CLIMATE COUNCIL

SEIZE THE DECADE – TECHNICAL APPENDIX

ENERGY SYSTEMS MODELLING

ONE EARTH CLIMATE MODEL 2.0

This analysis is based on the advanced version of the One Earth Climate Model (OECM 2.0). The OECM is an integrated energy assessment model, originally designed to find 1.5°C aligned decarbonisation pathways for ten world regions. OECM 2.0 merges an energy system model (EM), a transport model (TRAEM) and a power system model ([R]E 24/7) into one energy system model with independent demand and supply modules.

Sectors covered

The Global Industry Classification System (GICS) is used in the OECM 2.0 to enable the design of energy and emissions pathways for clearly defined industry sectors (sectoral pathways). The sectors covered within the model are cement, steel (including iron ore mining), aluminium (including bauxite mining), chemicals, textiles and leather, fisheries, agriculture and food processing, forestry and wood products and utilities. Commercial and residential buildings are also covered, as is transport (road, shipping and aviation) and electricity generation. Sectors that fall outside of these boundaries are categorised as 'other sectors'.

Demand module

The demand for a product (sector-specific gross domestic product (GDP) projections or market forecasts of material flows) combined with the energy intensity of production are inputs to the demand module. From this, the model estimates total energy demand. The demand module uses a bottom-up approach to estimate the energy demand for a process (e.g. steel production) or a consumer (e.g. a household) in a region (e.g. a city or country) or transport services over a period of time. One of the most important elements of this approach is the separation of the need (e.g. to get from home to work), how this need can be satisfied (e.g. with a tram), and the energy required to provide this service (e.g. electricity). This logic underpins the energy demand calculation across all sectors.

Finding pathways to reduce emissions for industry sectors requires very high technical resolution for the calculation and projection of future energy demands and the supply of electricity, (process) heat, and fuels. The energy demand calculation is broken down into the specific energy services that are required: electricity, heat (broken down into four heat levels: < 100 °C, 100–500 °C, 500–1000 °C, > 1000 °C), and fuels for processes that cannot (yet) be electrified. Synthetic fuels, such as hydrogen, are part of both the demand module, because electricity is required to produce it, and the supply module, because it is an energy source for other processes such as manufacturing.

Supply module

After the energy demand has been estimated, the supply of electricity, heat, and fuels on an annual basis was estimated. It is worth noting that in OECM 2.0, the supply does not differentiate between demand sectors. Therefore, the electricity demand for all sectors—residential, industry, and transport—is aggregated and is provided as a total value. Consequently, no specific electric generation mix for the transport sector, for example, is considered. These annual values are used in conjunction with calibrated proportions of supply technology to provide a breakdown of energy shares across the different supply technologies.

After this modelling step was completed, an additional power systems analysis – described in the following sections – was computed separately.

Power systems analysis

The power systems analysis was conducted to ensure that the electricity supply and demand is balanced throughout the year at hourly resolution, and identify possible additional infrastructure required to achieve a secure and low emissions power supply. The key technical assumptions for the power sector analysis are based on the AEMO ISP as the most detailed information source about the Australian NEM power grid.

Regions

The power systems analysis involved breaking down supply and demand (at hourly resolution) across 11 regions of Australia. The 11 regions included are: North and Far North Queensland (NQ), Central Queensland (CQ), Southern Queensland (SQ), North NSW (NNSW), Central NSW & Sydney (CNSW), Southern NSW (SNSW), Victoria (VIC), South Australia (SA), Tasmania (Tas), Northern Territory (NT), Western Australia (WA). The regions are based on AEMO's breakdown for the National Electricity Market, but the Central Queensland region was combined with the Gladstone Grid, Central New South Wales was combined with Sydney, Newcastle and Wollongong and Central South Australia was combined with South East South Australia (See map below).

NATIONAL ELECTRICITY MARKET REGIONS ASSESSED WITHIN POWER SYSTEMS ANALYSIS

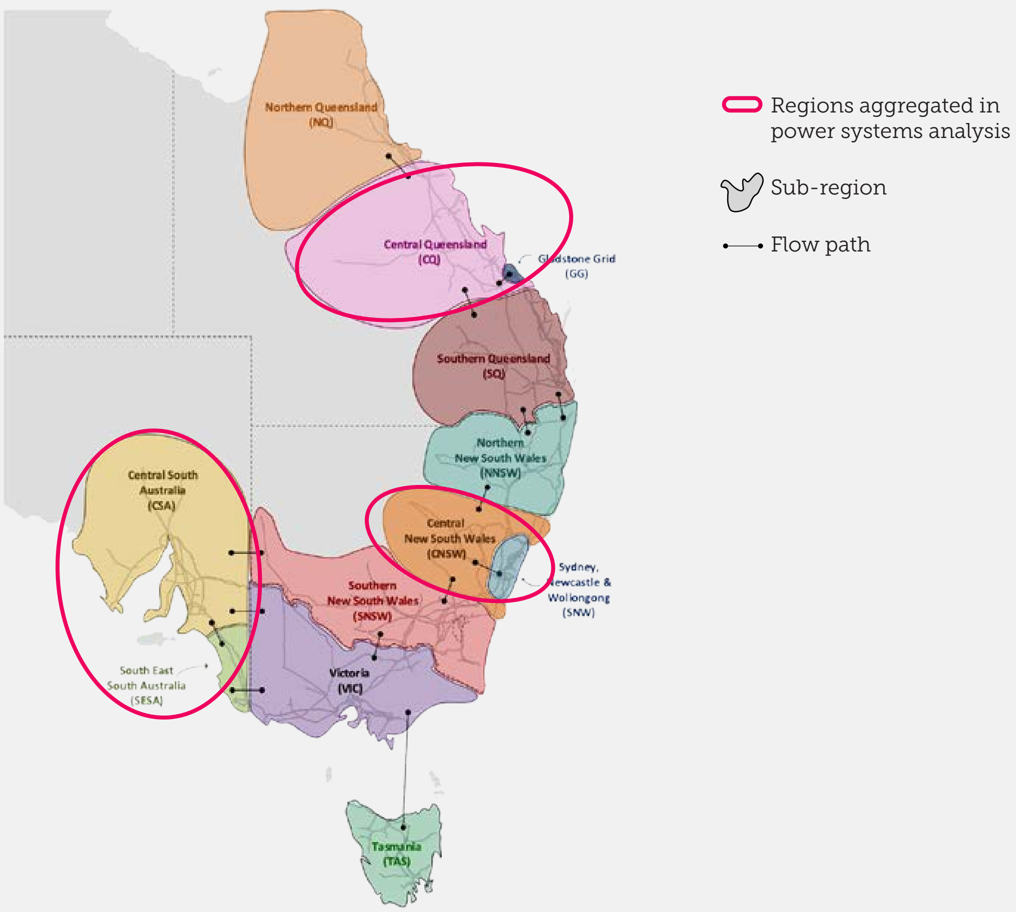

Figure 1: National Electricity Market regions assessed within power systems analysis, including necessary aggregations.

Electricity demand and synthetic load profile

The OECM power analysis model estimates the development of the future power demand and the resulting possible load curves. The model generates annual load curves with hourly resolution and the resulting annual power demands for households, industry and business and transport. The industry and transport sectors utilise a fixed load profile with demand higher during business/daylight hours and returning towards a baseload value outside these hours. These assumptions are in line with general business and industry load profiles, such that there is a high degree of constant demand from heavy industry operation and increased electricity demand in other business sectors.

The regional distribution of industry load was proportioned according to an approximation of GDP. A simple approach was used for the consideration of electrical demand related to the transport sector, such that demand across all transport types are considered in aggregate and the load profile shaped using the same logic as industry but proportioned across regions according to population.

Wind and solar energy potential mapping

GIS mapping was used to ascertain Australia's solar and wind energy resources. It was also used in the regional analysis of geographic and demographic parameters and the available infrastructure that could be leveraged in developing the scenarios. Mapping was used to allocate solar and onshore wind resources and for the demand projections for the eleven modelling regions.

Population density, access to electricity infrastructure within 10 km and economic development projections are key input parameters in a region-specific analysis of Australia's future energy situation, to clarify the requirements for additional power grid capacities and/or micro-grids. Offshore wind energy potential was also mapped for Australia.

The main data sources and assumptions made for this mapping are summarised in the table below.

Table 1: Geospatial analysis data sources.

Data	Assumptions	Source
Land use	Catchment scale land use of Australia – December 2020.	ABARES, Australian Government[1]
Digital Elevation Model (DEM)	For both solar and offshore wind analyses, any land with a slope of > 30% was excluded from all scenarios.	Multi-Error-Removed Improved-Terrain DEM[2]
Protected Areas	All protected areas designated national parks, wildlife reserves, hunting reserves, conservation areas, or buffer zones were excluded from all scenarios.	World Database on Protected Areas[3]
Electricity Transmission Lines	Solar and wind potential of areas ≤ 10 km from transmission lines was considered.	Geoscience Australia[4]
Solar Irradiance (direct normal irradiation: DNI)	The average yearly direct normal insolation/irradiation (DNI) values range from 1 to 5 MWh/m^2 per year (2.7–13.6 kWh/m2 per day).	Global Solar Atlas[5]
Wind Speeds	Wind speeds ≥ 5 m/s were considered at a height of 100 m.	Global Wind Atlas[6]

1 Catchment scale land use of Australia – December 2020: https://www.agriculture.gov.au/abares/aclump/catchment-scale-land-use-of-australia-update-december-2020

2 Multi-Error-Removed Improved-Terrain DEM: https://hydro.iis.u-tokyo.ac.jp/~yamadai/MERIT_DEM/

3 World Database on Protected Areas: https://www.protectedplanet.net/en/thematic-areas/wdpa?tab=WDPA

4 Electricity Transmission Lines: https://digital.atlas.gov.au/datasets/digitalatlas::electricity-transmission-lines/about

5 Global Solar Atlas: https://globalsolaratlas.info/map

6 Global Wind Atlas: https://globalwindatlas.info/en

As shown in the table above, for onshore wind potential, most agricultural and rural land-use classes (grazing, cropping, rural residential and agriculture, farm buildings), were included in the available land (LU) for onshore wind potential, whereas the land-use classes for nature conservation, managed resource protection, all forest land-use classes, intensive agriculture, urban/built up areas, slopes more than 30 degrees and permanent water bodies were excluded. For solar potential, most agricultural and rural land-use classes (e.g. grazing, cropping, horticulture), and some urban land-use classes (e.g. manufacturing and industrial, services, utilities) in the 'Catchment scale land use of Australia' dataset (ABARES) were included.

However, certain land-use classes (e.g. nature conservation, managed resource protection, all forest land-use classes, some urban and infrastructure land uses and water bodies) were excluded in the scenarios selected for the consideration of solar energy potential. Areas with slopes more than 30 degrees were also excluded, because installing and maintaining solar panels in steep areas is unrealistic.

The mapping procedure for offshore wind potential involved gridded bathymetry data (GEBCO_2023) for ocean depth, data on marine and coastal protected areas, and wind speed data (≥6m). Similar to [R]E Space methodology, all data were converted into suitable and non suitable areas for offshore wind. The latest data from the Digital Atlas of Australia was used to map the location of ports and its 50km radius.

Table 2: Additional data source for offshore wind geospatial analysis.

Data	Assumptions	Source
Gridded Bathymetry Data - Water depth	For offshore wind map, two scenarios are generated: areas with water depth > 50m and areas with water depth > 500m were excluded from all scenarios.	GEBCO_2023 Grid[7]
Protected Areas	All protected areas designated national parks, wildlife reserves, hunting reserves, conservation areas, or buffer zones were excluded from all scenarios.	World Database on Protected Areas
Major Maritime Ports	50km radius from ports were excluded from offshore potential areas.	Digital Atlas Australia[8]
Maritime boundaries	Australia EEZ (200NM).	Pacific Data Hub[9]
Wind Speeds	Wind speeds ≥ 6 m/s were considered at a height of 100m.	Global Wind Atlas

The estimated solar, onshore wind and offshore wind potentials – including the exclusions outlined above – are significant. The estimated potentials are:

- Solar: 11,905 GW
- Onshore wind: 2,006 GW
- Offshore wind: 5,318 GW

While this maximum capacity far exceeds the necessary capacity by 2030, the specific potential capacity by region available for potential solar, onshore and offshore wind power generation were identified, and fed into the calculations for the [R]E 24/7 model.

7 GEBCO_2023 Grid: https://www.gebco.net/data_and_products/gridded_bathymetry_data/

8 Major Maritime Ports: https://digital.atlas.gov.au/datasets/digitalatlas::major-maritime-ports/explore

9 Australia EEZ (200NM): https://pacificdata.org/data/dataset/australia-exclusive-economic-zone-200-nautical-mile/resource/6019f8eb-7da2-453e-9c58-d2c6def1f8ab

Interconnector limits

For this analysis, the current and future limits of interconnections between the defined grid regions are based on the following approximation: 500kV = 3000MW, 330kV = 1000MW, 132kV = 500MW. The carrying capacity of a powerline varies over time and is dependent on several parameters including the outside temperature, the utilisation of the line, the frequency, the physical characteristics of the line, the length of the line and power generation capacity connected to the line.

Inter-regional exchange of capacity is a function of load development and generation capacity in all nine NEM regions. The [R]E 24/7 model distributes generation capacity according to the regional load and the conditions for power generation. The locations of gas power plants are fixed and the installation of new capacities will depend on the possibility of fuel supply. Renewable power generation is more modular and can be distributed according to the load in the first place. However, as the share of renewable electricity increases, and the space available for utility-scale solar and onshore wind generation facilities and the availability and quality of local resources (such as solar radiation and/or wind speed) decrease, power might be generated further from its point of consumption. This will require more transmission capacity to exchange generation capacities between regions.

In this analysis, an increase in the necessary inter-regional exchange of capacity, in addition to the increase in grid capacity within the regions as demand increases, will start between 2025 and 2030. This will be particularly true of those regions with a high population density, high demand, and high solar and wind generation potential. The modelling assumed that between 2025 and 2030 the following interconnection changes would occur in line with AEMO's expected transmission expansion:[10]

1. Victoria – South New South Wales: Increase from 400 MW to 2069 MW
2. Victoria – Tasmania: Increase from 462MW to 1212 MW
3. Southern New South Wales – Central South Australia: New connection with 800 MW capacity.

Generation technologies, regional distribution and storage capacity

The maximum, minimum and average load in GW for the eleven regions was re-estimated for 2020, serving as a calibration for the model. The estimated values show a deviation in comparison with the published historical data of +/- 10%. Based on the re-estimated historical load and generation, the maximum load (demand), power generation and residual load was estimated for the years 2025 and 2030 with the projected electricity demand and supply development under the 'Necessary Ambition' Scenario (see table below for regional capacities in 2030).

The regional distribution of installed capacities for all power generation and storage technologies included in the analysis is based on current regional installed capacities, regional solar and wind potentials, and regional electricity demand. The significant regional differences in coal, gas and oil power generation and hydro power are based on current and projected regional installations.

10 https://aemo.com.au/-/media/files/major-publications/isp/2023/2023-transmission-expansion-options-report.pdf

Table 3: Assumed national allocation of generation capacity.

	Assumptions								
Technology	NQ	CQ	SQ	NNSW	CNSW	SNSW	Vic	SA	TAS
Mid-merit gas	2%	0%	19%	0%	17%	5%	17%	11%	3%
Photovoltaic - roof top	3%	3%	19%	4%	21%	4%	22%	9%	1%
Photovoltaic - utility scale	3%	6%	17%	5%	23%	12%	18%	8%	1%
Wind - onshore	8%	5%	14%	8%	17%	6%	22%	10%	7%
Wind - offshore	0%	0%	0%	0%	0%	0%	42%	0%	0%
CSP	0%	0%	0%	0%	12%	0%	0%	88%	0%
Battery - distributed	3%	3%	15%	5%	23%	5%	23%	11%	1%
Electric Vehicle - V2G	2%	2%	16%	3%	26%	5%	25%	7%	2%
Hydropower	2%	0%	7%	0%	3%	30%	29%	0%	28%
Geothermal	1%	77%	9%	0%	1%	0%	4%	7%	0%
Bioenergy	14%	29%	17%	2%	0%	3%	0%	2%	0%
Peaking Gas	2%	0%	19%	0%	17%	5%	17%	11%	3%
Ocean	9%	9%	9%	9%	9%	9%	9%	9%	9%
CoGen Bio	0%	25%	16%	31%	0%	0%	28%	0%	0%
CoGen Geothermal	1%	77%	9%	0%	1%	0%	4%	7%	0%
CoGen Gas	0%	0%	0%	5%	8%	45%	3%	0%	1%
CoGen Coal	0%	19%	28%	0%	45%	0%	0%	0%	0%
CoGen Lignite	0%	0%	0%	0%	0%	0%	100%	0%	0%
CoGen Oil	57%	0%	0%	0%	0%	0%	0%	14%	0%
CoGen Fuel Cell	9%	9%	9%	9%	9%	9%	9%	9%	9%
Fuel Cell	9%	9%	9%	9%	9%	9%	9%	9%	9%
Battery - utility scale	2%	3%	12%	6%	21%	10%	25%	15%	1%
Hydro Pump storage	3%	9%	28%	7%	17%	24%	0%	3%	9%
H2	0%	0%	50%	0%	0%	0%	0%	50%	0%

Finally, assumptions regarding the amount of available storage were made, based on publicly available data on potential projects, and AEMO forecasts. Notably, the storage favours a distributed approach, maximising reliability and cost-saving benefits for households. In addition, we do not assume any acceleration in pumped hydro capacity, noting the long lead time for these projects. Assumed storage capacity by 2030 is presented in Table 4.

Table 4: Assumed storage capacity available by 2030.

Storage Type	Capacity (GW)	Rationale
Distributed Batteries	25.5	In line with 2035 'Step Change', 2023 IASR workbook,
Utility Batteries	16.8	2030 Forecast, 2023 IASR workbook + Announced projects from Renew Economy Map,
Pumped Hydro	4.3	2030 forecast value, 2023 IASR workbook.
Total	**46.61**	

Note: Although values based on AEMO's 2023 IASR Assumption Workbook, the values do not match the excel file as these values were scaled to Australia wide potential.

RESULTS OF HOURLY ELECTRICITY SUPPLY ANALYSIS

The assumed capacities and locations of electricity generation and storage technologies were tested against solar and wind data from 2012, in order to produce scenarios comparable to AEMO's ISP.

The hourly analysis for 2030 demonstrated that the chosen electricity generation mix generated approximately 22% more electricity than required. Because of the very high surplus generation in times with strong conditions for wind and solar generation, curtailment still occurred, with all options for storage fully charged. In addition, periods of over and under supply were several months apart, with over supply occurring mostly during sunny periods, and under-supply occurring during winter, with lower capacity of solar and wind resources. Therefore, surplus electricity stored in batteries was not available to address all periods of under supply.

To address this supply gap, three options were considered:

1. Increased interconnection.
2. Increased demand side management.
3. Supply with gas generation.

To 2030, we do not expect further interconnection projects to be developed above and beyond the three projects anticipated by AEMO. In addition, the supply gaps were too great to be achieved with levels of demand-side management which could feasibly be implemented by 2030. As a result of these restrictions, and the fact that additional storage capacity would not cost-effectively reduce the supply gap, gas peaking generation was used to ensure reliability of electricity supply.

A total of 4,698 GWh of gas peaking generation was used to close supply gaps in 2030, increasing electricity sector emissions by 3.8 Mt CO_2e to a total of 12.7 Mt CO_2e. In future, demand for gas peaking can increasingly be reduced through increasing the availability of interconnection, and development of deep-storage projects not available by 2030. In addition, it is likely that 100% renewable hydrogen generation will be available in the early 2030s, offering a zero-emissions solution to supply during periods of extended low wind and solar resources.

Climate Council analysis

Climate Council has synthesised outputs of the ISF energy systems modelling alongside the Australian Government's emission projections to present a comprehensive pathway to a 75% reduction in emissions by 2030, below 2005 levels. In alignment with the policy levers proposed in this report, we have presented Climate Council's plan for the following five sectors:

Table 5: How Climate Council's plan maps to Australian Government emissions reporting sectors.

Sector	Mapping to Australian Government sectors[11]
How we power ourselves	Electricity
How we make things	Stationary energy (excluding energy used by buildings)[12] Industrial processes and product use Fugitive emissions
How we move around	Transport
How we care for land	Agriculture Land use, land use change and forestry, Waste
How we build things	Stationary energy used by buildings

11 Sectors based on DCCEEW (2023).

12 While building energy usage is typically considered in stationary energy, it is considered separately in this report due to the distinct policy solutions required to decarbonise homes and workplaces.

POWERING OURSELVES WITH RENEWABLE ELECTRICITY BACKED BY STORAGE

MODELLING APPROACH

Potential emissions reductions by 2030 are based on changes to the supply and demand of electricity, as modelled by ISF. As described above, the scenario leveraged sought to maximise decentralised storage and generation opportunities, close all coal fired power plants by 2030, and minimise other fossil fuel power generation where possible.

KEY ASSUMPTIONS USED IN REPORTING

In presenting the potential changes, the following assumptions were made.

Table 6: Assumptions used in reporting for the electricity sector.

Assumption	Value	Source
Average household solar PV capacity:	6 kW	Approximate average SGU solar installation size, based on Clean Energy Regulator in-stallation data.
Average household battery size	10 kW	Reported as typical household battery size by Victorian Department of Energy, Environment and Climate Action.
Average community battery size	750 kW	Illustrative assumption, based on range of 100 kW to 5 MW cited by DEECA (see above).
Utility scale storage capacity (or other dispatchable renewable ca-pacity) underwritten by Capacity Investment Scheme	7.9 GW	DCCEEW, About the Capacity Investment Scheme.
Renewable generation capacity underwritten by Capacity Investment Scheme	23 GW	DCCEEW, About the Capacity Investment Scheme.
Capacity of committed but not yet commissioned utility scale renewable energy generation projects	12.8 GW	Clean Energy Council Project Tracker, as of December 2023.
Capacity of committed but not yet commissioned utility scale battery storage projects	7.2 GW	Clean Energy Council Project Tracker, as of December 2023.
Capacity of pumped hydro storage available by 2030	4.3 GW	Snowy 2.0, Borumba and Kidston all expected to be ready by 2030, in line with AEMO's Draft 2024 ISP.

Note: These assumptions are not inputs or outputs of the ISF modelling, but are made for the purpose of drawing illustrative statements only.

ELECTRIFYING INDUSTRY AND SWITCHING TO ZERO-EMISSION FUELS

POTENTIAL EMISSIONS REDUCTIONS BY 2030 ARE BASED ON SEVERAL SOURCES:

Stationary energy emissions are based on ISF modelling results. The modelling considers increased energy efficiency, switching to zero-emission fuels (such as biofuels, geothermal and small amounts of hydrogen), and electrification where possible.

Fugitive emissions are based on 2023 emissions projections, with the addition of two key policies targeting reductions in coal mine fugitive emissions.

Firstly, it is assumed that no new coal mine projects or extensions to existing mines are approved, from the time of writing. Potential future coal mining projects are sourced from the Office of the Chief Economist's 2023 *Resources and energy major projects* dataset. A total of 26 projects at the committed, definitive feasibility or publicly announced stage and expected to be developed by 2030 were considered. Collectively, these projects represent an annual production of 180 million tonnes of coal, or a total of 32% of forecast run-of-mine coal production in 2030.[13]

The potential annual fugitive emissions associated with this production was estimated by applying the historic average emissions per million tonnes of coal production, which in 2020 was 0.05 Mt CO_2e per million tonnes of run-of-mine production (DCCEEW, 2023). As the on-site reductions made due to the Safeguard Mechanism are expected to reduce the average fugitive emissions intensity of coal mining by 2030, this reduction was also applied proportionally to the potential emissions of new coal mines.

Secondly, the overall fugitive emissions intensity of coal mining is assumed to decrease, with a mandated emissions intensity standard applied to all coal mines. In practice, the specific settings of this policy should be subject to detailed design, including an orderly phase-in which provides the opportunity for operators to either invest appropriately to reduce their emissions, or wind down operations.

For the purpose of this report, the impact of such a standard was considered for Australia's six gassiest coal mines still expected to be operating in 2030, with production and current emissions data sourced from Ember (2022) The potential emissions reduction was estimated on the basis of these mines reducing their emissions intensity to the 2020 average noted above (0.05 Mt CO_2e per million tonnes of million tonnes of run-of-mine production). As demonstrated in the table below, applying such a standard to these 6 mines could reduce their annual fugitive emissions by over 9 Mt.

Industrial processes and product use are not considered under the ISF energy systems analysis, nor considered a key focus of any proposed policies. Process emissions from steel, aluminium and cement are covered under the Safeguard Mechanism. As such, this report presents the anticipated 2030 industrial processes and product use emissions from DCCEEW (2023) unchanged.

13 Projected 2030 run-of-mine coal production is based on DCCEEW (2023, p. 60).

Table 7: Impact of tighter emissions standards on Australia's six gassiest coal mines.

			Emissions (Mt CO_2e)		
Coal Mine	**Location**	**2019-20 production** (million tonnes of coal)	**2019-20**	**2019-20 emissions under industry average intensity**	**Potential emissions reduction**
Appin	NSW	3.0	2.2	0.2	2.0
Tahmoor	NSW	1.8	1.2	0.1	1.1
Metropolitan	NSW	1.3	0.5	0.1	0.5
Moranbah	QLD	6.3	2.3	0.3	2.0
Capcoal	QLD	8.5	3.2	0.5	2.7
Grosvenor	QLD	3.5	1.2	0.2	1.0
Total		**24.4**	**10.6**	**1.4**	**9.3**

USING SHARED. ACTIVE AND ELECTRIC TRANSPORT TO GET AROUND AND MOVE FREIGHT

Transport emissions from road transport,aviation and shipping were analysed by ISF, as described above. Key changes considered to 2030 include mode-shift to shared and active transport, uptake of electric vehicles, and limited uptake of sustainable fuels (such as in aviation). Demand for electricity, fossil fuels and sustainable fuels is accounted for within the integrated ISF model.

Mode-shift estimates in this report are produced under the assumption that without intervention, each mode of transport will continue to grow in-line with its annual pre-covid growth rate, which were derived from BITRE (2023). Mode-shift estimates were then derived by comparing projected passenger kilometres travelled under business-as-usual to ISF modelling assumptions.

Rail transport emissions are not accounted for in ISF's modelling. However, it is anticipated that shifts from other modes to less emissions-intensive passenger and freight rail would occur. In order to estimate this impact, emissions are assumed to grow in-line with the demand for freight and passenger rail.

As passenger rail travel is primarily electrified and therefore significantly less emissions intensive than freight rail, emissions for each type of rail transport is considered separately.[14] To achieve this separation, aggregate rail emissions data for 2020 from DCCEEW was split into separate passenger and freight emissions estimates based on RISSB (2022). Emissions estimates for freight rail and passenger rail in 2020 were then compared against 2020 total freight tonne kilometres and passenger kilometres respectively, producing an estimate of emissions per kilometre. This parameter was then applied to ISF's rail demand forecasts for 2030, resulting in an increase of 0.6 Mt for passenger rail and 3.6 Mt for freight rail.

14 While there are also emissions associated with the generation of electricity used by rail freight, this is accounted for under the "How we power ourselves" section.

PROTECTING AND RESTORING OUR LANDSCAPES

ASSUMPTIONS FOR AGRICULTURE

For the agriculture sector, the Climate Council used the same assumptions around emissions reductions and adoption rates in the Net Zero Australia study, described in the Net Zero Australia Methods, Assumptions Scenarios and Sensitivities (MASS) report. We used the results for 2030. Results for 2030 indicate only a modest reduction in emissions, from 80 Mt CO_2e in 2030 in the BAU projections to 75.6 Mt CO_2e with mitigation measures. Note, emissions from agriculture regularly fluctuate on a seasonal and annual basis, and can reduce significantly following droughts in particular. Emissions from agriculture in 2021 were 74 Mt CO_2e, implying that reaching around 75 Mt CO_2e per year by 2030 is highly achievable. The difference about the target for 2030 is that this must be a sustainable reduction, and must further decline in the following years.

The key assumptions of this work are outlined in Table 8. The logic behind the assumptions is that there will be pressure from the supply chain to reduce emissions, especially export-focused companies and industry bodies, many of which have set targets for carbon neutrality. It is also assumed that there will be some level of incentives from the federal government (e.g. through the Emission Reduction Fund ACCU scheme). From this, the Net Zero Australia study attempted to make plausible assumptions around the potential emissions reductions and adoption of existing technologies (such as precision fertiliser management, covered anaerobic ponds and feed additives) and emerging technologies such as vaccines to inhibit methane emissions, which are expected to be available in the near future. It is assumed production of crops and herd numbers remain constant out to 2050, and no further policies are implemented to encourage farmers to reduce emissions.

Table 8: Assumptions around uptake of solutions and potential emissions reductions within the agriculture sector.

	2030
Dairy	
Enteric fermentation	50% reduction in 50% of herd
Manure management	100% reduction, 32% adoption rate
Slow release fertilisers	40% reduction, 70% adoption rate
Pasture fed beef	
Enteric fermentation	40% reduction in 1% of beef herd
Feedlot	
Enteric fermentation	80% reduction in 70% of herd
Manure management	100% reduction, 32% adoption rate
Sheep	
Enteric fermentation	40% reduction in 1% of flock
Swine	
Manure management	100% reduction, 32% adoption rate
Poultry	
Manure management	100% reduction, 32% adoption rate
Cotton	
Slow-release fertiliser	40% reduction, 70% adoption rate
Sugar cane	
Slow-release fertiliser	40% reduction, 70% adoption rate

ASSUMPTIONS FOR REDUCING EMISSIONS FROM LAND CLEARING

Total emissions from land clearing in 2020-2021 were around 27 Mt CO_2e. The current 2023 emissions projections show these emissions growing to around 35 Mt CO_2e by 2030 (see Figure 2). Emissions from land clearing can be broken down into primary land clearing (of remnant vegetation), secondary land clearing (regrowth of land that has been cleared previously) and other (all other emissions on lands with a history of clearing). When land is observed as cleared by the National Inventory System, that land stays in the 'land clearing' classification for 50 years (unless a forest regrows). Emissions from the ongoing decay of the cleared forests 'bleed' into future years and keep getting reported in the 'other' classification. Direct emissions from primary land clearing accounted for around 5 Mt CO_2e in 2020-21. Direct emissions from secondary clearing accounted for around 7 Mt CO_2e and emissions from previously cleared land accounted for around 15 Mt CO_2e. By 2030 we assume a minimum of around 5 Mt CO_2e could be avoided through enhanced regulations and an improved protected area network focused on preserving old growth, remnant and high conservation and mitigation value forests. Old growth forests are more important than younger and recovering forests from a biodiversity and climate perspective.

The estimate of 5 Mt CO_2e does not include the sequestration capacity associated with protecting these forests and bushlands, and does not account for the natural decline in emissions from high historical rates of clearing that occurs over time. Hence, whilst only an estimate, the figure is highly conservative.

For land clearing to be controlled over the long term, long-term policy certainty from state and federal governments is needed, and more resources need to be allocated to encouraging, supporting and enforcing compliance with vegetation laws.

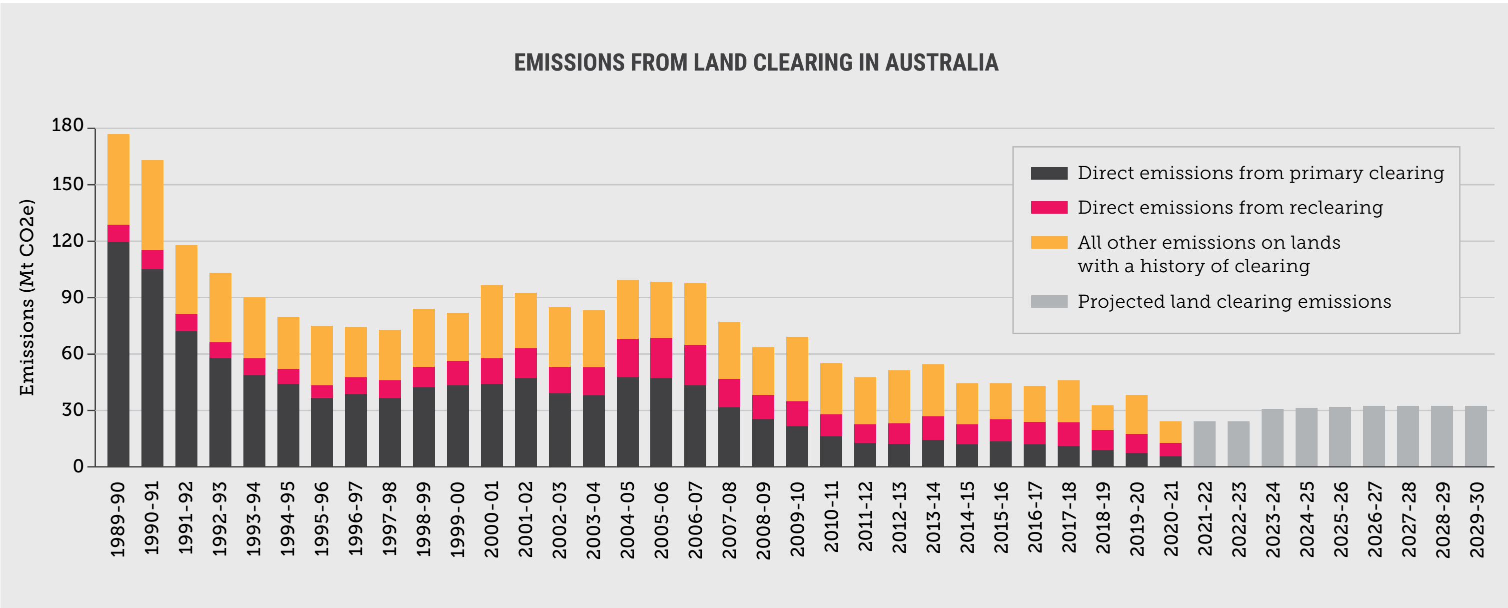

Figure 2: Disaggregated emissions and removals associated with forest conversions (historical) and future projected emissions from land clearing based on the Government's 2023 emissions projections.

ASSUMPTIONS FOR REDUCING EMISSIONS FROM NATIVE FOREST LOGGING

In Australia's National Greenhouse Accounts, native forest logging is separated from other forms of land clearing, and is accounted for under the category of 'forests'. Australia does net accounting and reporting of native forest logging, which means that the direct emissions from logging, and the reduction in sequestration potential are not explicitly reported, masking the mitigation benefits of forest protection. Harvested native forests are reported as a net sink because the emissions from the relatively smaller areas that are logged each year are swamped by emissions removals from the much larger areas of managed forest that are not logged that year. A paper published in 2011 using Fullcam modelling estimated that net emissions from native forest logging were around 26 Mt CO_2e. But native forest logging has declined significantly since this time (Macintosh 2011). Reports by the Tree Projects suggest that the direct emissions from native forest logging in Tasmania, Victoria and NSW were around 11 Mt CO_2e in recent years (based on five year averages) (The Tree Projects 2022a, 2022b, 2022c).

Going forward, given the only jurisdictions with continued native forest logging are NSW, TAS and QLD, and QLD is scheduled to wind back logging on public land, a conservative estimate based on the opinion of experts we consulted is that 6-7 Mt CO_2e per year could be avoided over the next 20 years by ending native forest logging. This estimate accounts for the drop in sustainable yield in both Tasmania and NSW due to the reduction in the available resource (due to past over harvesting, fires and the shifting of state forests into reserves). It must be noted that this is a highly conservative figure, as it does not take into account loss of soil carbon and underground carbon (tree roots), which can account for 25-50% of overall forest carbon.

LIVING AND WORKING IN BUILDINGS THAT ARE ELECTRIFIED AND EFFICIENT

For the purposes of this report, the building emissions were disaggregated from stationary energy using emissions data from the Australian Government 2023 projection for current and projected 2030 emissions. ISF modelled emission reductions for buildings are based on increasing energy efficiency and electrification of fossil gas appliances where possible.

The modelling also accounted for the expected increase in total building floor area to 2030, using ABS data on the average floor area for new builds and size of the current dwelling stock, projected to 2030 using the NCC 2022 Regulatory Impact Statement new dwelling forecasts (p. 239).

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