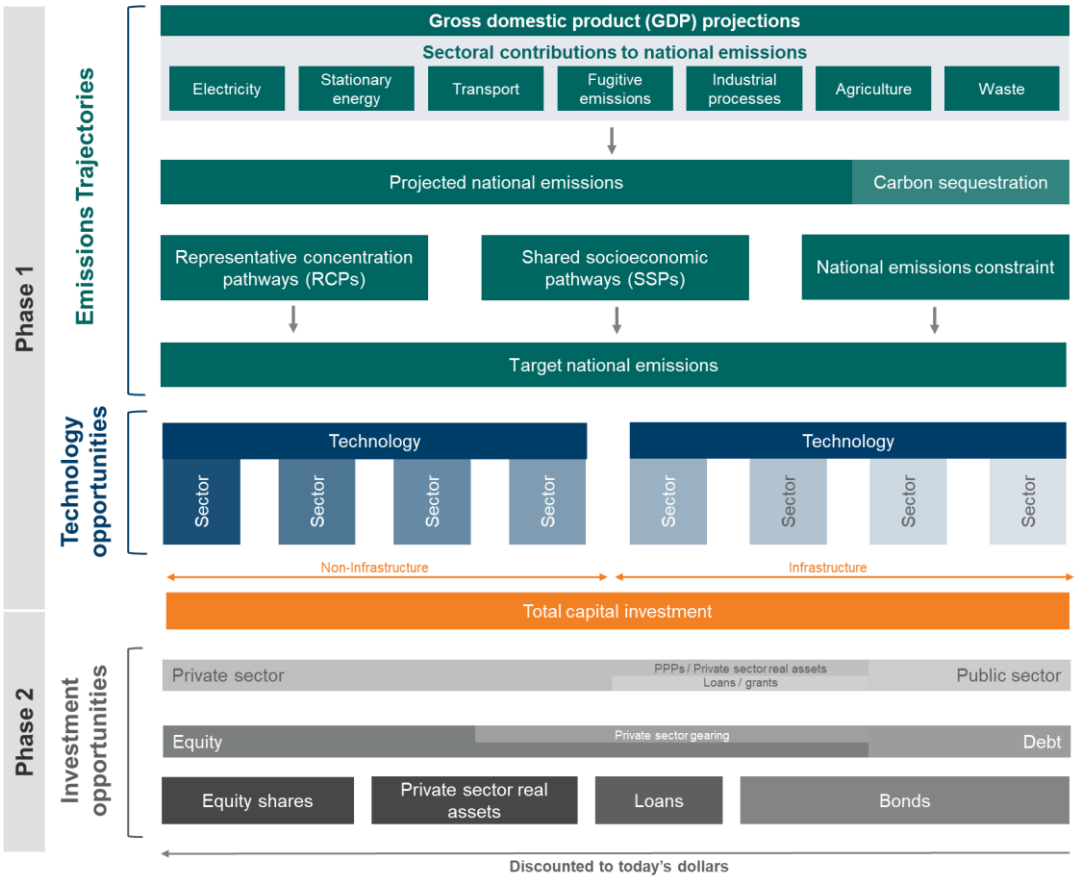
Investment opportunities: Model overview and assumptions

Our modelling was conducted in two phases and was prepared using information in the public domain and our own intellectual property. In the first phase, we established economy-wide, annual abatement requirements in each economic sector to meet the emissions constraints set by the Orderly and Hothouse scenarios to 2050. We then developed granular investment estimates for those abatement opportunities which take place within Australia, have scale potential, and involve additional expenditure rather than a reallocation of business as usual (BAU) spending. In the second phase we allocated these investment opportunities into asset classes.

The two phases of the modelling process are illustrated below.



In Phase 1 we utilised Energetics' proprietary model of Australia's emissions from 2020 to 2050. The model is built on the relationships between sectoral emissions and measures of economic activity in sectors,[1] derived from data since 1990. Its key principles are:

- Business as usual (BAU) improvements are captured by the relationships derived from historical data. These BAU trends have captured a range of significant disruptions such as the global financial crisis of 2008, the imposition and removal of the carbon tax, the rise of

[1] GDP and transport emissions, value added by the commercial sector and emissions for the commercial sector, etc.

renewable power generation at rooftop and utility scale, as well as the emergence to LED lighting.
- Decarbonisation of power generation is driven by the closure of aging coal-fired power stations and their replacement with generation and storage capacity informed by the Australian Energy Market Operator's (AEMO) 2020 Integrated System Plan scenarios.
- Major technological disruptions, which are those that are considered to be more disruptive than events captured in the BAU trends, are applied according to a cost-based merit order adapted to the narrative of the decarbonisation scenario.

Energetics' merit order has been constructed through extensive analysis of research literature as well as our own experience, and accounts for both current and emerging technologies.

As this analysis was from the perspective of Australian institutional investors, technologies were prioritised based on two criteria: 1) that they were additional and 2) could be deployed at scale.

Once the abatement was accounted for by technology and sector, the capital investments considered in the analysis were screened using an additional criterion: that the investments were in Australia.

Once estimates of the total funding requirement for each scenario were determined, in Phase 2 we allocated the total quantum of required funding to asset classes by making several assumptions informed by our research, which included:

- The share of public and private sector spending on infrastructure projects
- The level of corporate gearing across industry sectors
- The share of bond finance in corporate total debt
- The share of real asset ownership in institutional investor equity allocations
- Discount rates which reflect the perspective, risk environment and risk appetite of the investment markets in each scenario.

Each asset class assumption was dynamic across the time period of analysis, as the diverging track records of technologies and changing risk profiles of each scenario were assumed to either increase or decrease the initial assumptions over time.

One example of this is estimating project capital structures over time. We assumed that new technologies in sectors would initially be funded at lower levels of gearing than the balance sheets of established companies in those sectors. This reflects the higher risk of new technologies and ventures. Over time we assumed that, as technologies matured, they were funded with more debt and less equity. In the Orderly scenario, technologies in each sector would be geared at higher levels as time went on, eventually achieving today's sector corporate gearing levels at the end of the analysis period. As the Hothouse scenario is characterised by less certainty overall and less clean technology deployment, it was assumed that levels of debt in the capital structures of all sectors started lower and finished lower than in the Orderly scenario. To avoid double-counting, refinancing was not considered in the analysis.

The assumed increase in regulatory and policy uncertainty of the Hothouse scenario was reflected in the discount rate, which incorporated a higher weighting to the cost of equity and included an additive premium to both the cost of equity and debt of three per cent.

The following pages outline Energetics' modelling input sources.

Modelling input sources

The following are the modelling inputs sourced from publicly available information that were used in completing the analysis. Other inputs also formed the basis of the modelling undertaken but were developed through a combination of publicly available information and Energetics analysis based on multiple sources, industry knowledge and current projects. These inputs are proprietary information of Energetics and are not included here.

Description	Value	Unit	Source
Carbon sequestration			
Average sequestration rate of terrestrial or other biological carbon sequestration projects	15	tCO2 per ha per yr	CSIRO - ***https://publications.csiro.au/rpr/download?pid=csiro:EP113280&dsid=DS6***
Cost to develop carbon sequestration projects	1,000	$ per ha	
Transport			
Net Zero Emissions scenario: upstream and midstream capex costs for Hydrogen technologies using PEM – 2025	1.41	$ per kg H2	Deloitte – ***https://www2.deloitte.com/content/dam/Deloitte/au/Documents/future-of-cities/deloitte-au-australian-global-hydrogen-demand-growth-scenario-analysis-091219.pdf***
Net Zero Emissions scenario: upstream and midstream capex costs for Hydrogen technologies using PEM – 2030	1.17	$ per kgH2	
Hothouse scenario: upstream and midstream capex costs for Hydrogen technologies using PEM – 2025	1.48	$ per kgH2	

Description	Value	Unit	Source
Hothouse scenario: Capex upstream and midstream capex costs for Hydrogen technologies using PEM – 2030	1.29	$ per kgH2	Deloitte – ***https://www2.deloitte.com/content/dam/Deloitte/au/Documents/future-of-cities/deloitte-au-australian-global-hydrogen-demand-growth-scenario-analysis-091219.pdf***
EV market penetration saturation year	2040		ARENA - ***https://arena.gov.au/assets/2018/06/australian-ev-market-study-report.pdf***
Level 2 charger infrastructure costs per unit	USD10,000	$ (2014)	
Direct current fast charger infrastructure costs per unit	USD80,000	$ (2014)	
Energy content of hydrogen	120	GJ per tonne	Deloitte - ***https://www2.deloitte.com/content/dam/Deloitte/au/Documents/future-of-cities/deloitte-au-australian-global-hydrogen-demand-growth-scenario-analysis-091219.pdf***
Energy content of biodiesel	34.6	GJ per kL	Clean Energy Regulator - ***http://www.cleanenergyregulator.gov.au/NGER/Legislation/Measurement-Determination***
Energy content of bioethanol	23.4	GJ per kL	
Capex for biodiesel plants	0.44	$AUD per L (2008)	International Institute for Sustainable Development - ***https://www.iisd.org/system/files/publications/biofuels_subsidies_aus.pdf***
Capex for bioethanol plants	0.85	$AUD per L (2008)	
Ratio of Australian bioethanol production to biodiesel production - 2019	4.4	Times	ARENA - ***https://arena.gov.au/assets/2019/11/biofuels-and-transport-an-australian-opportunity.pdf***

Description	Value	Unit	Source
Agriculture			
Cost of methanogenic vaccinations per head of cattle – 2028	4.5	$ per dose	Meat and Livestock Australia ***https://www.mla.com.au/research-and-development/search-rd-reports/final-report-details/Greenhouse-gas-mitigation-potential-of-the-Australian-red-meat-production-and-processing-sectors/3726***
Cost of methanogenic vaccinations per head of sheep – 2028	2	$ per dose	
Cost of feed supplements to reduce methane per head of cattle – 2025	54.75	$ per head	
Cost of feed supplements to reduce methane per head of sheep – 2025	10.95	$ per head	
Cost of slow release supplements to reduce methane per head of cattle – 2030	18	$ per head	
Cost of slow release supplements to reduce methane per head of cattle – 2030	4.5	$ per head	
Head count of cattle	25	Million head	
Head count sheep	75	Million head	
Commercial Property			
Average commercial solar system prices	1	$ per Watt	Solar Choice - ***https://www.solarchoice.net.au/commercial-solar-power-system-prices***

Description	Value	Unit	Source
Mining and Metals			
Capex of a single ventilation air methane (VAM) plant (capex average of three types of technologies)	12,978,900	$AUD (2004)	CSIRO - ***https://www.globalmethane.org/documents/events_coal_20060522_csiro.pdf***
Average percentage of VAM emissions as a percent of total underground coal mine emissions	64	%	
Volume flowrate of methane air emissions from an underground QLD coal mine used to size and cost VAM equipment	32,433,515	m3 per yr	
Methane density at 28^{o}C	0.000642	t per m3	Nist WebBook - ***https://webbook.nist.gov/cgi/fluid.cgi?ID=C74828&Action=Page***
Electricity			
National electricity market (NEM) electricity as a percentage of total national electricity generation	85.6	%	ARENA - ***https://arena.gov.au/assets/2017/02/CSIRO-Electricity-market-analysis-for-IGEG.pdf***
CAPEX for electricity infrastructure	Various	$ (2019)	AEMO - ***https://aemo.com.au/energy-systems/major-publications/integrated-system-plan-isp/2020-integrated-system-plan-isp***

Description	Value	Unit	Source
Manufacturing			
Capex costs for abating nitrous oxide emissions during nitric acid production with the use of a catalyst	EUR657	€ million per year (2009)	McKinsey - ***https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/Sustainability/cost%20curve%20PDFs/Pathways_lowcarbon_economy_Version2.ashx***
Total cost of SaskPower's Shand CCS retrofit with life extension	USD986	$ million per year (2018)	CCS Knowledge - ***https://ccsknowledge.com/pub/documents/publications/Shand%20CCS%20Feasibility%20Study%20Public%20_Full%20Report_NOV2018.pdf***
Capex costs for anaerobic digesters in industrial process heating applications	5.1	$ per million W	ARENA - ***https://arena.gov.au/assets/2019/11/appendices-renewable-energy-options-for-industrial-process-heat.pdf***
General			
Rate of inflation	2	% per annum	Selected value, bottom of the Reserve Bank of Australia's target inflation range
Euro to AUD conversion rate	0.6	AUD c / EUR	Selected rate based on historical movements
USD to AUD conversion rate	0.7	AUD c / USD	Selected rate based on historical movements
Orderly scenario discount rate	6.8	%	Energetics analysis, utilising the Capital Asset Pricing Model and Weighted Average Cost of Capital methodologies and varied according to scenario funding flows to sectors
Hothouse scenario discount rate	9.9	%	

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