total added capacity for small-scale rooftop solar in 2023 could reach or exceed the record of 3.2 GW in 2021 if the 2022 H2 trend continues. Supply chain constraints, particularly labour, may limit the installed capacity. Installation wait times are currently reported to be 3 to 5 months.

This turnaround in renewables investment in H2 is a great start for the government's goal of 82% renewables by 2030. Renewables generation in the National Electricity Market (NEM) averaged 35% for 2022, with Q4 averaging more than 40%. We expect renewables should average about 40% of NEM generation for the 2023 calendar year.

There were several factors contributing to the increase in large-scale investment. These include government policy/targets, proposed investment in large batteries and major grid upgrades, announcements of early exit of coal fired generation and high wholesale electricity and large-scale generation certificate (LGC) prices.

Higher retail energy prices contributed to the increase in rooftop solar in H2. The Australian Government's community batteries policies and ongoing announcements by states and territories will be important in enabling more rooftop solar installations in 2023.

According to AEMO's Q4 Quarterly Energy Dynamics report, the NEM had its lowest ever quarterly emissions (26.4 million tonnes carbon dioxide equivalent CO_2-e) and emissions intensity (0.64 t CO_2-e/MWh).

In Q4 2022, solar PV and wind set the price in 17% of Q4 intervals, up from 11% in Q3. Renewables setting the price in the last quarter of the year contributed to a material decline in average wholesale electricity prices, from $216 per megawatt hour (MWh) in Q3 to $96 in Q4.

Other key market highlights for renewables in 2022 include:

- Total of over 5.3 GW of new renewable generation capacity added. 2.5 GW of large-scale wind and solar and 2.8 GW of small-scale rooftop solar.
- LGC eligible renewable generation of 44,000 GWh in 2022, up from 39,000 GWh in 2021.
- Voluntary cancellation of 7.4 million LGCs, an increase of 30% from the 5.7 million in 2021.
- LGC spot prices grew strongly from $42.40 and reached a high of $70 before settling to $65 at the end of 2022. The spot price further declined to just over $50 in the first few weeks of 2023.
- The market still has an effective deficit of 15.5 million LGCs to redeem all shortfall, both paid and carried forward.
- The (Small Technology Certificate) STC Clearing House remains in a material deficit of 4.7 million at the Q4 surrender date of 14 February 2023.

Chapter 2 includes in depth market information and data on renewables, LGCs and STCs and our estimates for 2023.

Table ES.1: Certificate prices, Q4 2022[1]

Certificate type	Spot price AUD (31 December 2022)	Change over the quarter

[1] Data sourced from Jarden and TFS Green

ACCU	$33.80	+$3.05
LGC	$57.00	-$7.25
STC	$39.90	+$0.00

1. Australian carbon credit units

Key messages

- 2022 saw a record 17.7 million ACCUs issued, up from 17 million ACCUs in 2021.
    - 2023 issuances are expected to see a modest increase and exceed 18 million.
- Total ACCU holdings in ANREU doubled in 2022 to 22.7 million.
- 23 million units were transacted in the secondary market in 2022, triple the volume in 2021.
- Cancellation of ACCUs for non-commonwealth[2] demand totalled 1.5 million in 2022, up 56% from 2021.
- The 15th ERF auction will be held on 29-30 March 2023.

2022 was an eventful year for Australia's ACCU market with significantly increased trading activity and accumulation, spot price variability likely driven by a range of factors and integrity claims followed by a review by former Chief Scientist Professor Ian Chubb.

There were some significant events shortly after the end of the quarter.

Firstly, the report of the independent review of ACCUs was released on 9 January 2023 concluding the current ACCU scheme arrangements are robust and the claims about a lack of integrity were not supported. The Review made 16 recommendations to enhance confidence in the integrity and effectiveness of the scheme. The government accepted all 16 recommendations in principle.

Secondly, on 10 January 2023, the Australian Government released the proposed design rules for the Safeguard Mechanism reforms for consultation, including a proposed decay trajectory for baselines of 4.9% out to 2030.

The market responded to these key events with the reported spot generic ACCU price increasing from $34.50 to $38.50 in the following 2 weeks. Reported spot and forward trading volumes were 3.2 million in this 2-week period, 2.5 times the previous largest 2-week volume. However, by mid-February the price had lost most of those gains.

In 2022, stratified pricing was first reported for ACCUs where some buyers were prepared to pay an increased premium for units with social, environmental and economic co-benefits. This is further discussed below.

Trade volumes and accumulation of ACCUs in the Australian National Registry of Emissions Units (ANREU) materially increased during the year, potentially related to hedging against expected increased liability in anticipation of declining baselines under the Safeguard Mechanism.

ACCU prices – the year in review

As discussed in March 2022 report, on the back of low trade volumes and some speculative behaviour the ACCU generic spot price reached an all-time high of $57.50 in late January 2022 before softening to $48 at

[2] This is typically cancellations of ACCUs voluntarily by business to reduce net emissions or as required by state/territory approvals. Commonwealth demand is considered delivery against carbon abatement contracts.

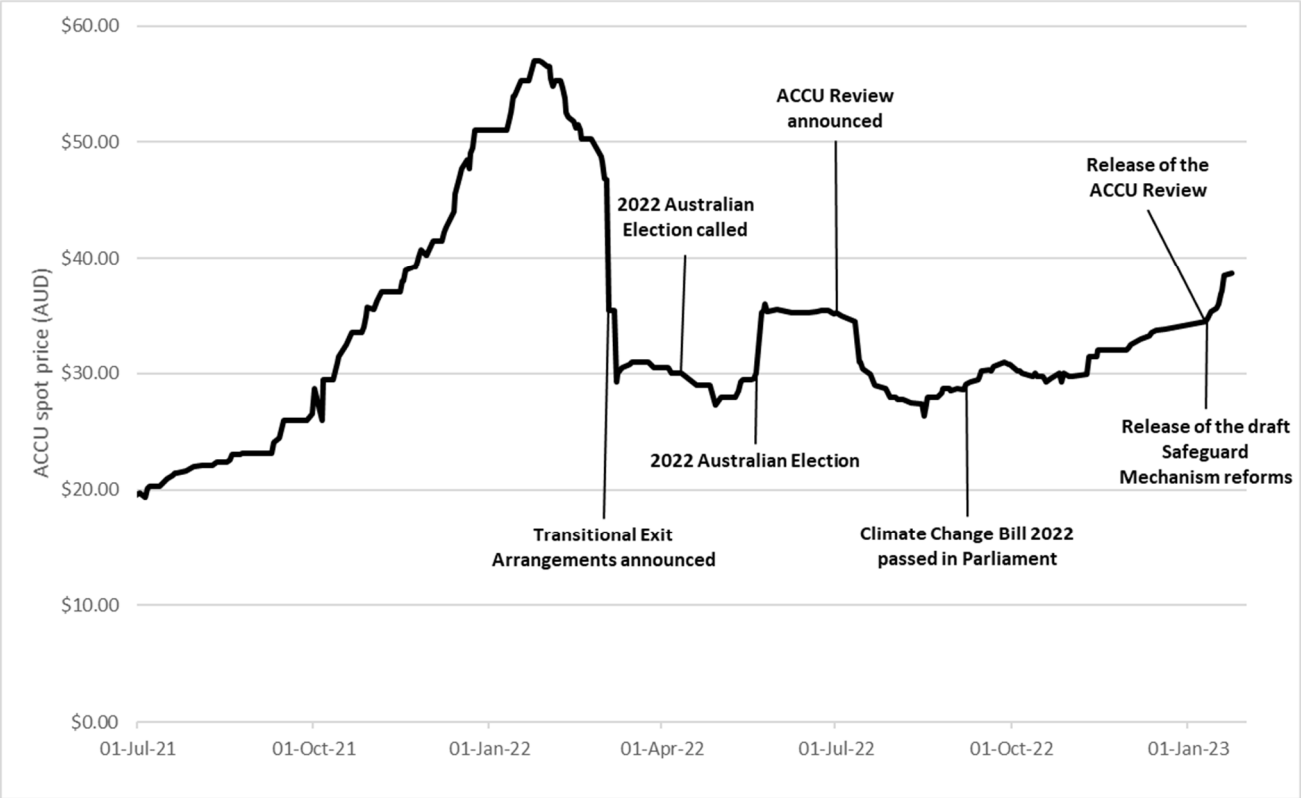
the end of February. The announcement of the contract milestone exit arrangements in early March saw the price drop to $35.40 on the back of a single high-volume trade with further decreases in price through March and April before settling around the $30 level (see Figure 1.1).

Prices generally stabilised for much of the remainder of 2022 as the market found an effective floor within a small price range of around double the average Commonwealth contract price plus a commercial premium.

Immediately following the federal election, the price jumped from $30 to $35.50, the largest single day increase in ACCU price. Prices remained around $35 per unit on low volumes and infrequent trades until the announcement of the Independent Review of Australian Carbon Credit Units on 1 July. ACCU spot prices declined through July and August. The introduction to, and subsequent passage through, the Australian Parliament of the *Climate Change Act 2022* (in which Australia's target of 43% emissions reductions below 2005 levels by 2030 was legislated) saw some renewed interest in ACCU purchasing with a high volume of units traded at around $30 per unit.

In Q4 2022, some upward price momentum saw the ACCU spot price increase from $30.75 to finish the calendar year at $33.80.

Figure 1.1: Generic ACCU spot price, July 2021 to January 2023



This graph shows volume weighted average of ACCU generic spot price where generic spot price refers to price of ACCU spot trades with unspecified method. Spot trade data is compiled from trades reported by Jarden and TFS Green and may not be comprehensive.

The next key event for ACCU prices will be when legislative certainty on the details of the Safeguard reforms are known.

Stratification of ACCU prices

Stratification is common in established markets, including Australia's key commodity export markets. Stratification points to increasing depth in both the supply and demand of carbon units with nearly 60% of units transacted through the reported spot market attracting a premium above the generic unit spot price.

Premiums have fluctuated throughout the year and differ depending on attributes including method type and the type and quality of co-benefits. For example, Savanna fire management ACCUs attracted premiums up to $23.50 compared to generic ACCUs, though reported trades of these units are infrequent. ACCUs from projects with First Nations People co-benefits, attracted the highest premiums.

Human-induced Regeneration (HIR) units in the spot market attracted a premium of over $6 above generic ACCUs for most of the year, but this fell to around $2.50 in Q4 2022. Post quarter, the HIR premium has reduced further to around $1. This convergence in price could be partly due to increased demand in advance of Safeguard Mechanism changes being legislated. Trade data highlights the volume of reported HIR ACCUs traded outpacing generic ACCUs since stratified reporting began in May 2022.

Release of Draft Safeguard Mechanism Rules

On 10 January, the Australian Government opened a further consultation on the detailed design of the proposed Safeguard Mechanism Reforms that are scheduled to commence on 1 July 2023. The proposed design would see the reset of existing Safeguard facilities' baselines so that they start closer to each facility's current performance, with most of the baseline reflecting its site-specific emissions intensity and a small proportion of the baseline using the industry average emissions intensity value. Each year, the proportion of the baseline calculated using site-specific values will decrease and the proportion using industry average will increase, so that by 2029-2030, all baselines will be calculated using industry average emissions intensities only.

New facilities will have baselines set in line with international best practice, adapted for an Australian context.

A set 4.9% decline rate would apply to Safeguard baselines to 2029-2030.

To support business in meeting their obligations, it is proposed that a new unit – a Safeguard Mechanism Credit (SMC) – would be created. An SMC would be issued for each tonne of carbon dioxide equivalent emissions that a facility is below its baseline. SMCs can be used by other Safeguard facilities that are above their baselines to reduce net emissions. They would be a compliance unit that is not a carbon offset.

The proposed reforms also allow the use of ACCUs to reduce a facility's net emissions.

The Government has also flagged the establishment of a cost containment measure. The cost containment measure will provide for ACCUs delivered under ACCU contracts to the CER after 13 January 2023 to be sold to safeguard entities at a fixed price, initially at $75 per tonne of CO_2-e in 2023–24, increasing with the CPI plus 2% each year. This measure is only to be used as a last resort. As such, ACCUs can only be bought by Safeguard entities under this measure if they are in an excess emissions situation and the ACCUs will be automatically surrendered to the CER for compliance against a current or previous year.

Consultation on the design reforms closed on 24 February 2023.

Trends in ACCU supply and demand

The proposed Safeguard policy changes do not place a limit on the use of ACCUs by each Safeguard entity to meet increasing compliance obligations with the proposed 4.9% per annum compounding baseline decline.

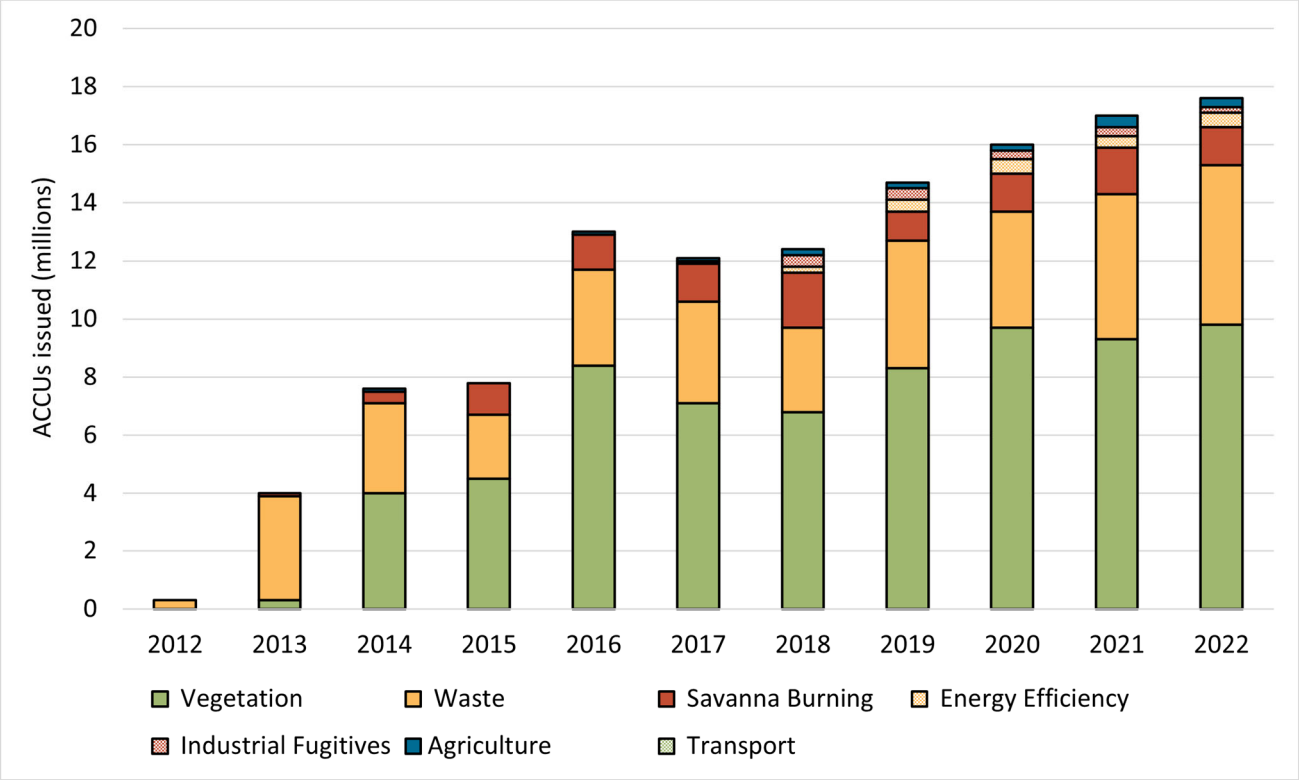
However, that does not mean that there will be sufficient ACCU supply for every Safeguard entity to meet all future liability with ACCUs.

As Figure 1.2 shows, annual ACCU supply has increased by a total of 5.6 million since 2017 – an average increase of 1.1 million per annum. However, over the last 2 years that annual rate of increase has fallen to

0.85 million ACCUs. The increase in 2023 looks like being much less than that. The reason for this apparent deceleration is not clear and could reflect uncertainty in the market in the face of dynamic policy settings.

The Q1 2023 report will provide more analysis on these issues and how they might impact future supply. While the proposed Carbon Abatement Integrity Committee (CAIC) will develop new methods in the future, it is not currently possible to predict the timing or level of any future additional supply. After a method is made, it will typically be at least 2 years (and often much longer) before any new ACCU are issued depending on the type of method.

Figure 1.2: ACCUs issued per method type, 2012 to 2022



There are many other sources of demand for ACCUs in addition to Commonwealth purchasing and potentially increasing Safeguard mechanism demand.

As detailed further in the chapter, non-commonwealth demand has more than tripled since 2018 to 1.5 million in 2022, which was up 56% year on year. Programs like Climate Active and consumer choices skewing to businesses with clear climate ambition are driving voluntary action and the demand for ACCUs. Additionally, the CER's Corporate Emissions Reduction Transparency report makes it easier for corporates to clearly demonstrate their progress towards their net emissions reduction commitments. Treasury has also consulted on the government's proposed mandatory regime for standardised, internationally-aligned requirements for disclosure of climate-related financial risks and opportunities in Australia. These types of commitments and reporting are likely to further increase demand for ACCUs in the future.

The Australian Carbon Exchange is expected to be delivered by late 2023 and should enable futures markets to emerge. The future price signal for ACCUs may be one important factor for Safeguard entities working through their compliance options under the proposed Safeguard reforms. That is whether to invest in reducing their emissions at the source and be credited with SMCs or to use ACCUs. Where it is technically and commercially feasible to reduce emissions at their source, entities that do so will avoid the risk of long term ACCU purchases at an unknown future cost.

The Australian Carbon Exchange

The agency is close to finalising its assessment of tenders for the implementation of an Australian Carbon Exchange. This initiative aims to provide industry and community confidence by creating a centralised, standardised and regulated marketplace. This is expected to improve market depth and liquidity, enhance price discovery and price/volume transparency and reduce the cost of transacting.

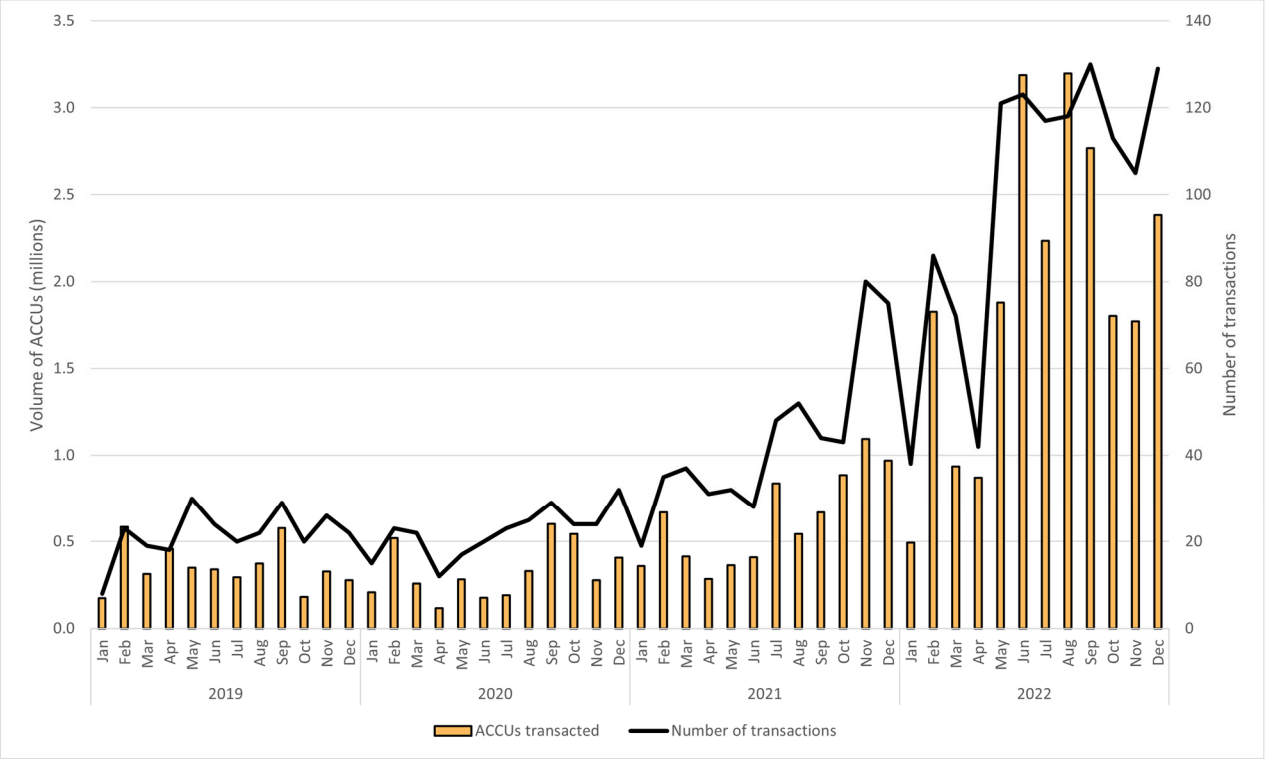
Additionally, a modernised Unit Register may enhance the efficiency for existing over the counter markets while also supporting the emergence of new markets, such as futures markets for ACCUs, LGCs and other units and certificates such as SMCs that the agency may regulate in the future. It is proposed the new Unit Register will also be able to connect with other trusted carbon trading platforms and marketplaces.

Trading activity stepped up in 2022

There was a step up in volumes in 2022 with 23 million ACCUs transacted in the secondary market, triple the volume transacted in 2021 (see Figure 1.3). The average transaction size also increased in 2022, up nearly 37% on 2021 from around 14,300 to 19,500 ACCUs per trade. Accumulation from corporates and financial intermediaries has contributed to the increase in transactions, especially in the second half of 2022 potentially as companies prepare for proposed changes to the Safeguard Mechanism.

Activity consolidated in Q4 2022 with around 2 million ACCUs transacted per month.

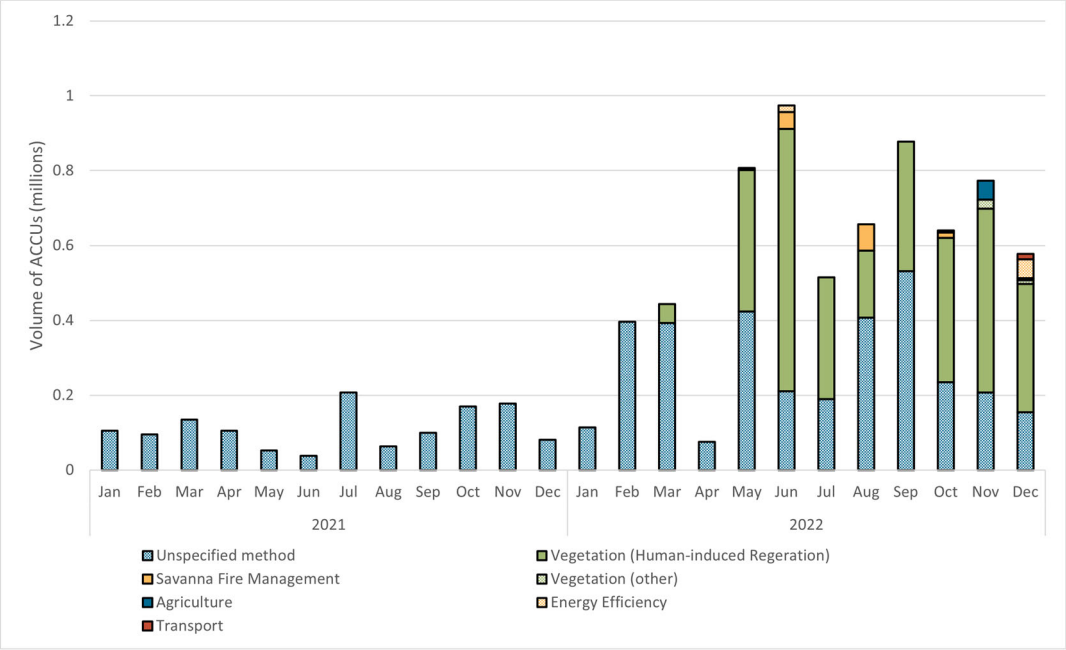
Figure 1.3: ACCU market transactions, January 2019 to December 2022[3]



The increase in transaction numbers is reflected in broad trends of reported trading volumes by environmental brokers (see Figure 1.4), though trading activity continues to be sporadic at times. In 2022 over 6.8 million ACCUs (of the total 23 million traded) were reported in spot trades, which is more than 5 times the volume reported in 2021. Since May, when price stratification reporting began, HIR units made up 54% of the ACCU volumes reported in spot trades. HIR ACCUs represent approximately one third of all units issued in 2022.

[3] ACCU market transactions refer to the transfer of ACCUs between accounts belonging to separate entities or corporate groups and does not include issuances, delivery to the ERF, and surrender or cancellations of ACCUs. Transactions involving the transfer of ACCUs between project proponents, between project proponents and project developers, and between accounts belonging to the same company and/or subsidiaries are excluded.

Figure 1.4: Reported ACCU spot trades by method type, January 2021 to December 2022



Spot trade data is compiled from trades reported by Jarden and TFS Green and may not be comprehensive.

In addition to the reported spot trades, environmental brokers reported significant interest from market participants in forward trades with almost 3 million ACCUs agreed for future delivery in 2022, 1.2 million of which were reportedly contracted in Q4 alone. Forward trade volumes were infrequent but often for large packets.

The material increase in forward trade volume is not necessarily indicative of forward price predictions in the spot market as there may be several reasons for why market participants engage in forward trades including for hedging purposes.

Market sources have also reported increased use of repo (repurchase) trades. These are short term agreements to sell ACCUs and buy them back later, using a combination of spot and forward trades. These trades occur because sellers may wish to manage working capital whilst maintaining access to ACCUs. With repo trades, the premium – the difference between the spot and forward price – primarily reflects cost of carry.

Non-Commonwealth demand for ACCUs

The QCMR includes an analysis of cancellations of ACCUs in the Australian National Register of Emissions Units (ANREU) for purposes other than deliveries to the Emissions Reduction Fund (ERF) or surrenders for Safeguard Mechanism obligations. These cancellations could be voluntary to show progress towards reducing net scope 1 emissions or to meet state/territory regulatory requirements.

This analysis breaks out the volume of ACCUs by the reason for cancellation (the source of demand) to examine drivers of ongoing demand growth and help understand potential sources of growth in the future.

Cancellations are experiencing an ongoing period of growth and evolution, including from sources outside of the previously used 'voluntary demand' description. To ensure this analysis remains impactful for participants and to better inform the market, CER has redesigned this analysis as "non-Commonwealth demand" and refined its approach to classifying cancellations to reflect the distinctions more accurately in the market.

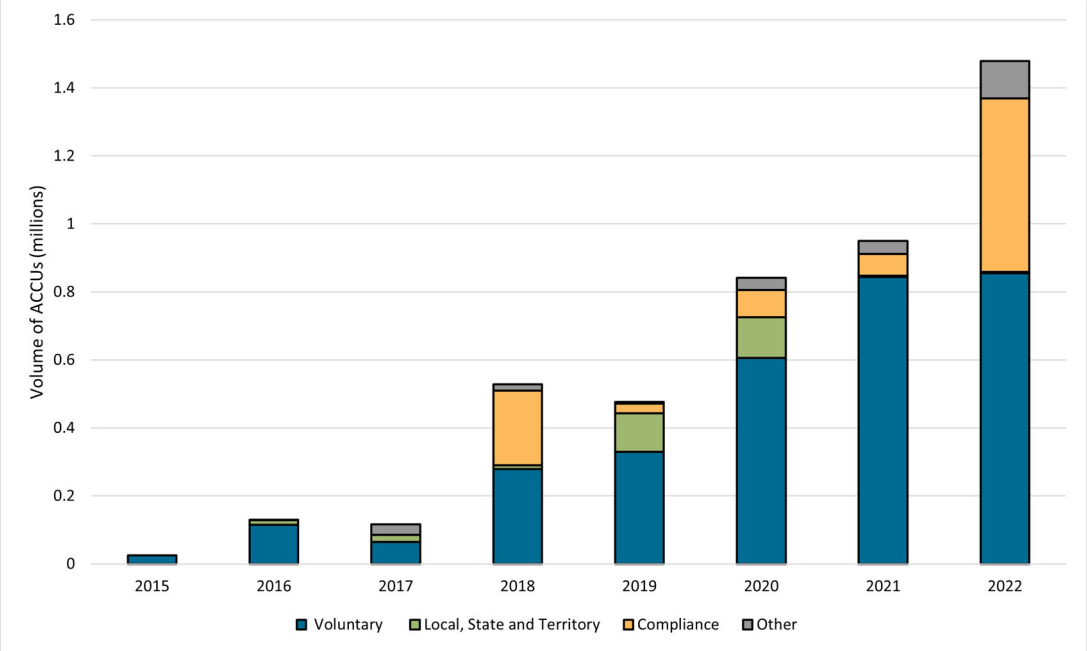
This classification system is uniform across ACCU and LGC cancellations.

New classification	Covered activities
Voluntary demand	Cancellations made against voluntary certification programs such as Climate Active, and any sort of organisational emissions or energy targets.
Local, state and territory government demand (LS&T)	Cancellations by or on behalf of local, state and territory governments, for example to offset emissions from state fleets or meet emissions reduction targets.
Compliance demand	Cancellations by private organisations and corporations for compliance or obligations against municipal, local, state and territory government laws, approvals, or contracts. For example, to meet Environmental Protection Agency requirements.
Other demand	All activity not covered in the previous categories, primarily due to lack of information available. This grouping has declined substantially as part of these new classifications.

Classification of this data is based on best judgment of information available to the CER and may not be comprehensive.

Cancellation of ACCUs to meet compliance obligations has been a strong driver for ACCUs in 2022. The 1.5 million ACCUs cancelled exceeds the 1.1 million expectation from the March report (see Figure 1.5). Excluding compliance, cancellations in 2022 reached 970,000 ACCUs—modest growth from 886,000 in 2021. Voluntary cancellations comprised 58% (855,000 ACCUs) of volume, the majority of which were for Climate Active purposes.

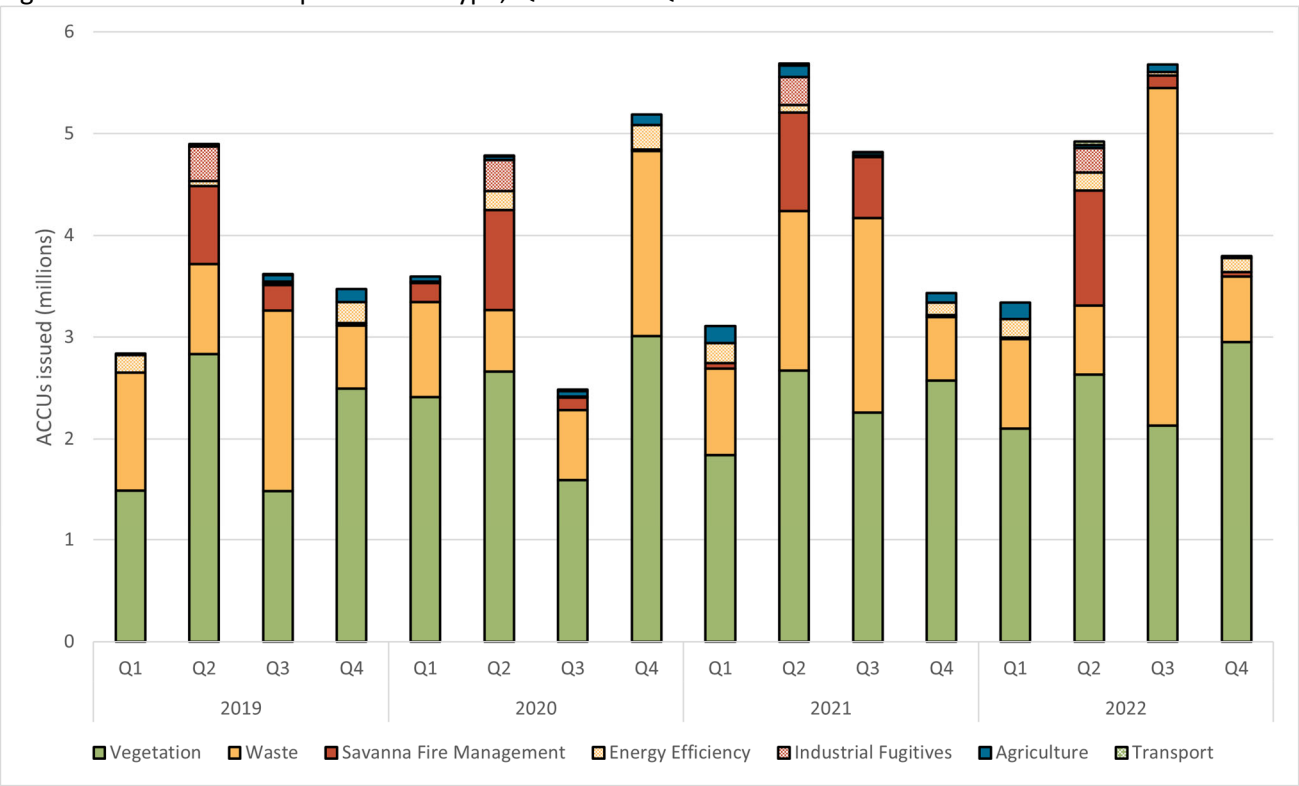
Figure 1.5: Non-Commonwealth ACCU cancellations by demand source, 2015 to 2022



Breakdown of new ACCU supply

95% of the nearly 4 million ACCUs issued in Q4 2022 can be attributed to 2 method types – vegetation (78%) and waste (17%), see Figure 1.6.

Figure 1.6: ACCUs issued per method type, Q1 2019 to Q4 2022



In 2022, 385 projects were registered, bringing the total portfolio to 1,434. Throughout 2022, 31 projects were credited for the first time, contributing 1.4 million ACCUs to supply. In total, 593 projects are generating ACCUs.

Contract milestone exit arrangements

Under the exit arrangements for fixed delivery contract milestones, 2.6 million ACCUs completed exits in the first window from 4 March to 30 June. A further 3.2 million ACCUs of contract milestones were eligible to participate in the second pilot window from 1 July to 31 December. The first two exit rounds were run as pilots, and the government will decide if there are to be future exit arrangements in due course.

ACCU Supply Balance

At the start of 2022, total ACCU holdings in ANREU was 11.5 million units. By the end of the year, holdings had nearly doubled to 22.7 million units (see Table 1.1), largely on the back of reduced delivery against fixed delivery contract milestones.[4] In the December 2021 report, the CER noted that 12 million ACCUs were scheduled for delivery against fixed delivery contracts in 2022.[5] Over the course of the year, contract holders delivered 4.7 million ACCUs to ERF contracts while others opted-in to the streamlined exit arrangements, increasing ANREU holdings and providing additional ACCU supply to the market.

Table 1.1: Balance of supply and demand 2022

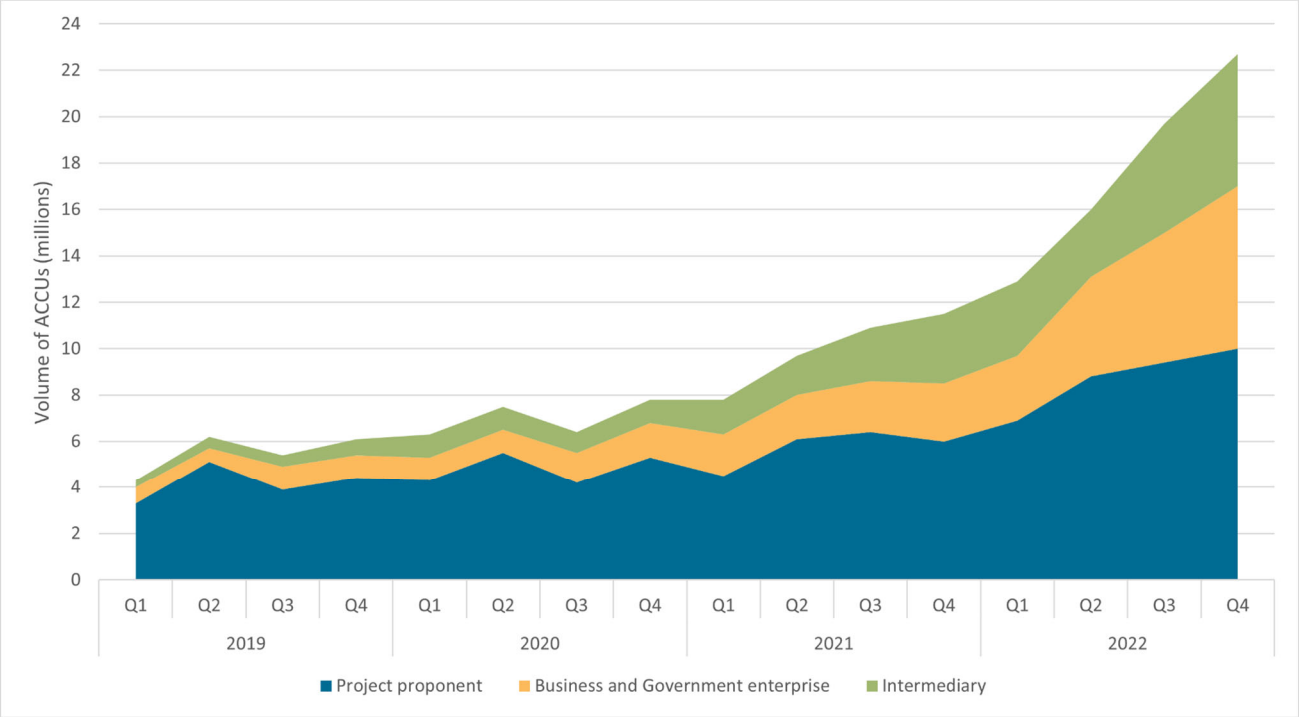
Balance carried forward from 2021	+11,452,691
ACCUs supply	+17,738,059
Actual ERF contract deliveries	-4,711,549
Safeguard demand[6]	-348,535
Non-Commonwealth demand	-1,479,281
ACCU relinquishment[7]	-0
Net balance at the end of 2022	**22,651,385**

Within a specified period, supply of ACCUs refers to ACCUs issued. Demand of ACCUs incorporates Commonwealth ERF contract deliveries, safeguard mechanism cancellations, relinquishments and state and territory government and private sector voluntary cancellation.

All holdings' categories increased during 2022 with business and government enterprises nearly tripling holdings (see Figure 1.6). ACCU holdings by intermediaries are nearly double that of Q4 2021 as intermediaries position themselves to play an increased role in facilitating trading between the supply and demand sides of the market. There could be a variety of reasons motivating accumulation of ACCUs amongst these participants including anticipation of safeguard mechanism reforms, increased voluntary corporate ambition and speculation as traders become more active.

[4] There were 4.7 million ACCUs delivered against Commonwealth contracts in 2022 versus 12.4 million in 2021.
[5] See Table 1.7 in the December 2022 Quarterly Carbon Market Report.
[6] Safeguard mechanism cancellations do not include deemed cancellations. A 'deemed' cancellation occurs when ACCUs issued under an ERF project at a safeguard facility, in a particular year, are delivered to the Commonwealth under an ERF contract.
[7] For more information see here.

Figure 1.7: ACCU holdings by market participation, Q1 2019 to Q4 2022



Note: The breakdown of accounts in ANREU is based on ACCU transaction characteristics of individual accounts. It is not a representation of corporate entity characteristics. An entity controlling more than one account can be represented in the data in multiple categories.

2. State of Total Renewables

Key messages

- Renewable energy met a record average 35% of demand in the National Electricity Market (NEM) in 2022, with more than 40% in Q4.
- Total new investment in wind and solar hit a record 7.1 gigawatts (GW)
    - 4.3 GW of large-scale wind and solar energy projects reached a final investment decision (FID) in 2022 – a 50% increase over 2021.
    - 2.8 GW of small-scale solar PV capacity was installed in 2022, third highest annual capacity installed on record. The H2 trend suggests a bigger year in 2023.
- A total of 5.3 GW of new renewable energy capacity was added to the grid in 2022 including 2.5 GW of large-scale wind and solar.

In 2022, the large-scale renewable energy sector responded to strong investment signals with 4.3 GW of large-scale wind and solar projects reaching final investment decision (FID), 2.1 GW of which was committed in Q4 alone. In comparison, an average 2.8 GW reached FID annually over the 2019 to 2021 period.

Key investment signals included:

- the legislated 2030 emissions reduction target
- the Australian Government goal of 82% renewable energy by 2030
- announced earlier closure of coal plants
- business demand for renewable energy
- proposed acceleration of large batteries and grid upgrades
- high wholesale electricity prices in some jurisdictions and strong LGC prices.

There are promising signs for the rooftop solar industry as well, which rebounded strongly across the second half of 2022. This resulted in 2.8 GW installed capacity for the year exceeding CER's expectation set in early 2022 of 2.3 GW. Q4 was the second highest installed capacity quarter on record. A key factor driving these trends may have been increasing retail energy prices. Despite the temporary cap on coal and gas prices introduced in December 2022, retail energy prices appear set for another increase in 2023.[8] This may see increased uptake of solar PV continue through 2023 unless increasing interest rates and tightening household budgets supress demand.

[8] In the Budget October 2022-23 paper (Budget Paper No. 1, Budget Strategy and Outlook), Treasury has assumed retail electricity prices will increase by an average of 20 per cent nationally in late 2022, and stated that given forward wholesale contract prices for electricity remain elevated, retail electricity prices are expected to rise by a further 30 per cent in 2023–24.

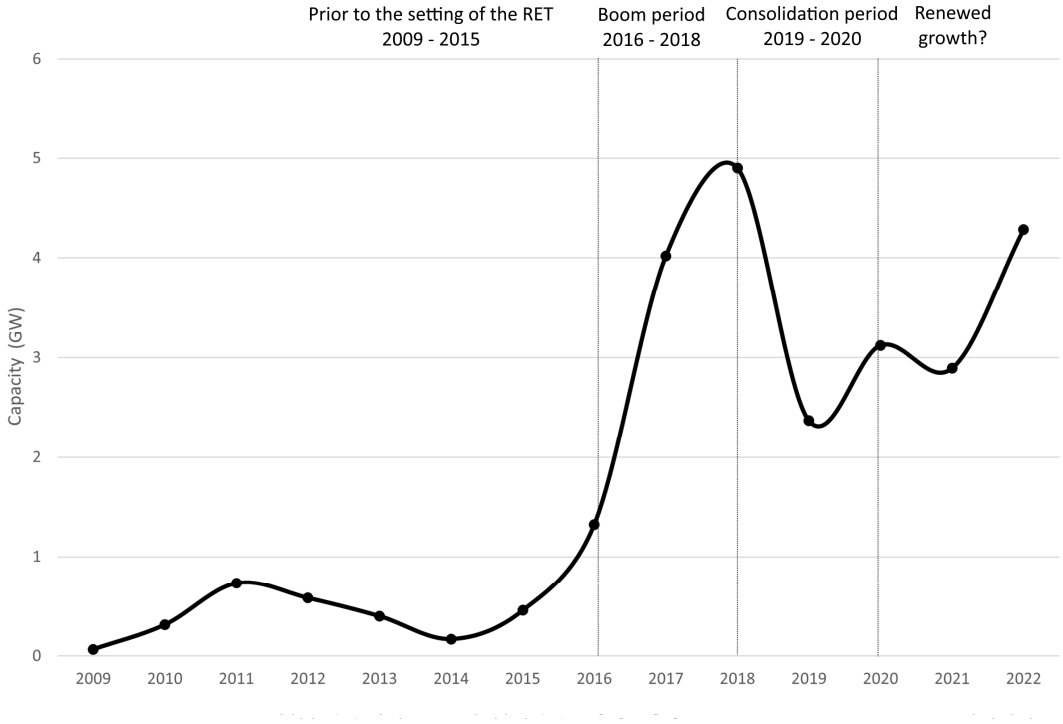
Ongoing state and Australian Government policy announcements on the installation of community batteries will be key watch points for this sector. Batteries will help ease some low voltage distribution network constraints and enable more solar PV to be installed than otherwise possible.

This increase in large-scale renewables and rooftop solar investment are promising developments that can be built on in Australia's journey to achieve 82% renewable generation, and 43% emissions reduction from 2005 level, by 2030.

Investment primed for growth?

The 4.3 GW FID capacity for large-scale renewables in 2022 is the second highest annual capacity on record (see Figure 2.1). A new investment boom cycle may be forming, similar to that observed in 2016 - 2018 when the industry delivered a significant increase in investment to meet the 2020 Large-scale Renewable Energy Target. Future growth will depend on whether supply chains can rebound from constraints that arose from the pandemic and capitalise on the favourable investment environment for renewables.

Figure 2.1: Final investment decision for large-scale renewable generation, 2009 to 2022



Investment signals indicate a strong outlook for future renewable energy investment. The increase in FID capacity announcements is expected to continue in 2023. As highlighted in Figure 2.1, the renewables industry scaled up investment significantly from 2016 to 2018. Much of this investment was delivered between 2016 and 2020. Whether the industry can again scale up to enable an increased level of investment decision in 2023 and beyond, off the back of the big step up in H2 2022, remains to be seen.

For projects to reach FID, engineering, procurement and construction (EPC) contracts and contracts to procure key components are needed at commercial costs. Potential supply chain constraints for contractors and components represent the key risks to ongoing increases in investment. Some are arguing that incentives such as the Inflation Reduction Act in the United States of America will skew investment away from Australia. However, there are many large international renewables developers in Australia who have serious proven intent to invest here. Time will tell how these forces play out.

Factors contributing to a favourable investment environment for renewables

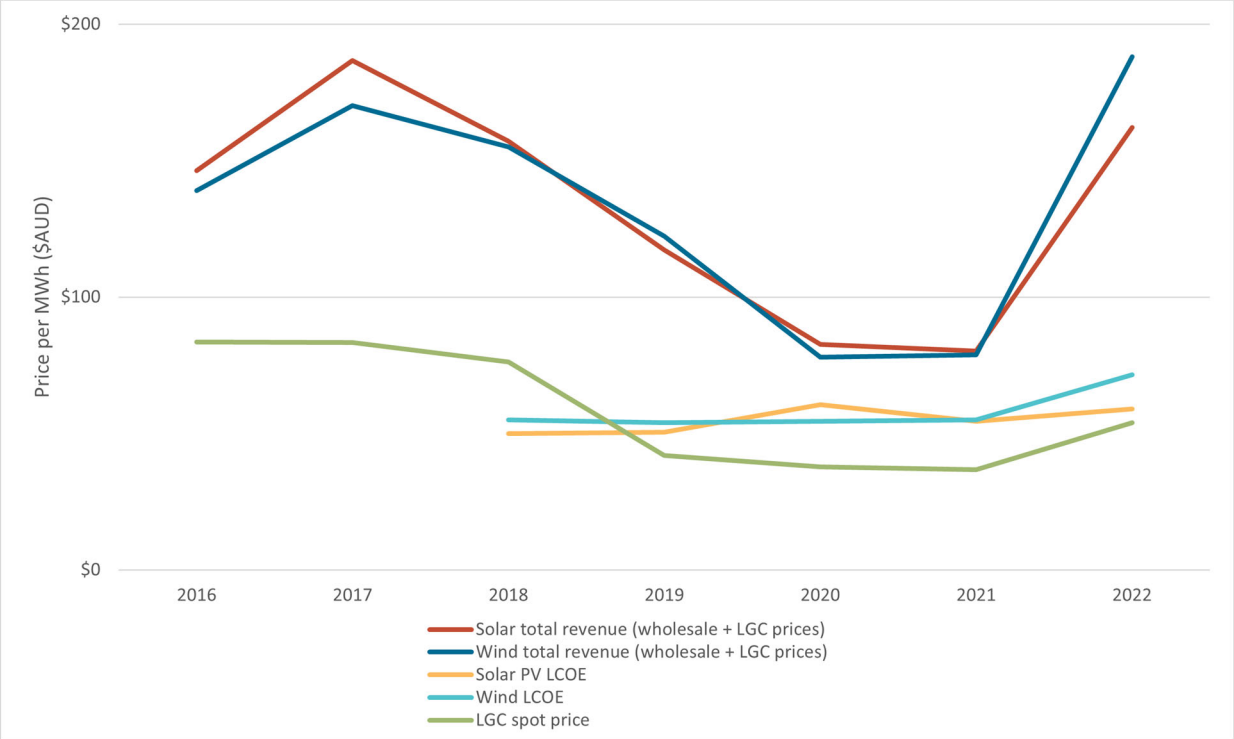
Favourable policy and regulatory landscape

- In line with Australia's emissions reduction target of 43% from 2005 level by 2030 and net zero emissions by 2050, the Minister for Climate Change and Energy set an ambition to get to 82% renewables share of electricity nationally by 2030. In progressing this agenda, the government is heavily investing in electricity network upgrades and storage, facilitating a faster transition to renewables through Powering Australia.
- State and territory governments have announced strengthened emissions reduction and renewable energy targets:
    - The Victorian Government announced new renewable energy targets of 65% by 2030, and 95% by 2035. In progressing this, the second Victorian Renewable Energy Target Auction was held in October. This brought forward 623 MW of new renewable generation capacity and delivered up to 365 MW and 600 MWh of new battery energy storage.
    - The Queensland Government announced new renewable energy targets of 70% by 2032, and 80% by 2035. As part of the *Queensland Energy and Jobs plan*, all publicly owned coal-fired power stations have been committed to be converted into clean energy hubs by 2035.
    - The New South Wales Government announced new commitments to reduce emissions by 70% below 2005 levels by 2035, paving the way for a quicker transition to renewable energy.
    - The Western Australian Government has committed to reducing emissions from all government agencies by 80% below 2020 levels by 2030. Legislation will also be introduced to formalise their goal of net zero by 2050.
- The reforms to the Safeguard Mechanism and baseline decay should progressively encourage facilities to consider fuel switching and electrification to reduce on-site scope 1 emissions.
- The Australian Government is facilitating growth of an Australian green hydrogen industry with a $525 million investment in developing hydrogen hubs. This is likely to attract complementary investment in renewables.
- The consultation on the proposed Guarantee of Origin (GO) scheme, including for renewable electricity certification ran from 12 December 2022 to 8 February 2023. This scheme will offer a mechanism to track and verify emissions associated with hydrogen and other low emissions commodities produced in Australia, signalling increased demand for renewables as a means for clean energy production.
- The Australian Energy Market Operator (AEMO) has been working closely with industry to make grid connection processes easier and faster. To replace the retiring coal fleet, AEMO has noted the need to connect at least 5 GW of large-scale renewable generation and storage capacity each year from 2022 to 2030. Recognising the faster pace of renewables integration and coal exit, AEMO adopted the Step Change Integrated System Plan scenario for the first time in 2022.

Price signals for investment

- LGC spot prices averaged $54 in 2022, 46% above 2021 prices. Prices grew strongly across future vintages as well. In early 2023, prices across most vintages have fallen (see *2A: Large-scale Generation Certificates (LGCs)* for further information).
- While wholesale electricity prices have decreased from the extremes observed in mid-2022, prices are still relatively high, with Q4 2022 prices averaging 55% higher than Q4 2021. The combined wholesale electricity and LGC prices send a clear signal that more generation capacity is required.
- CSIRO's 2022-23 GenCost consultation draft report suggests the levelised cost of energy (LCOE) of solar is $59 per MWh and wind is $71 per MWh. This reaffirms that solar and wind are some of the cheapest forms of new energy and provides attractive investment opportunities for project developers (see Figure 2.2).

Figure 2.2: LGC spot price, NEM wholesale price and wind and solar LCOE[9]



- Coal-fired power stations continue to bring forward their closure dates in response to developments in the energy market. The most recent is the AGL Loy Yang A power station targeted closure in 2035, which is 10 years earlier than previously scheduled. This sends a strong investment signal to the market to build wind and solar power stations in time to replace the retiring coal fleet.

Continuing improvement of grid infrastructure and storage

- Major grid upgrades progressed in 2022, and significant investments were made in infrastructure and battery storage, opening opportunities to connect new power stations to the grid and providing firming for variable renewables generation. Major developments include:
    - The Australian Renewable Energy Agency (ARENA) $176 million funding announcement for eight grid-scale battery projects across Australia. These batteries will be equipped with grid-forming inverter technology that provide essential system stability services.
    - Australian Government and New South Wales Government joint investment of $7.8 billion to help finance the development of eight critical projects across the state. This includes connecting New South Wales Renewable Energy Zones and plugging Snowy 2.0 into the grid.
    - New South Wales Eastern-section of Project EnergyConnect has received Australian Government and New South Wales governments approval. Construction of this 900 km long interconnector allows energy sharing between New South Wales and South Australia for the first time. This will enable the connection of further renewable generation. This project is on-track to be delivered by 2025.

Experienced and evolving industry

[9] LCOE data sourced from CSIRO GenCost reports. NEM wholesale price sourced from OpenNEM. LGC spot price sourced from Jarden and TFS Green

- On the supply side, project developers have access to a more diverse range of financing options, with many international companies having access to significant equity.
- On the demand side, developments such as Rio Tinto setting high ambition for additional renewables in Western Australia and Queensland could start to flow through to FID in the next few years. Furthermore, recent merger and acquisition activities, such as Squadron Energy acquiring CWP Renewables, could lead to surprises on the upside for investment.

Commercial processes to get projects to FID take significant time and do not follow a standard pattern. Announcements can vary considerably from quarter to quarter, even in a market that is rising. It is difficult to estimate future FID capacity given the factors previously discussed. However, with all the right investment signals in place, FID may increase again in 2023. Industry analyst Rystad suggests over 12 GW of large-scale wind and solar projects currently hold development approval with another 15 GW at concept or various stages in the approval process.[10] Given the investment environment, many of these projects could progress to FID over coming years.

The dynamics of investment are much simpler in the Small-scale Renewable Energy Scheme (SRES). The decision to invest in rooftop solar is consumer driven. Rooftop solar is an attractive investment for consumers, with average payback periods being as low as 3 years because of rising energy costs. Some jurisdictions and large solar retailers offer no interest loans which may entice new purchases in an environment of increasing interest rates.

However, the lag between signing a contract and installation is dependent on supply side factors, including installers and components as well as approvals. Market intelligence suggests current wait times of 3 to 5 months in some regions as demand outpaces available resources. Consumers who had systems installed in Q4 2022 were likely to have inquired and made investment decisions in Q3 2022. Investment decisions made in late 2022 and early 2023 will not be reflected in the installation data until Q2 2023. These supply chain constraints may limit how much capacity is installed in 2023.

The rooftop solar industry has previously handled higher levels of demand, with more than 6 GW total installed during 2020 and 2021. This supports optimism that the industry can progressively scale up to meet increasing demand.

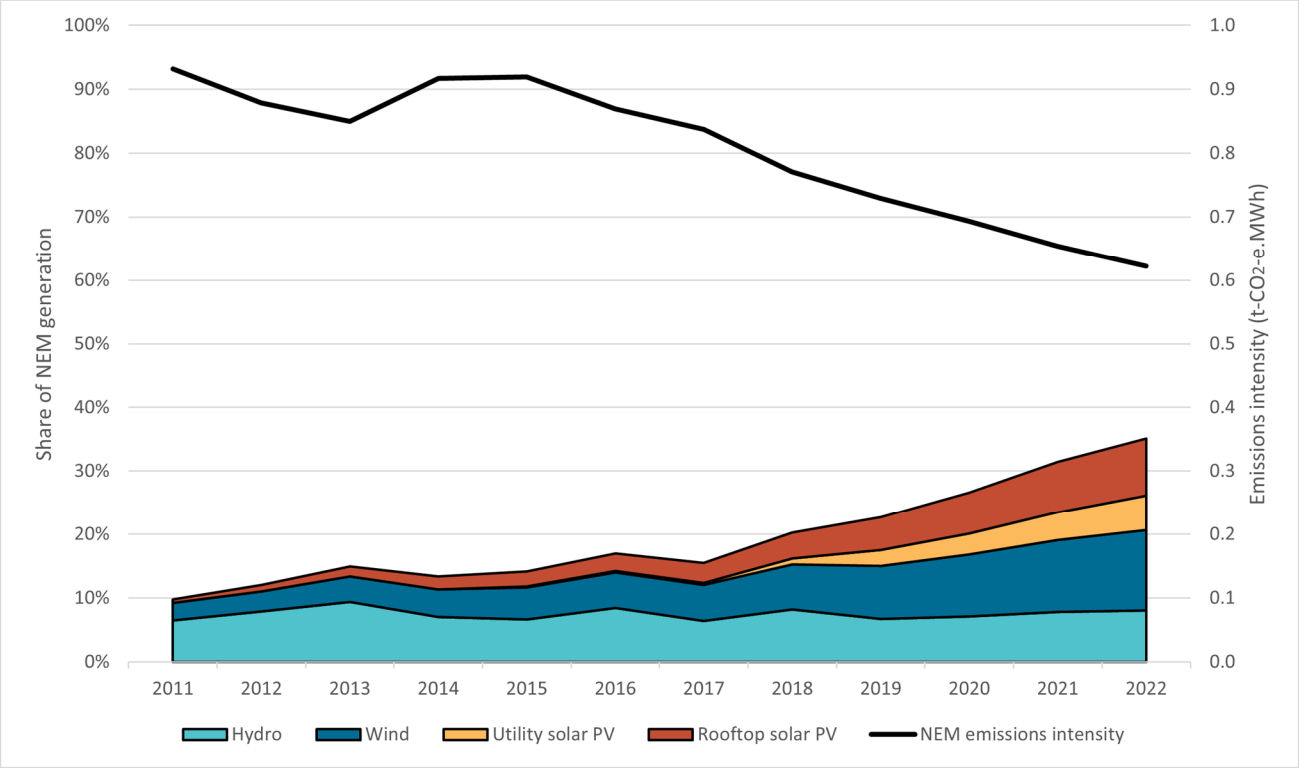
NEM renewable generation share grows

Renewables contributed 35% of total NEM generation in 2022, up 4 percentage points from 2021 (see Figure 2.3). The year finished strongly with both November and December recording 42% renewable generation in the NEM, compared to 36% over the same period in 2021. Solar performed at a record level in December with 23% of total generation. CER expects renewables could reach an average of 40% of total NEM generation during 2023.

The rapid increase in renewable generation is bringing the emissions intensity of the grid down. Data from the *AEMO Quarterly Energy Dynamics Q4 2022* report shows NEM emission intensity dropped to a record low of 0.62 tCO_2-e/MWh by the end of 2022. This decline will continue as more renewable generators come online and coal generators reduce production and eventually exit. Increasing solar and wind generation continues to push down wholesale electricity prices. Solar PV and wind set the price in 17% of Q4 intervals, up from 11% in Q3, and average NEM wholesale electricity prices were down 57% quarter on quarter.

Figure 2.3: Renewables generation share in the National Electricity Market, 2011 to 2022

[10] Data as at 20 February 2023. Data refers to projects that may come online by 2030.



Note: a small portion of renewable generation including biomass is not shown. NEM emissions intensity sourced from AEMO Quarterly Energy Dynamics Q4 2022

In a world first for a grid of its size, South Australia recorded more than 10 consecutive days when average production of wind and solar accounted for 100% of the state's demand. The state met an average 85% of its demand in December with renewables. This is a significant achievement that highlights the opportunity for South Australian generation to help meet demand in other parts of the grid when the NSW to SA interconnector is completed, and to support electrification of energy-intensive industries within the state. In recognition of this opportunity, the South Australian Government has committed $593 million to its Hydrogen Jobs Plan, which will see development of a hydrogen power station, electrolyser and storage facility within the Whyalla City Council by 2025.

Over the last 5 years, Australia has added an average of nearly 6 GW of new renewable energy capacity per annum and increased the share of renewable generation by 4 percentage points annually. To achieve 82% renewables by 2030, annual added capacity must increase beyond this level. If current electricity demand stayed the same to the end of the decade, renewable generation share must increase by 6 percentage points each year and annual added capacity must increase to at least 7 GW on a sustained basis.[11] Investment of 7.1 GW (large-scale FID of 4.3 GW and 2.8 GW of small-scale installations) in 2022 is a good start.

AEMO's 2022 Integrated System Plan (ISP) suggests 2030 demand could increase by 8% under the step-change scenario, and 43% under the Hydrogen Superpower scenario.

Electricity demand is predicted to increase due to:

- continuing electrification generally

[11] Assuming no additional demand, 82% renewables in the NEM would require approximately 170 terra watt-hours (TWh) of annual renewables generation, almost 100 TWh more than the 72 TWh generated in 2022. Based on the 2022 split of wind and solar approved under the LRET and SRES, current capacity factors and assuming total demand remains stable, this would roughly require almost 57 GW of new renewables over 2023-2030, or just over 7 GW each year.

- increased fuel switching across both residential and commercial sectors
- increased uptake of electric vehicles
- development of a renewables led hydrogen economy.

Electrification and any new sources of large demand, such as low emissions hydrogen and metals, will require further capacity growth beyond 7 GW per annum to match demand. Investment will need to continue to increase to achieve 82% renewables share of electricity by 2030 and to meet increasing low emissions electricity demand.

2A. Large-scale generation certificates (LGCs)

Key messages

- Generation eligible for LGCs reached 44,000 GWh in 2022, up from 39,000 GWh in 2021.
- LGC spot prices settled about $65 for most of Q4.
    - The spot price began to decline from late December 2022 to $49.85 by 31 January 2023 and fell further in February.
- Non-RET LGC demand reached a record of 7.4 million certificates cancelled to prove use of renewable energy.
    - This increased total demand for LGCs by 23% above the legislated RET of 33,000 GWh.
- The market still has an effective deficit of 15.5 million LGCs to redeem all shortfall, both paid and carried forward.
- 2.5 GW of new wind and solar capacity was approved for LGC creation in 2022.

Approved capacity remains stable

Capacity approved for LGC creation in 2022 was 2.5 GW, and another 640 MW remained under application at the end of December 2022. The 2.5 GW approved capacity could generate up to 6 million MWh and LGCs per year once it reaches full generation. This is equivalent to 2.9% of 2022 NEM electricity demand, noting that not all approved capacity is connected to the NEM.

Solar was the dominant source for approved capacity for the second consecutive year (see Figure 2.4). This was helped along by the 522 MW New England solar farm, the largest solar farm registered in Australia. However, this trend will change in future with wind accounting for 58% of the current total committed capacity of 6.8 GW that is either under construction or will be soon. Solar typically has a shorter build time compared to wind for the same capacity and can often start generating quicker once projects have reached FID.

Figure 2.4 highlights the lower level of capacity approved in 2021 and 2022 following the larger levels approved during 2018 to 2020. This reflects the build of renewable energy projects that reached FID between late 2016 and 2018, and the pull back in FID in 2019 to 2.3 GW (see Figure 2.1). Depending on the size of the power station, projects can take multiple years from start of construction to reach registration (first generation) – typically 1 to 2 years for solar and more than 2 years for wind.

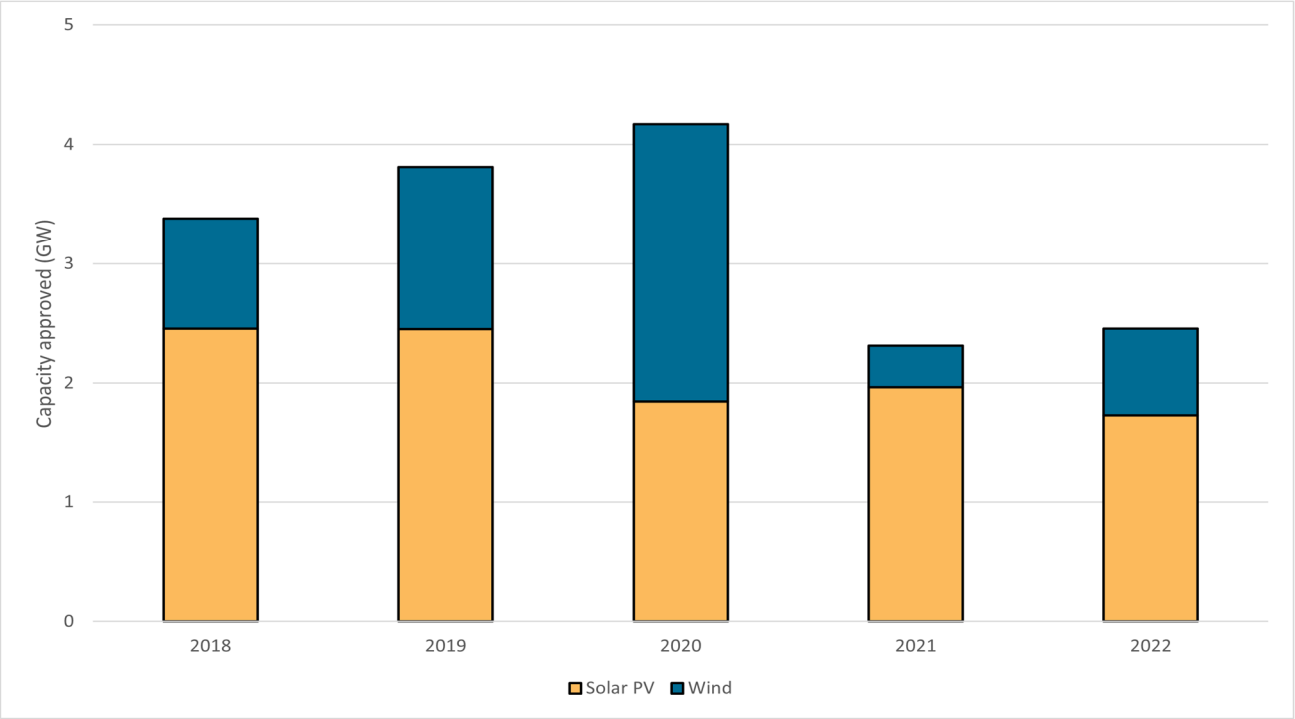
FID capacity in 2020 and 2021 averaged 3 GW per year and increased to 4.3 GW in 2022. Despite this, it is estimated that capacity approved in 2023 will be similar to 2022 at about 2.5 GW. Multiple factors are contributing to longer timeframes between increasing FID and seeing that increase flow through to generation/approval including:

- projects getting much larger on average, indicating longer build time. For example, the 1 GW MacIntyre Wind farm reached FID in Q4 2021 but is not expected to commence generating till late 2023 or early 2024.

- the big increase in FID in 2022, most of which was in Q4, suggests the impact on approved capacity may not be realised until 2024.

Capacity approved in 2023 could exceed 2.5 GW if some projects that reached FID in 2022 come through for registration this year. At this stage, approved capacity is most likely to show growth again between 2024 and 2026.

Figure 2.4: Solar PV and wind capacity approved for large-scale renewable generation, 2018 to 2022



LGC supply and demand dynamics

Following the annual surrender of LGCs for RET liability for the 2022 assessment year on 14 February 2023, there was still almost $1 billion in consolidated revenue that can be redeemed under the 3-year rule. This represents about 15 million LGCs are needed. In addition, there was about 500,000 of LGC liability carried forward by electricity retailers under the 10% borrowing rule. Considering the need for liquidity for the market to operate, there is still an effective deficit of about 15.5 million LGCs. Despite LGC supply increasing materially year on year for the last 3 years, this effective deficit has stayed about the same as voluntary cancellations increase rapidly and shortfall continues to be taken and redeemed.

11.2 million LGCs were validated in Q4 2022, taking total 2022 calendar year supply to 42.1 million – an 8% increase on 2021.[12] Including holdings of 7.8 million LGCs from previous years, 49.9 million LGCs were theoretically available in 2022 for cancellation against statutory and voluntary demand and to redeem shortfall. However, markets need liquidity to function and the 7.8 million could be seen as representing the liquidity needed in the 2021 assessment year.

By the surrender deadline of 14 February 2023, 28.5 million LGCs were cancelled against liability for the 2022 assessment year resulting in a surrender rate of 86%. 5.1 million LGCs were taken as shortfall, higher than the 4.9 million LGCs for 2021. Of the 5.1 million LGCs taken as shortfall for 2022, 4.6 million LGCs

[12] The 42.1 million refers to LGCs that have been validated by the CER during 2022 calendar year. This is different to eligible generation for 2022, which is estimated to be around 44,000 GWh (equivalent to 44 million LGCs). LGCs in relation to the 44,000 GWh will be created and validated throughout 2023.

related to paid shortfall and 0.5 million was carry forward shortfall. The balance for the 2022 assessment year after surrender was 8.8 million LGCs (see Table 2.1). This balance does not consider LGCs that have been validated in 2023.

Detailed results for the 2022 assessment year will be provided through the CER's Certificate shortfall register.

Table 2.1: LGC balance at the end of the 2022 assessment year

	Supply	Demand
LGCs available from previous assessment years	+7.8 million	
2022 LGC supply (available for 2022 surrender)	+42.1 million	
LGCs surrendered 2022 assessment year		-28.5 million
Shortfall charge refunds		-5.2 million
Voluntary cancellations		-7.4 million
Estimated total balance for 2022 assessment year	**+8.8 million**	

The dynamics of the shortfall mechanism suggests electricity retailers and the market generally are continuing to use the shortfall provisions as an effective liquidity mechanism. While the shortfall mechanism remains in material use, the 8.8 million LGC balance could be seen as the liquidity the market needs. This is approximately 1 million more than at the end of the 2021 assessment year.

Supply and demand for LGCs will continue to remain tight for the foreseeable future. New LGC supply in 2023 is expected to be in the range of 45 to 48 million LGCs.[13] At the end of the 2022 assessment year, 15 million LGCs, equal to approximately $1 billion of shortfall charge, remained eligible for refund. Including the 0.5 million carry forward shortfall. This creates an effective deficit of 15.5 million LGCs in the market and voluntary demand to cancel LGCs is expected to continue to grow.

There is significant unrealised demand for LGCs when considering the potential demand from National Greenhouse and Energy Report (NGER) reporters. Many reporters have emissions reduction and renewable energy use commitments and will likely use LGCs as a vehicle to demonstrate some or all of this. The underlying electricity used by above threshold NGER reporters in their recently published scope 2 electricity emissions was 111 million MWh in 2021-22, equivalent to 111 million LGCs. Even when adjusted for RET liability, around half of the 33 million LGCs, and the current breakdown of voluntary demand cancellations discussed below, there is potential annual demand of around 90 million LGCs from NGER reporters above the publication threshold.

Additionally, the Australian Government commitment to mandate and standardise disclosure of climate-related financial risks and opportunities will likely see voluntary LGC cancellation continue to increase. It is difficult to predict when the effective LGC deficit of 15.5 million will decline. It will be interesting to see whether this effective deficit changes during 2023.

While this deficit remains, the shortfall mechanism component of LRET liability and the associated price dynamics around the $65 LGC shortfall charge remain a consideration for liable entities. This effective deficit

[13] Assuming typical wind and solar patterns and no major curtailment events

has not reduced in the last year despite LGC supply increasing year on year by 3.2 million and voluntary cancellations increasing by 1.6 million. This effective deficit is unlikely to decline in the short term. These dynamics may impact spot and forward LGC prices in the future.

Table 2.2 shows the volume of LGCs that must be surrendered by liable entities during 2024, 2025 and 2026 to ensure they do not forfeit the right to recoup shortfall charges. Some entities may choose to surrender LGCs earlier than required. With an effective deficit of 15.5 million LGCs we expect ongoing shortfall charge to be taken.

Table 2.2 Potential LGC demand from redeeming shortfall charge

Year due*	Shortfall charge paid (million)	Volume of LGCs (million)
2024	$397	6.1
2025	$277	4.3
2026	$299	4.6
Total	$973	15.0

*Liable entities generally have 3 years from the date the shortfall charge is paid to claim a refund by surrendering required LGCs. For example, entities paying shortfall charge in 2023 against 2022 liability will have until 2026 to recoup their shortfall charge.

Renewable energy guarantee of origin

In December 2022, the Australian Government released a policy position paper for renewable electricity certification under the Guarantee of Origin scheme (RE-GO). Submissions closed on 3 February 2022. A new mechanism is proposed to provide organisations with certainty around how renewable electricity would be recognised in the market, primarily after 2030. Coverage would extend to electricity for international export and below-baseline generation. This could support planning, contracting and investment decisions being made by businesses today and help position Australia as a trusted supplier of renewable electricity and low emissions products.

Below baseline generation is the large-scale generation (mainly hydro) that was in existence when the RET commenced and that does not earn LGCs. This generation is on average about 12,000 GWh per annum. Under the policy proposal, this could add about 12 million RE-GO certificates each year. However, the government's policy proposal would only allow the use of these RE-GO certificates for voluntary purposes, including for programs such as Climate Active, GreenPower and the Corporate Emissions Reduction Transparency report. Unlike LGCs, RE-GOs would not be available to the market to redeem shortfall or to meet liability under the RET.

Much of the generation that would be eligible for RE-GO certificates is eligible for International Renewable Energy Certificates (I-RECs). It is our understanding that much of the potential supply of I-RECs (and possible RE-GOs) is already contracted and sold through power purchase agreements (PPAs). As a result, we think the effective extra supply of certificates available to the market may only be about 2 million certificates and only

for voluntary purposes. RE-GOs would be expected to trade at a material discount to the price of LGCs because they can't be used for RET liability or shortfall redemption. Looking at the potential voluntary demand with NGER reporters, it is likely these surplus RE-GO certificates would be quickly consumed in additional voluntary demand and there will be no impact on the LGC price. This is all subject to potential legislative change in the future.

The Renewable Power Percentage (RPP)

The LRET requires liable entities to surrender 33 million LGCs annually until 2030. For 2023, this equals an RPP of 18.96%.

The CER will track certificate availability to meet RPP demand and report on this throughout the year.

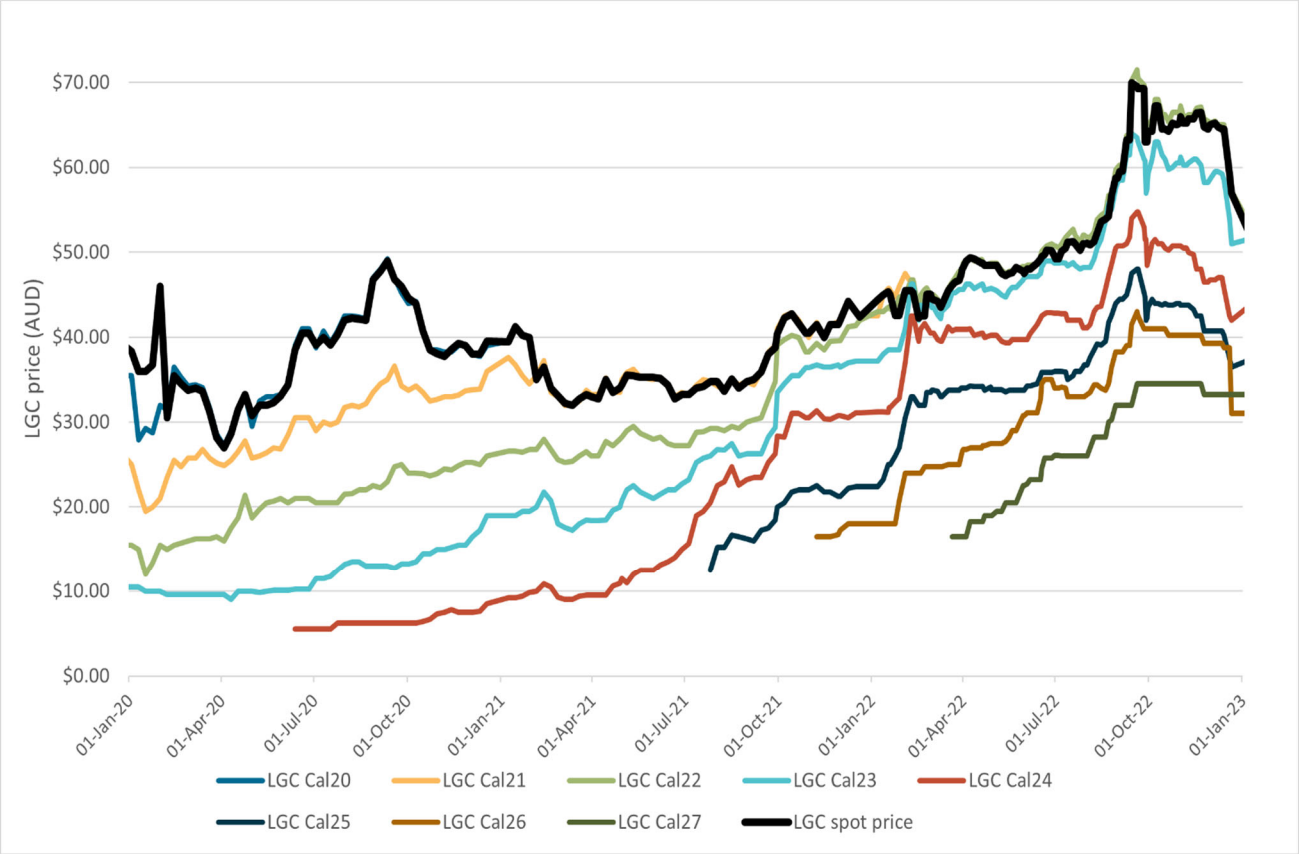
LGC price falls from recent highs

LGC spot prices saw a period of relative stability during Q4, sitting around $65. Late December volatility saw spot prices closing the quarter at $57, with further decreases through January. This suggests liable entities finalised their positions for 2022 liability ahead of the 14 February surrender deadline. Most future vintages have broadly followed the spot price patterns over the quarter. Shorter term futures reflect the declining values more closely (see Figure 2.5).

The spot and forward price graphs below show how the forward markets since 2020 have underestimated the tightness of supply and demand and the effective deficit of LGCs.

It will be interesting to see whether the spot price changes once the market fully digests the level of the effective LGC deficit and the need for material shortfall charge to be taken for several years yet.

Figure 2.5: LGC spot and forward prices, January 2020 to December 2022[14]



[14] Pricing data is compiled from trades reported by TFS Green and may not be comprehensive.

Non-RET demand for LGCs

The QCMR includes an analysis of LGC cancellations in the Renewable Energy Certificate Registry (REC Registry) for purposes other than mandatory surrenders against the Renewable Energy Target (RET) scheme. These cancellations could be voluntary to show progress towards reducing net scope 2 emissions or to meet state or territory government regulatory requirements.

This analysis breaks out the volume of LGCs by the reason for cancellation (the source of demand) to examine drivers of ongoing demand growth and help understand potential sources of growth in the future.

Cancellations are experiencing an ongoing period of growth and evolution. This includes sources outside of the previously used 'voluntary demand' description. To ensure this analysis remains useful for participants and to better inform the market, the CER has redesigned this analysis as "non-RET demand" and refined its approach to classifying cancellations to reflect the distinctions more accurately in the market.

This classification system is uniform across ACCU and LGC cancellations.

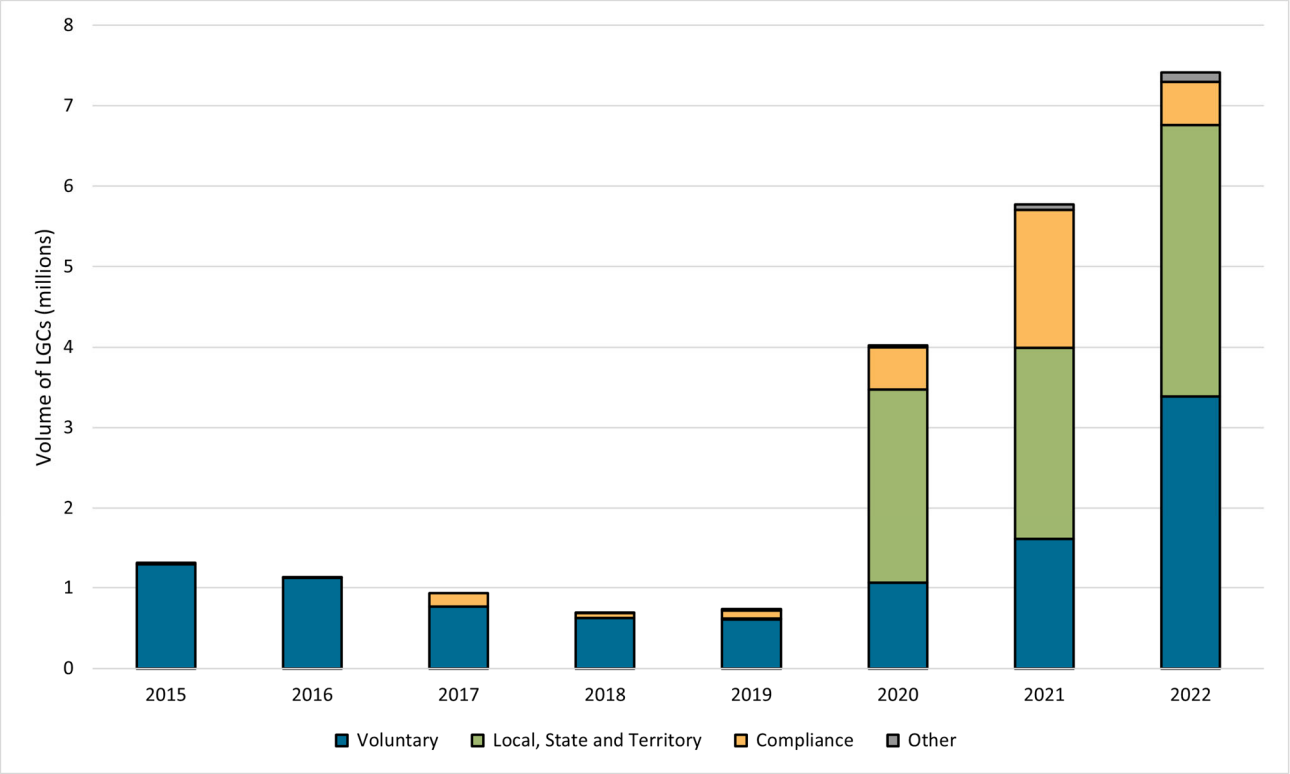
New classification	Covered activities
Voluntary demand	Cancellations made against voluntary certification programs (such as Climate Active and GreenPower) and organisational emissions or energy targets.
Local, state and territory government demand (LS&T)	Cancellations on behalf of local, state and territory governments, such as to meet state renewable energy targets or offset emissions from state fleets.
Compliance demand	Cancellations by private organisations and corporations for compliance or obligations against municipal, local, state and territory government laws, approvals, or contracts. For example, to prove renewable energy for desalination or state Environmental Protection Agency requirements.
Other demand	All activities not covered in the previous categories, primarily due to lack of information available. This grouping has declined substantially as part of these new classifications.

Classification of this data is based on information available to the CER and may not be comprehensive.

Non-RET LGC cancellations totalled 7.4 million certificates in 2022 (see Figure 2.6), with almost 1.2 million LGCs cancelled in Q4. Annual demand increased by 1.6 million compared to 2021. This was primarily driven by GreenPower, local, state and territory governments, and growing corporate voluntary ambition to demonstrate renewable energy use. The 7.4 million LGCs has effectively increased total demand by 23% above the legislated 32.6 million LGCs. Voluntary demand growth has kept LGC availability relatively tight, creating upward pressure on prices and creating an incentive for additional renewable investment. Annual

demand of 7.4 million LGCs is equivalent to the output of over 3 GW of utility-scale renewables and covers almost 3.6% of total electricity demand in the NEM.[15]

Figure 2.6 Non-RET LGC cancellations by demand source, 2015 to 2022



[15] 3 GW of renewables assumes a 30% wind and 70% solar PV split. Australian electricity usage refers to 2022 NEM demand sourced from OpenNEM.

2B. Small-scale technology certificates (STCs)

Key figures

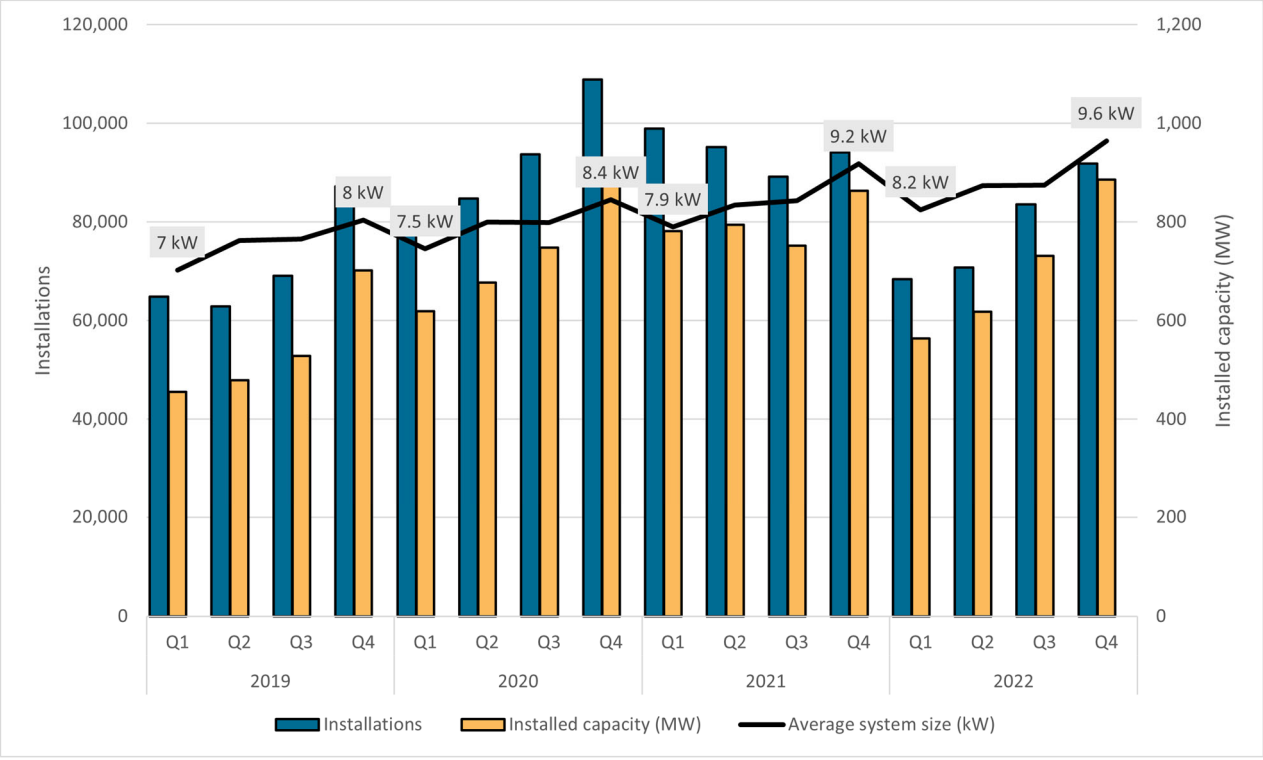
- 2.8 GW of small-scale solar PV capacity was installed in 2022, an increase from the original estimate of 2.3 GW total capacity for 2022.
- In 2022, almost 7% of rooftop solar PV systems included a reported concurrent battery installation, up from 3% in 2021.
- 8.4 million STCs were surrendered on 14 February 2023, resulting in a surrender rate of 99% for the Q4 surrender period.
- Following surrender, **the STC clearing house** was in deficit by **4.7 million** certificates.
- The 2023 Small-scale Technology Percentage (STP) was set at 16.29%, requiring liable entities to cumulatively surrender 34.4 million STCs.

Third highest annual installed solar PV capacity on record

Following a slow start to the year, demand for rooftop solar PV rebounded in the second half of 2022. A total of 2.8 GW of small-scale solar capacity was installed in 2022. This is the third highest installed capacity on record, surpassed only by the pandemic boom years where discretionary spending was skewed to home improvements. As discussed in the March and June QCMRs, a combination of factors contributed to the contraction in the first half of the year. This includes household discretionary spending shifts to travel following the easing of prolonged COVID-19 lockdowns and restrictions.

Almost 900 MW of small-scale solar capacity was installed in Q4 2022 with a record average system size of 9.6 kW (see Figure 2.7). This was driven by the seasonal uptick in larger commercial and industrial installs.

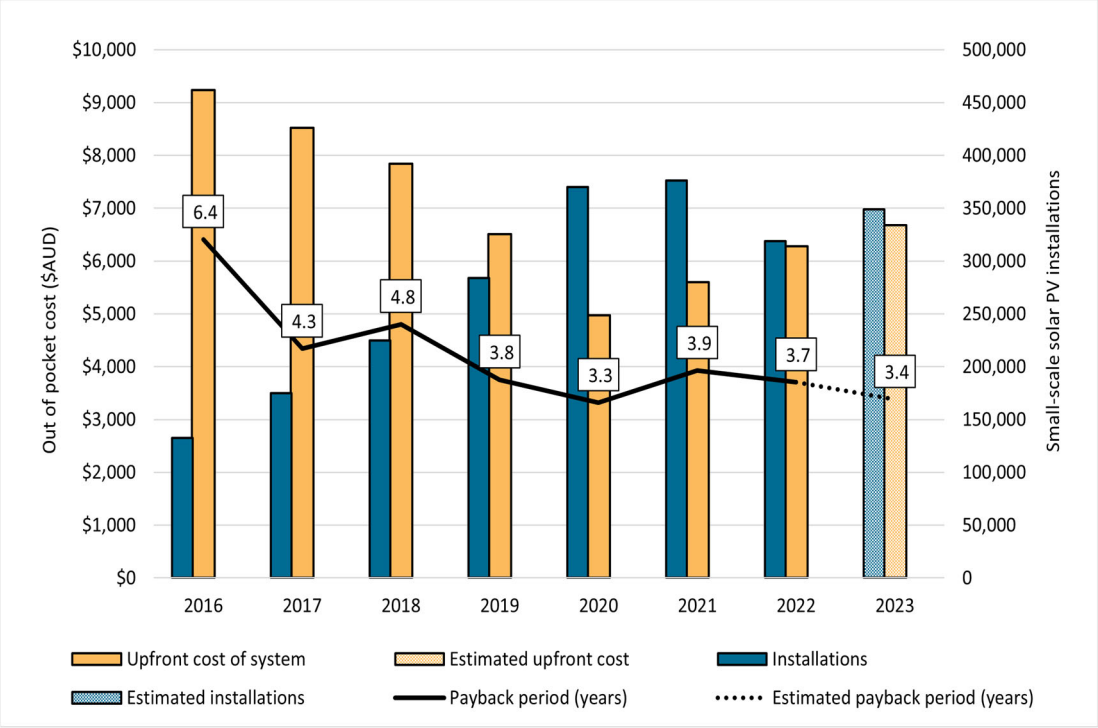
Figure 2.7 Small-scale solar PV installations, installed capacity, and average system size, Q1 2019 to Q4 2022



In 2022, only 5% of all SRES installations were commercial and industrial systems greater than 15 kW. However, they contributed 18% of total additional installed capacity. About 500 MW was installed in this capacity bracket over the year, a slight decrease from the 560 MW in 2021. Commercial demand for small-scale solar may increase in 2023 as businesses look to manage cost pressures from high energy prices.

Figure 2.8 shows the number of installations and the average upfront cost to consumers of rooftop solar PV systems from 2016 to 2023.[16] There has been an upward trend in rooftop solar PV installations since 2016. This correlates to a reduction in the payback period until 2020 driven by component price reductions, economies of scale in manufacturing processes, installation efficiency and increased competition in the industry. The steep decline in the payback period in 2017 was in part due to the doubling of the feed-in-tariff in New South Wales.

Figure 2.8 Small-scale solar PV 7 kW system indicative payback period, 2016 to 2023



Note: Cost is not adjusted for inflation. This does not affect the payback period. Payback periods are based on an average 7 kW system installed in Sydney. Further assumptions are noted in QCMR data workbook – December Quarter 2022.

From 2020, increasing component prices due to COVID-19 related shortages, combined with ongoing increases in average system size, increased the upfront cost of solar PV systems. However, those larger systems have shorter payback periods. In mid-2022 increasing energy prices started bringing payback periods down again. For 2023, increasing energy prices may reduce payback periods to 3-4 years in some areas, despite STC reductions from the reduced deeming. Higher energy prices improve the economics of installing rooftop solar, as consumers can avoid purchasing energy from the grid while their solar systems are generating power.

Figure 2.8 shows consumers have been commercially savvy in increasingly investing in rooftop solar as payback periods fall.

[16] Estimates provided for 2023 are indicative only. Upfront costs are based on average 7kW system installed in NSW and include the value of the STC incentive. Prices for 2016-2022 data sourced from Solar Choice.

In 2023, system installations and installed solar PV capacity may return to near record levels as energy bills increase and payback periods fall. The CER expects at least 3 GW of small-scale solar PV to be installed in 2023. If the H2 2022 trend continues, total added capacity for 2023 could reach or exceed the 3.2 GW record seen in 2021.

Increasing demand for battery storage

The proportion of solar systems with concurrent battery storage reported to the CER increased to almost 7% of total installations in 2022. This is more than double the 3% in 2021, noting it is a change off a small base. As noted in the June QCMR, this data is voluntarily reported to the CER so it provides an indication of year on year growth rather than the total number of battery installations.[17]

STC market dynamics

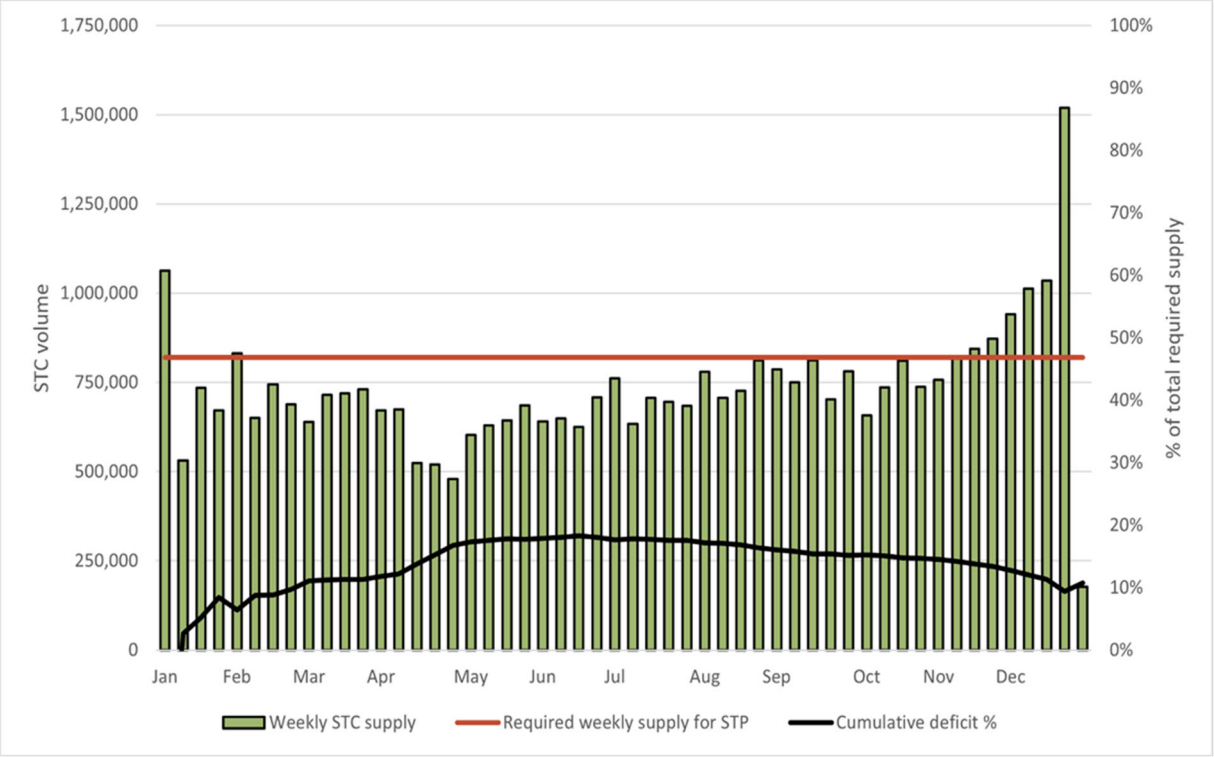
Over the 2022 assessment year, 42.6 million STCs needed to be created and surrendered (or about 820,000 creations each week) to meet the Small-scale Technology Percentage (STP) for 2022 of 27.26%.[18]

In 2022, only 38 million STCs were created. This meant new STC supply was below the required amount to meet STP liability in most weeks. This created a certificate deficit that peaked in mid-June 2022 (see Figure 2.9).

Creations trended up towards the end of the year with almost every week in November and December above the weekly volume required for the STP. However, this was not sufficient to address the deficit from the first half of the year. By the end of the year the deficit had declined to 10% of required creations, or approximately 4.3 million STCs.

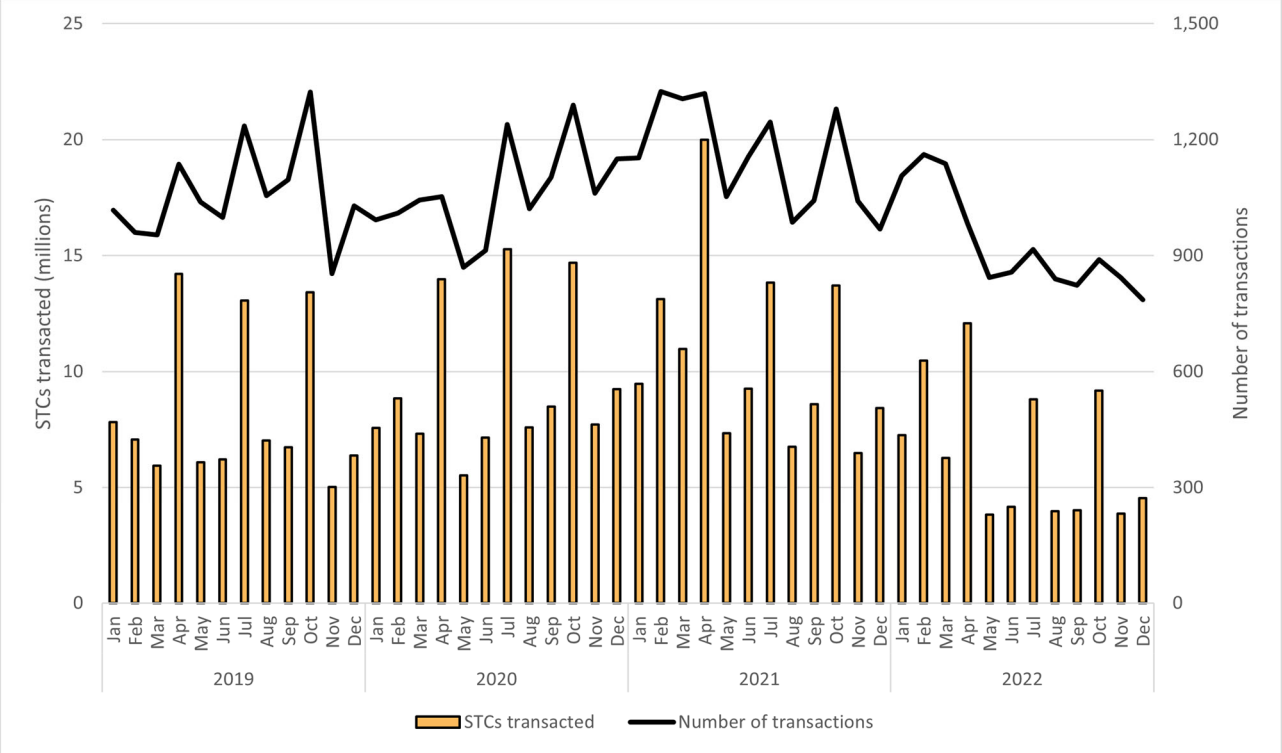
Figure 2.9 Weekly STC supply, required supply to meet STP and cumulative deficit, 2022

[17] Based on data voluntarily reported to the Clean Energy Regulator. This may be an underestimate of the total number of households with rooftop solar PV systems with connected battery storage.
[18] 42.6 million STCs reflects the nominal target of 47.7 million STCs minus the remaining balance of 5.1 million STCs following the 2021 assessment year.



The low availability of STCs on the open market saw a decline in STC transactions (see Figure 2.10) and a near constant STC spot price at $39.90 for most of the year as the Clearing House remained in material use. The seasonal peaks around the surrender dates in February, April, July and October were still observed but were subdued relative to previous years despite the higher surrender requirements.

Figure 2.10 STC market transactions, January 2019 to December 2022



Note: STC clearing house transactions are not included in this graph

The STC clearing house saw sustained use during 2022, facilitating 260 transactions for 16.2 million regulator created certificates. If recent strong installation and STC creation trends continue it is likely the STC clearing house will return to surplus in late 2023.

The small-scale technology percentage

The 2023 small-scale technology percentage (STP) has been set at 16.29%.

Liable entities (generally electricity retailers) will be required to surrender 34.4 million STCs to meet their RET obligations for 2023.

The CER will track certificate availability to meet STP demand and report on this throughout 2023.

3. International carbon units

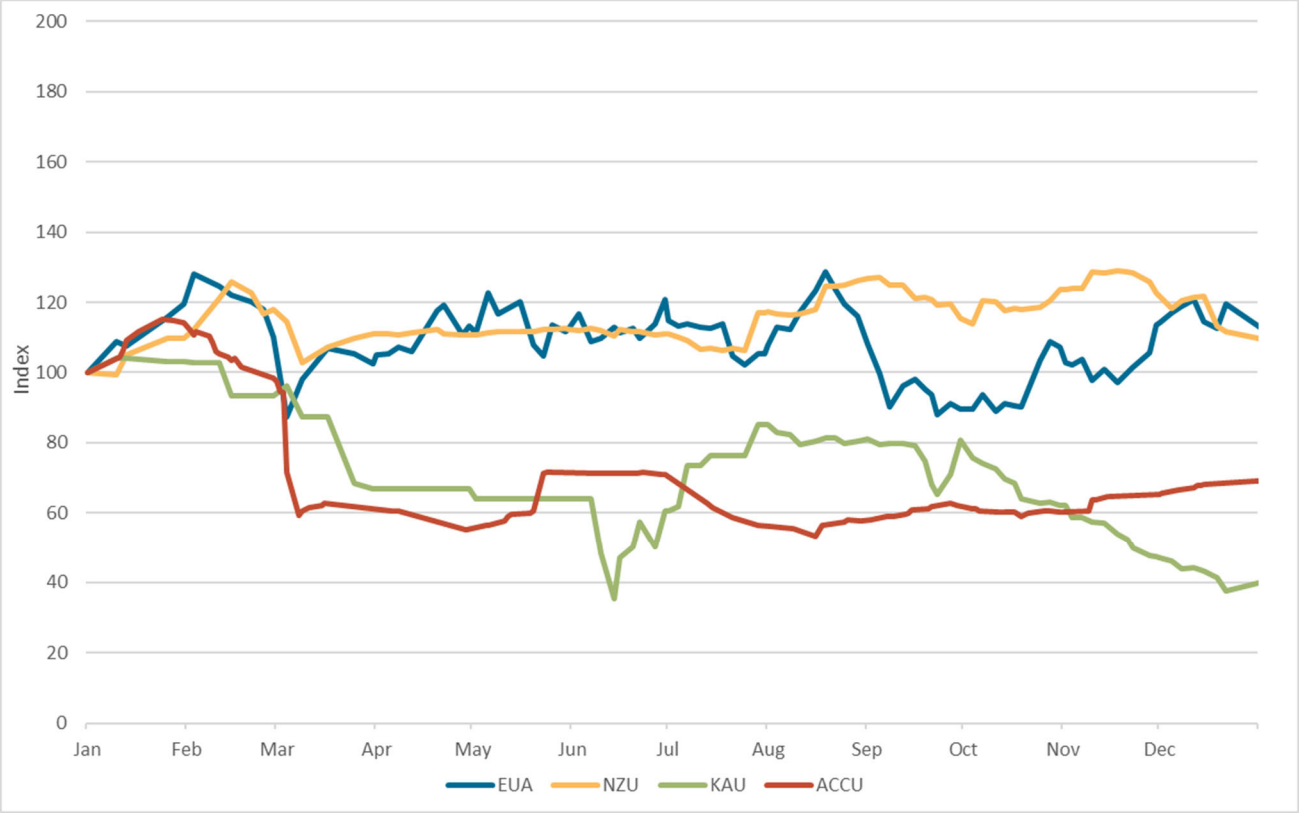
International carbon markets experienced a volatile year in 2022. The initial optimism in the market was driven by a successful COP26 outcome in November 2021. In particular, the agreement on the principles of global carbon trading was a key development. Throughout 2022, the invasion of Ukraine on 24 February 2022 and local carbon policies led to different market outcomes (see Figure 3.1).

European Union Allowance (EUA) prices saw an initial 30% decline from the start of the invasion (€90 to €65 or A$142 to A$97) but peaked at €99 (A$145) in August 2022 (see Figure 3.1). The recovery was the result of higher demand for EUAs by European power generators switching from Russian gas imports to more carbon-intensive coal. This switch was due to supply concerns and forced gas consumption cuts by European Union (EU) governments to increase gas storage for winter. After the peak, EUA prices declined. Internal EU legislative negotiations (Trialogues) on carbon trading reforms considered increasing short-term auction supply to fund the REPowerEU program. Prices recovered following the discussions with proposed reforms being less bearish than the market expected. EUA prices finished the year nearly 13% higher than the start of the year (see Table 3.1).

New Zealand Units (NZU) prices were less affected by the Ukraine war, falling 16% from NZ$80 to NZ$70 (A$74 to A$66) from the start of the war to 9 March 2022 (see Figure 3.1). Prices recovered sufficiently for NZU to reach a new high in September (NZ$87 or A$78) and again in November (NZ$88 or A$82). Market bullishness was amplified by expectations that the New Zealand government would accept the Climate Change Commission's emissions trading system (ETS) reform recommendations to increase the Cost Containment Reserve trigger price. However, prices declined when the government announced only a marginal increase. NZU prices finished the year nearly 12% higher than the start of the year (see Table 3.1).

In the South Korean ETS, the Ukraine war may have contributed to the 35% decline of Korean Allowance Unit (KAU) prices from ₩31,800 to ₩20,550 (A$38 to A$23) between 24 February and 30 June 2022 (see Figure 3.1). This decline in demand is likely due to an oversupply of units. Compliance entities offloaded excess KAUs to meet carryover restrictions for the 2022 compliance period (starting on 1 July 2022). In the second half of the 2022 calendar year, there was some bullishness as the South Korean government sought to improve the ETS market activity and increase its emission reduction ambition. However, these reforms failed to gain traction and KAUs ended the year over 60% lower than the start of the year (see Table 3.1).

Figure 3.1 Changes in EUA, NZU, KAU, and generic ACCU spot prices, 1 January 2022 to 31 December 2022, indexed to 1 January 2022



Data sourced from TFS Green, Jarden, Ember, Carbon News and KRX

Table 3.1: International unit prices

Product	Spot price 31 Dec 2021	Spot price 31 Dec 2022	Annual change	Spot price (31 Dec 2022) Australian dollar terms*
European Union Allowances (EUA)	€74.61	€84.11	€9.50 (12.7%)	$132.84
New Zealand Units (NZU)	NZ$68.50	NZ$76.50	NZ$8.00 (11.7%)	$71.46
Korean Allowance Units (KAU)	₩34,000	₩12,800	-₩21,200 (-62.4%)	$14.86

*Exchange rate as at 31 December 2022

4. Emissions Reduction

In 2022, we administered schemes that reduced emissions by 61.3 million tonnes of carbon dioxide equivalent (CO_2-e). This is an improvement on 2021 where CER schemes reduced emissions by 58.1 million CO_2-e.

In 2022, the Emissions Reduction Fund (ERF) issued Australian Carbon Credit Units (ACCUs) equivalent to 17.7 million tonnes of CO_2-e emissions abatement. This is a 4% increase compared to 2021.

The Renewable Energy Target (RET) contributed 43.6 million tonnes CO_2-e of emissions reduction in 2022, a 6% increase from 2021. Of which, 26.1 million tonnes of CO_2-e were from the Large-scale Renewable Energy Target (LRET) and 17.5 million tonnes CO_2-e were from the Small-scale Renewable Energy Target (SRES). As discussed in the September 2021 QCMR, it is expected that renewables captured under the RET will continue to reduce emissions but at a reduced rate as the emissions intensity of the grid declines.

The RET added 8.6 million MWh of renewable energy to the grid in 2022. The emissions reduction estimate for 2022 was based on the average emissions intensity of the grid. This fell to 0.61 tonnes CO_2-e per MWh compared to 0.65 tonnes CO_2-e per MWh in 2021. This modest difference is due to the rapidly declining emissions intensity of the grid as uptake of renewable energy continues to increase.

We estimate scheme-based emissions reductions in 2023 to be 63.7 million tonnes of CO_2-e. This is an anticipated increase of 4% compared to 2022 (see Figure 4.1).

We have incorporated National Electricity Market (NEM) and South West Interconnected System (SWIS) data when calculating our estimates. This provides a better estimate for the national emissions intensity factors for 2021 and 2022. A linear forecast has been used to estimate the 2023 emissions intensity factor for the emissions reductions from the RET.

Emissions reductions using thermal displacement

When using the thermal generation displacement approach, we estimate emissions reductions in 2022 to be 84.5 million tonnes of CO_2-e. Every additional MWh of additional renewable generation displaces a MWh of either coal or gas generation. This includes renewables incentivised through the LRET and SRES schemes. The September 2021 QCMR provides a methodological overview of the emissions reduction estimates using average emissions intensity and emissions intensity of displaced thermal generation. The estimate of emissions reductions using thermal displacement is higher because electricity generated from displaced thermal fuel sources (primarily coal and gas) has a higher emissions intensity than electricity from the current generation mix in the NEM and SWIS. We estimate 0.93 tonnes CO_2-e per MWh for thermal generation versus 0.61 tonnes CO_2-e per MWh for the grid.

We project the 2023 estimate using the thermal displacement approach will be 90.8 million tonnes of CO_2-e.

Figure: 4.1 Estimated emissions reduction from ERF and RET, 2011 to 2023

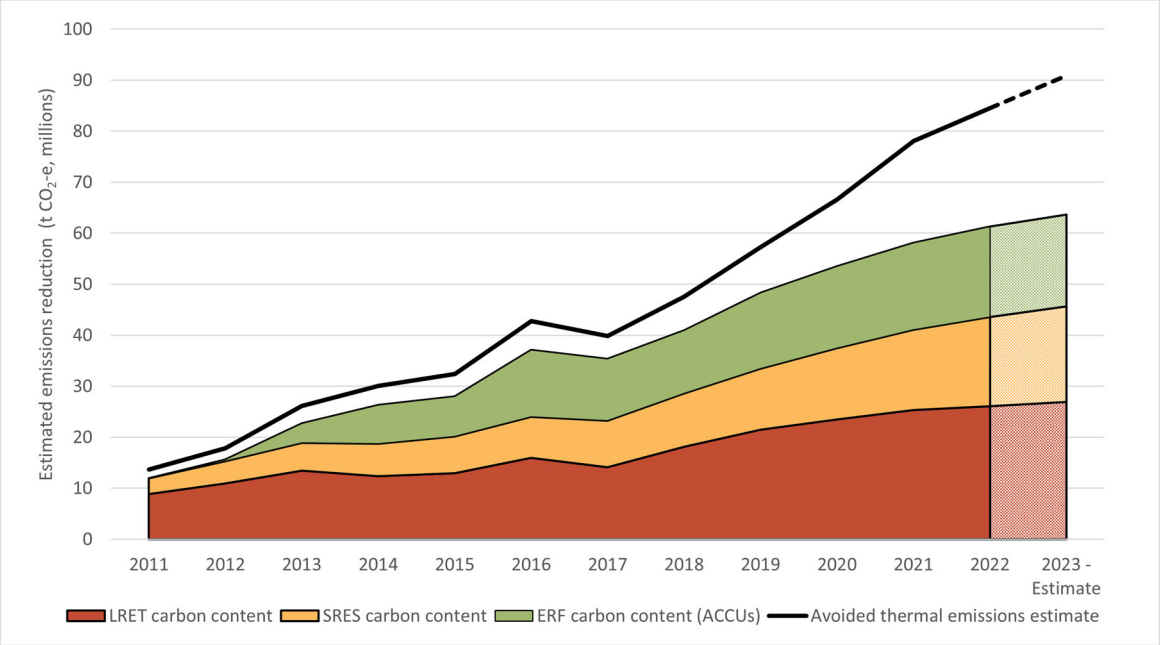


Table 4.1: Emissions reduction by estimation method

2022 Emissions reduction by scheme (million tonnes CO_2-e)	'Carbon content' estimate (conservative approach)	'Avoided emissions' estimate (thermal displacement)
LRET	26	40.2
SRES	17.5	26.6
ERF	17.7	17.7
Total	61.3	84.5

Glossary

Term	Meaning
Australian carbon credit unit (ACCU)	One Australian carbon credit unit represents one tonne of verified carbon dioxide equivalent abatement. ACCUs are created from eligible offsets projects and issued by the Clean Energy Regulator in accordance with section 147 of the *Carbon Credits (Carbon Farming Initiative) Act 2011* **(CFI Act)**. Transactions of ACCUs occur through the Australian National Registry of Emissions Units (ANREU).
Australian National Registry of Emissions Units (ANREU)	The registry in which all transactions of Australian carbon credit units takes place. A seller must have an ANREU account to participate in the Emissions Reduction Fund.
Baseline	The baseline is the reference point against which an entity's emissions or electricity generation can be measured. A power station which generates renewable energy in excess of their baseline can earn large-scale generation certificates under the Renewable Energy (Electricity) Regulations 2001. An entity with obligations under the safeguard mechanism must keep its net emissions at or below its baseline.
Cal prices	This is the forward trade price for large-scale generation certificates traded for the calendar year it is referring to. For example, Cal24 is the calendar year 2024.
Carbon abatement	Carbon abatement refers to a reduction in atmospheric carbon dioxide through emissions avoidance or carbon sequestration.
Certificate spot price	Certificate spot price refers to the secondary market price for small-scale technology certificates, large-scale generation certificates and Australian Carbon Credit Units.
Climate Active	Climate Active is a unique partnership between the Australian Government and Australian businesses that enables voluntary climate action. Climate Active certifies businesses that have credibly reached a state of carbon neutrality by measuring, reducing and offsetting their carbon emissions against the requirements of the Climate Active Carbon Neutral Standard. Certification is available for organisations (in relation to business operations), products and services, buildings, events and precincts.
Emissions avoidance	Emissions avoidance refers to projects that generate abatement by reducing or avoiding greenhouse gas emissions which would otherwise have occurred. For example, savanna fire management may reduce carbon dioxide emissions by reducing the frequency and extent of late dry season fires. Capturing and flaring landfill gases converts methane to carbon dioxide, which has lower global warming potential than methane.
Emissions Reduction Fund (ERF)	The Emissions Reduction Fund is a scheme where the Government purchases the lowest cost abatement (in the form of Australian carbon credit units) from a wide range of sources, providing an incentive to businesses, households and landowners to proactively reduce their emissions.

Greenhouse gas emissions	Greenhouse gas emissions are gases which trap heat in the atmosphere, such as carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Greenhouse gas emissions are measured as tonnes of carbon dioxide equivalence (CO_2-e). This means that the amount of a greenhouse gas that a business emits is measured as an equivalent amount of carbon dioxide, which has a global warming potential of one.
GreenPower	GreenPower is the only voluntary government accredited program for renewable energy in Australia. A joint initiative of the governments of the Australian Capital Territory, New South Wales, South Australia, Victoria and Tasmania, GreenPower guarantees that any GreenPower-accredited energy sold by Australian energy retailers is renewably sourced.
National Greenhouse and Energy Reporting Scheme (NGER)	The National Greenhouse and Energy Reporting scheme is a single, national framework for corporations to report on greenhouse gas emissions, energy use and energy production.
Optional delivery contract	An optional delivery contract is an agreement that gives proponents the right, but not the obligation, to sell up to a nominated quantity of ACCUs to the Commonwealth at a fixed price. Under optional delivery contracts, the Clean Energy Regulator is essentially underpinning the project with project proponents retaining the flexibility to sell ACCUs on the secondary market.
Project proponent	A project proponent is an individual, a collective of individuals or an organisation with the legal responsibility for running a project under the ERF. This means they will hold the legal right to the project and will be issued any ACCUs created from project activities.
Safeguard surrender	Safeguard surrender is the statutory obligation to surrender carbon units above an entity's baseline.
Secondary market	The secondary market consists of financial institutions, traders, agents and installers, parties that are involved in the buying and selling of renewable energy certificates or ACCUs between private entities. For example, the price of an ACCU on the secondary market is the price at which private entities agree to trade ACCUs. While the Clean Energy Regulator does not intervene in the secondary market, the Clean Energy Regulator's Renewable Energy Certificate Registry facilitates transactions between parties.
Sequestration	Sequestration refers to the capture and storage of carbon dioxide. It typically refers to the absorption of carbon by ecosystems, including oceans, soils and vegetation.
Small-scale technology certificate	A renewable energy certificate created by the owner of a small-scale system, or their installer, for the electricity generated or displaced by that system. While the number of certificates that can be created per system is based on several factors, including its geographical location, installation date, and other factors, one certificate is typically equal to one megawatt hour of eligible renewable electricity.

List of acronyms and abbreviations

Abbreviation	Term
ACCU	Australian carbon credit unit
ANREU	Australian National Registry of Emissions Units
CERT	Corporate Emissions Reduction Transparency
ERF	Emissions Reduction Fund
EUA	European Union allowance unit
FID	Final Investment Decision
GW	Gigawatt
LGC	Large-scale generation certificate
LRET	Large-scale Renewable Energy Target
MW	Megawatt
NGER	National Greenhouse and Energy Reporting Act 2007
RPP	Renewable Power Percentage
RET	Renewable Energy Target
SRES	Small-scale Renewable Energy Scheme
STC	Small-scale technology certificate
STP	Small-scale technology percentage