October 2020.

Climate Change Resilience Report.

about this report.

This Climate Change Resilience Report is prepared in consideration of the Financial Stability Board's Task Force Recommendations for Climate-related Disclosures (TCFD) and should be read in conjunction with other recent APA Group public disclosures. It builds on our experience and learnings from APA Group's Climate Scenario Analysis conducted in FY2019, as described in APA Group's FY2019 Sustainability Report.

The updated analysis that informs this report was undertaken by APA Group, supported by an expert third party, Energetics Pty Ltd.

Energetics is a specialist climate risk and resilience management consultancy, advising ASX200 companies across all sectors of the economy and all tiers of government. Using a proven approach, Energetics engages with the vast resources of Australian climate science to help clients understand both the physical and transition challenges arising from the changing climate. Energetics advises on strategic responses, adaptation pathways and emerging opportunities for new products, services and investments.

Energetics undertook all external analysis associated with preparing the scenarios we have used. Analysis of the potential financial impacts on the asset portfolio and on financial statement disclosures was completed by APA Group.

The financial assessment contained in this report assumes business as usual within the existing asset portfolio, with no strategic acquisitions or decisions made by APA Group during the period.

Important Information

Boundary and Scope

APA Group (APA) comprises two registered investment schemes – Australian Pipeline Trust (APT) and APT Investment Trust (APTIT) – and their controlled entities.

This report relates to APA Group's wholly owned and operated assets; assets with an equity interest where APA maintains operational control and the operational aspects of non-APA assets where we maintained operational control as at the date of this report.

Statements about the future

The report contains forward-looking statements. Such forward-looking statements are based on the information available as at the date of this report and are made with the best intentions, but they are not statements of fact or a preferred view of the future. APA Group recognises that the future involves known and unknown risks and uncertainties, many beyond our control.

contents.

This may cause actual results to differ materially from these statements. As such, readers are cautioned against reliance on forward-looking statements.

The report analyses climate-related risks under three divergent climate scenarios for 2020-2050 and the risks that are foreseeably relevant to maintaining the resilience of APA Group's existing portfolio (at the time of analysis) under each scenario.

Scenarios are neither predictions nor forecasts but are useful for providing a view of the implications of developments and actions. Readers should be aware that scenarios do not constitute definitive outcomes for us. Scenario analysis relies on assumptions that may or may not be, or prove to be, correct and may or may not eventuate, and scenarios may be impacted by additional factors to the assumptions disclosed.

Except as required by applicable regulations or by law, APA Group assumes no obligation to update this report, including with respect to any forward-looking statements or scenario analysis contained within it.

Cover and Contents: Darling Downs Solar Farm, Queensland. Back Cover: Badgingarra Wind Farm, Western Australia.

highlights.

APA's current asset portfolio remains robust under all scenarios – including the 1.5°C scenario - with the portfolio benefiting from contracts currently in place.

Compared to the Net Present Value (NPV)[1] of cash flows from APA's Carrying Value Case (CVC)[2]:

- Whilst the 1.5°C demand scenario results in somewhat reduced revenues from 2040 there is no impairment[3] impact on the APA asset portfolio
- the 2-3°C scenario has an immaterial impact
- the >4°C scenario leads to a positive impact.

By FY2040, if the 1.5°C scenario pathway were to eventuate, revenue would be somewhat reduced when compared to revenue forecast under APA's CVC.

Under the 2-3°C and >4°C scenarios, revenue impact is more gradual, with most revenue changes occurring in the decade leading to FY2050.

All three scenarios present diversification opportunities for APA into electricity technologies and infrastructure.

Under all modelled outcomes, there is no impairment[4] impact on the APA asset portfolio.

1. Assessment based on discounting ungeared pre-tax cash flows by the pre-tax discount rate disclosed in the FY2020 Financial Statements Note 13.
2. Forecast of revenue and costs associated with APA's existing asset portfolio as at FY2020. This case has been used to assess asset impairment as detailed in FY2020 Financial Statements Note 13. For the purpose of this report and analysis, this case is used as the baseline case to test resilience. The CVC assumes business as usual within the existing asset portfolio with no strategic acquisitions or decisions made by APA during the period, including maintaining a consistent asset footprint and cost base throughout.
3. Further information on CVC and impairment analysis can be found in the FY2020 Financial Statements Note 13.
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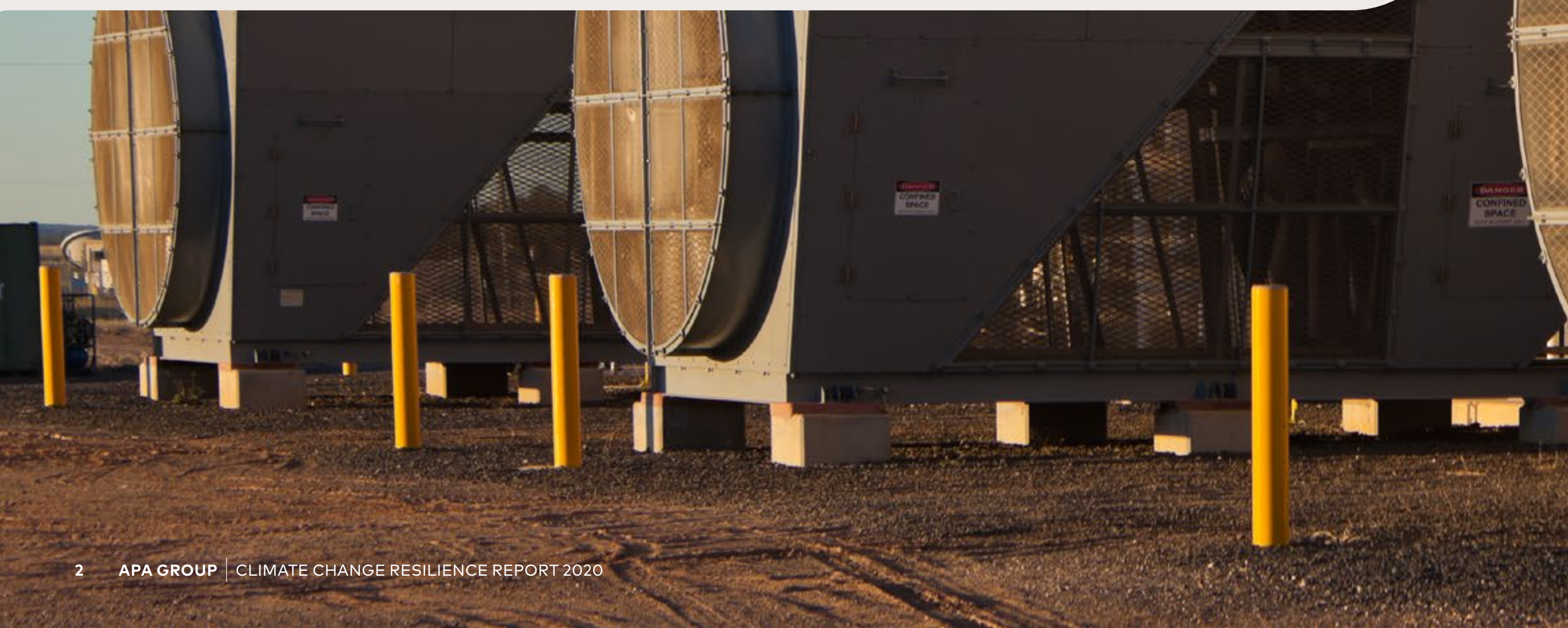


Wallumbilla Compressor Station, Queensland.

statement from CEO.

As our strategy continues to evolve, we are taking clear, thoughtful and deliberate steps to understand and respond to the challenges and opportunities presented to our business.

Rob Wheals | CEO & Managing Director

Australia is at an important juncture as we come to terms with a rapid succession of generation-changing socioeconomic, environmental and health challenges and the corresponding opportunities. Expectations that business, particularly the energy sector, will meet these challenges and deliver on community expectations is at an all-time high, and we all have a role to play.

APA's Purpose is to strengthen communities though responsible energy. This means doing the right thing, creating value for all stakeholders, taking a long-term view, investing in new technologies and new energy, and innovating for a sustainable future.

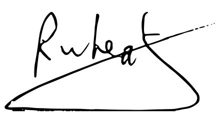
As our strategy continues to evolve, we are taking clear, thoughtful and deliberate steps to understand and respond to the challenges and opportunities presented to our business by climate change. This Climate Change Resilience Report represents an important step by disclosing some of the work we have been doing to test our existing portfolio under a range of climate transition scenarios, including a 1.5°C pathway.

That our quality portfolio of assets remains robust under all scenarios - including the 1.5°C pathway - demonstrates the strength of our current business. The analysis also indicates a number of opportunities and risks for us to consider as we continue to evolve our strategy.

In addition to considering these insights in our strategy and planning processes, we are taking steps to embed consideration of climate change across our business. These efforts will be guided by a Climate Change Management Plan and Policy to be finalised later this year.

Our progress will continue to be disclosed in accordance with the Financial Stability Board's Task Force Recommendations for Climate-related Financial Disclosures (TCFD).

Feedback on this report is welcome. Please contact us at: sustainability@apa.com.au



Rob Wheals
CEO & Managing Director

Diamantina Power Station, Mount Isa, Queensland.

introduction.

This report represents a step change in APA's climate change disclosure.

As APA's first stand-alone Climate Change Resilience Report, this report represents a step change in our climate change disclosure. This progression reflects a growing maturity in APA's understanding of, and response to, the complexity of this important societal issue.

In FY2018, APA committed to disclosing in alignment with the Financial Stability Board's Task Force Recommendations on Climate-related Financial Disclosures (TCFD).

In our FY2019 Sustainability Report, we communicated our approach against the four TCFD core elements.

For FY2020, we have taken the significant step of producing this additional report, which:

- provides an overview of the findings of our most recent climate transition scenario analysis, including opportunities and strengths, weaknesses and threats
- models the impact of different climate change scenarios on APA's revenues and Net Present Value (NPV)[5] to assess current asset portfolio resilience through to 2050
- indicates the scenario outcomes that will be taken into account in our longer-term ongoing corporate strategy and planning processes
- describes the signposts we intend to monitor so APA can be positioned to take advantage of any opportunities arising from the world's low-carbon energy transition and similarly manage risks.

Embedding consideration for climate change

APA is in the process of developing a Climate Change Management Plan. This plan will establish the framework for embedding consideration of climate change – and the insights, risks and opportunities identified in this report – in our organisational governance, strategy, and planning processes.

The plan will identify targets, metrics and management controls to guide performance and further enhance governance and risk management processes. Advancing our physical climate risk assessment will be another key deliverable.

To fulfil APA's commitment to disclosing in accordance with the TCFD, we will publish and provide updates on key aspects of the plan as we adopt them.

Governance
The organisation's governance around climate-related risks and opportunities.

Strategy
The actual and potential impacts of climate-related risks and opportunities on the organisation's businesses, strategy, and financial planning

Risk Management
The processes used by the organisation to identify, assess, and manage climate-related risks

Metrics and Targets
The metrics and targets used to assess and manage relevant climate-related risks and opportunities.

Figure 1 – Core elements of the Recommended Climate-related Financial Disclosures. Adapted from The Final Report: Recommendations of the Task Force on Climate-related Financial Disclosures (https://www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-2017-TCFD-Report-11052018.pdf)

5. Assessment based on discounting ungeared pre-tax cash flows by the pre-tax discount rate disclosed in the FY2020 Financial Statements Note 13.

APA's current asset portfolio remains robust under all scenarios – including the 1.5°C scenario - with the portfolio benefiting from contracts currently in place.

John Smith, Supervisor Field Operations, Victoria.

About APA

In addition to being Australia's largest natural gas infrastructure business, APA is also currently Australia's 6th largest owner of renewable energy power generation[6] and 54% of our power generation capacity comes from renewable sources.

APA is a leading developer, owner and operator of Australian energy infrastructure. We own and/or operate around $22 billion of energy infrastructure assets across Australia and operate them with a skilled workforce of around 1,900 people.

We have a diverse portfolio of over 15,000 kilometres[7] of natural gas transmission pipelines that span every state and territory on mainland Australia and deliver about half the nation's natural gas.

We also own, or have interests in, related energy infrastructure assets such as gas storage facilities, gas processing facilities, gas compression facilities, electricity transmission and renewable and gas fired power generation assets.

APA is currently Australia's 6th largest owner of renewable energy generation[8], with 54% of our power generation portfolio capacity coming from renewable energies.

Purpose:

We strengthen communities through **responsible energy.**

6. https://www.bnef.com/core/country-profiles/aus. Ranking of 6th at the time of writing (September 2020)
7. Owned and/or operated by APA.
8. https://www.bnef.com/core/country-profiles/aus. Ranking of 6th at the time of writing (September 2020)

APA's position on climate change.

APA takes the science of climate change seriously and supports a global transition to a lower-carbon future.

As a leading energy infrastructure business, APA delivers about half the nation's natural gas to Australian businesses and consumers. Climate change therefore presents both challenges and opportunities, not only for our business, but for the long-term prosperity of the Australian economy and its local communities.

We are committed to being part of the successful transition to a lower-carbon future and have taken steps to understand how we can best respond to the challenges inherent in climate change.

A key driver for our approach is APA's Purpose: **To strengthen communities through responsible energy**. This means taking a long-term view and being here for future generations. It also means innovating for a sustainable future by investing in technology and new ways of generating energy and carrying out our business in an environmentally and socially responsible way.

These key tenets of how we do business are reflected in our principles-based approach to climate change.

APA takes the science of climate change seriously and we support a global transition to a lower-carbon future in accordance with the Paris Agreement goals. We will continue taking steps to understand how we can best respond to the challenges and opportunities this presents.

In addition, we are collaborating with our industry peers and advocating for outcomes that we believe are in the best interests of our customers and the communities we serve.

We will keep stakeholders informed of our approach and performance. To this end, we published a Climate Change Position Statement in FY2020 and have produced this Climate Change Resilience Report.

We are not complacent, and recognise we need to do more to respond to climate change risks. As part of our maturing approach, we are currently developing a Climate Change Management Plan, and Climate Change Policy which will be released during FY2021.

APA is currently developing a Climate Change Policy for publication during FY2021.

Darling Downs Solar Farm, Queensland.

scenario analysis and resilience testing.

Wallumbilla Compressor Station, Queensland.

Highlights.

APA's current asset portfolio remains robust under all scenarios – including the 1.5°C scenario - with the portfolio benefiting from contracts currently in place.

Compared to the Net Present Value (NPV)[9] of cash flows from APA's Carrying Value Case (CVC)[10]:

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scenario analysis and resilience testing.

Scenario analysis methodology

How APA uses scenario analysis

Scenario analysis is a well-established method of informing strategic planning and an important and useful tool for understanding the strategic implications of climate-related risks and opportunities.

At APA, we have used climate scenario analysis to better understand possible future states and pathways and test the climate transition resilience of our existing portfolio. We will continue to evolve how we apply it and take into account the results in our ongoing development of strategy and planning processes (see Figure 2).

During FY2020, APA commissioned expert third party Energetics to help us leverage insights from our initial FY2019 climate transition scenario analysis process, expanding the scope and rigour of the analysis to mature our resilience testing approach. We used more challenging conditions to explore a broader and richer uncertainty space and take advantage of recent research and developments in publicly available data.

Fine-tuning our approach

APA's FY2020 scenario analysis built on the work done in FY2019 by:

- extending the scenario time horizon from 2030 to 2050
- including a scenario that limits global temperature rise to 1.5°C
- varying socioeconomic parameters across scenarios
- adding electricity transformation pathways from the Australian Energy Market Operator (AEMO) 2020 Integrated System Plan (ISP), which provides a power system roadmap
- evaluating the financial impacts of each scenario on APA's current asset portfolio to test resilience
- estimating the potential for renewable gas (biogas, 'green' hydrogen or carbon-neutral methane) to replace a share of national gas use
- applying TCFD selection criteria and characteristics to the scenarios, testing whether they were plausible, distinctive, consistent, relevant and challenging.

To help with comparability, credibility and transparency, we selected base scenarios and datasets that are publicly available, peer reviewed and commonly used.

Where there was information or data gaps, we identified assumptions or alternatives (see Supporting Information Chapter).

Using economy-wide modelling

Energetics adopted an economy-wide modelling approach so APA could identify and quantify opportunities more accurately. We did this because:

- APA has diverse energy asset types and customers across multiple sectors, so a range of potential emissions reduction options could affect demand
- national emissions constraints mean abatement in one sector depends on achieving abatement in other sectors.

Energetics modelled the scenarios using their proprietary economy-wide decarbonisation model. The scenario framework parameters (Table 1) set the model's constraints, based on historical data adjusted for scenario-specific assumptions to produce projected national emissions for each scenario. See the Supporting Information Chapter for more information.

The modelling results were mapped to APA's asset groups and customer and market segments. We were able to test our portfolio resilience under each scenario and quantify potential revenue impacts and asset impairment[13] using existing corporate models. Figure 2 shows the process.

It should be noted that the approach assumes business as usual within the existing asset portfolio, with no strategic acquisitions or decisions made by APA during the period, including maintaining a consistent asset footprint and cost base throughout. The key assumptions and limitations of this analysis are explained in the Supporting Information Chapter.

APA's transition scenarios and datasets are based on publicly available, peer reviewed and commonly used datasets.

13. Please refer to APA financial modelling assumptions and limitations in the Supporting Information Chapter at the end of this report.

Climate Resilience Testing Process

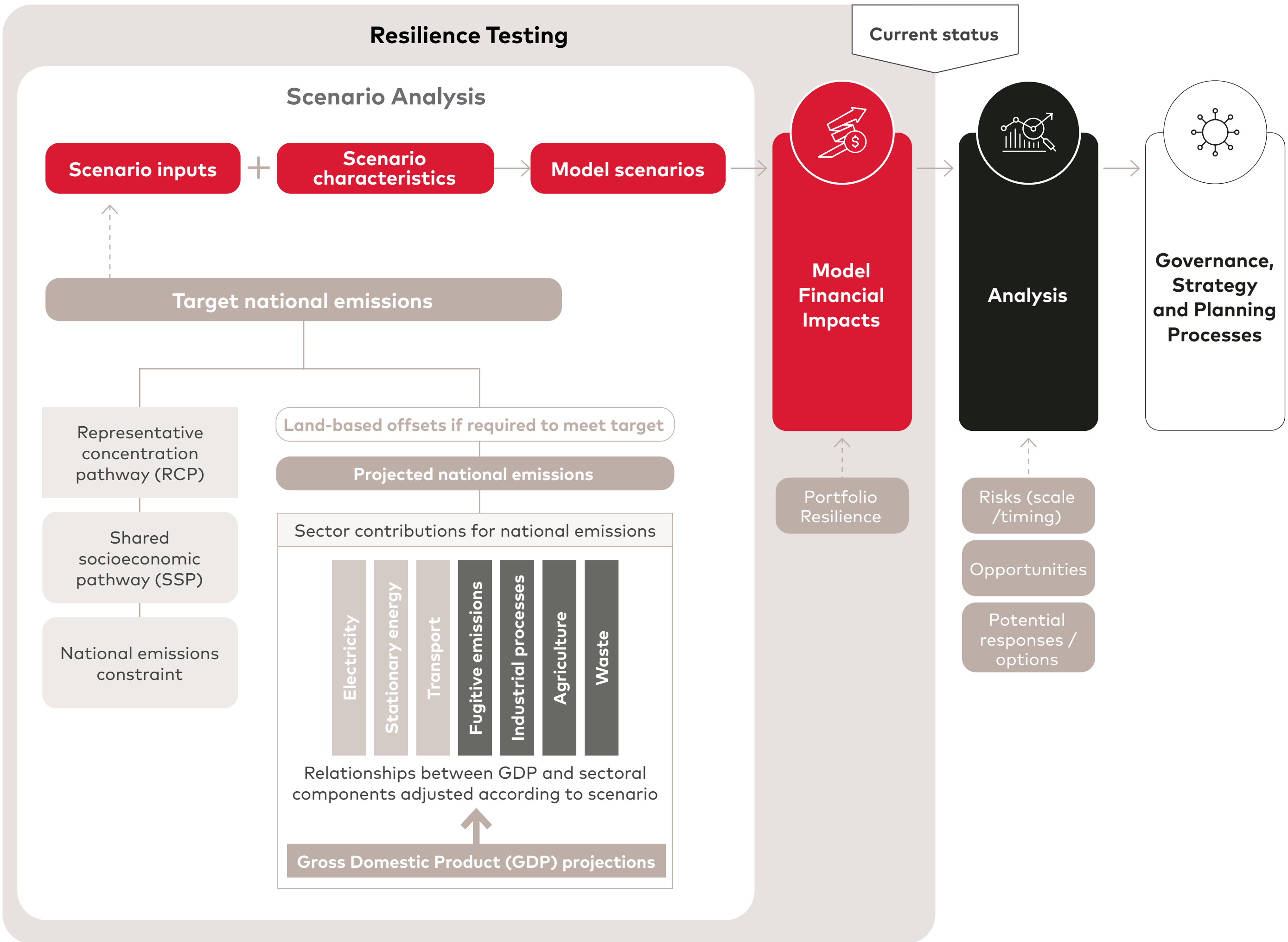

Figure 2 - APA's resilience testing process overview

scenario analysis and resilience testing.

Table 1 - Framework parameters for APA's 2020 scenario analysis

Framework Parameter	1.5˚C scenario	2-3˚C scenario	>4˚C scenario
Purpose for scenario selection	Test implications of Paris Agreement's stretch goal.	Test implications of current pledges and practices.	Test implications of unmitigated climate change.
Temperature Outcome			
Representative concentration pathway (RCP)	1.9	4.5	8.5
Temperature range	1.3°C-1.4°C	2.5°C-2.7°C	3.0°C-5.1°C
Probability of achieving scenario temperature outcome	33% probability of exceeding 1.5°C.	12% probability of >3°C. 79% probability of >2°C.	62% probability of >4°C 100% probability of >3°C
Emissions			
Australian emissions constraints	National carbon budget consistent with a 50% probability of 1.5°C.[14]	Trajectory to the national target of 26% below 2005 levels by 2030 extended thereafter.[15]	None required.
Cumulative emissions budget 2020-2050 ($MtCO_2e$)	6,490	13,125	nil
Socioeconomic Context			
Shared Socioeconomic Pathway (SSP)	SSP1	SSP3	SSP5
Key social and political characteristics	Sustainable approach, global cooperation.	Nationalist, security-focused.	Materialist, highly globalised.
Key economic characteristics	Strong growth, rapid development of abatement technologies.	Low growth, slow technology development.	Fast growth due to heavy use of fossil fuels, rapid innovation in technology.
Australian GDP growth (average YOY change%)	3.5%	1.7%	5.5%
Asian demand for gas (narrative and data)	Growing demand to 2030, fast transition from coal.	Slow growth. Slow transition from coal.	High demand for gas supported by high population growth.
Approach to technology development	Rapid development of decarbonisation solutions.	Slow development due to limited investment and knowledge transfer between regions.	High technology innovation to drive economic growth.
Rate of energy productivity improvement	Consistent with highest historical performance.	Below historical performance.	Moderate, due to technology innovation.
Reference AEMO ISP scenario	Step change.	Central.	Slow change.
Renewable gas share of pipeline supply derived from IEA WEO 2019	Sustainable Development scenario, share in leading nations.	Stated Policies scenario, global average share.	Current Policies scenario, global average share.

14. Based on Meinshausen, M., Robiou Du Pont, Y., and Talberg, A., Greenhouse gas emissions budgets for Victoria, University of Melbourne. https://www.climatechange.vic.gov.au/__data/assets/pdf_file/0016/421702/Greenhouse-Gas-Emissions-Budgets-for-Victoria.pdf

15. Calculated from Commonwealth Government, 2019. Australian emissions projections 2019. https://www.industry.gov.au/data-and-publications/australias-emissions-projections-2019

Table 2 - Summary of indicator results across scenarios

Indicator Category	1.5˚C scenario	2-3˚C scenario	>4˚C scenario
Emissions			
National emissions (gross $MtCO_2e$)	10,626 (cumulative) 179 by 2050	14,918 (cumulative) 373 by 2050	22,575 (cumulative) 1,010 by 2050
National emissions (net $MtCO_2e$)	6,490 (cumulative) 0 by 2050	13,125 (cumulative) 338 by 2050	22,572 (cumulative) 1,010 by 2050
Offsets ($MtCO_2e$)	4,133 (cumulative)	1,793 (cumulative)	N/A
Rate of emissions reduction (%, average annual)	With offsets: 19% Without offsets: 3.7%	With offsets: 1.5% Without offsets: 1.4%	N/A
Energy			
Gas demand (domestic) in 2050 (PJ)	776 (approximately 50% decrease from 2018)	1,411 (approximately 5% decrease from 2018)	7,893 (approximately five times greater than 2018)
LNG exports to Asia [16] in 2050 (PJ)	1,421	1,971	2,516
Renewable gas, % of gas supplied via pipelines in 2050	30%	3%	2%
Electricity demand in 2050 (TWh)	606	384 [17]	1,111
Renewable energy in electricity in 2050 (%)	98%	77%	44%
Renewable energy in electricity in 2050 (TWh)	591	296	485 [18]
Industrial energy productivity (average annual %)	4.7% [19]	1.2%	2.2%
Other			
Electric vehicle share of light vehicles in 2050	100%	40%	20%
Renewable fuel, % of heavy transport use in 2050	60%	10%	0%

16. The Asian gas demand dataset from the SSP database (see Supporting Information Chapter) includes Afghanistan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China (incl. Hong Kong and Macao, excl. Taiwan), Democratic People's Republic of Korea, Fiji, French Polynesia, India, Indonesia, Lao People's Democratic Republic, Malaysia, Maldives, Micronesia (Fed. States of), Mongolia, Myanmar, Nepal, New Caledonia, Pakistan, Papua New Guinea, Philippines, Republic of Korea, Samoa, Singapore, Solomon Islands, Sri Lanka, Taiwan, Thailand, Timor-Leste, Vanuatu, and Vietnam. It excludes the Middle East, Japan and former Soviet Union states.
17. Lower population growth and GDP in the 2-3ºC scenario results in lower electricity demand compared to other scenarios.
18. Higher overall electricity demand in the >4ºC scenario results in a higher TWh of renewable electricity demand in the grid, despite having a lower percentage share than the 2-3ºC scenario.
19. Technology innovation focused on enhancing energy productivity and reducing emissions results in higher productivity in this scenario.

scenario analysis and resilience testing.

Scenario analysis outcomes and insights

Overview of insights

1.5˚C | 2-3˚C | >4˚C

Outcomes common to all scenarios

- Decreased domestic gas demand from residential and commercial sectors
- Ongoing demand for LNG exports
- Increasing electricity demand due to multiple drivers for electrification
- Minimal change to industrial gas demand
- Strong growth in renewable energy production

Outcomes of the 1.5˚C and 2-3˚C only

- Decreased overall demand for gas
- Growth in renewable gas and renewable fuels
- Growth in demand for carbon offsets

Figure 3 - Key outcomes of the scenario analysis

The Wallumbilla Gladstone Pipeline, Curtis Island, Queensland.

scenario analysis and resilience testing.

All three scenarios present a range of potential impacts and opportunities for APA.

Sunset over Wallumbilla Gas Hub, Queensland.

Scenario insights

All three scenarios present a range of potential challenges and opportunities for APA. These will be taken into account in our corporate strategy review and development processes.

Strengths

Under all scenarios, there is an increasing role for energy infrastructure.

Under both the 1.5°C and 2-3°C scenarios, revenues from our existing portfolio are generally secure, with opportunities to increase investment in the growth of new energy technologies.

In the case of 1.5°C, APA's existing infrastructure is well positioned to support new technology shifts in renewable gas. While under the 2-3°C scenario, strong ongoing demand for gas export and domestic industry provides a demand floor for pipeline assets.

The resilience of our existing asset base and revenue model to the impacts of unmitigated climate change mean the >4°C scenario would likely see APA benefit from growth in demand for gas and electricity.

Opportunities

All three scenarios present opportunities for further diversification into clean energy technologies and infrastructure. Variable renewable energy sources such as wind and solar, grow strongly in all scenarios, which drives growth in auxiliary services like energy storage, firming capacity and electricity transmission.

In addition, each scenario presents unique opportunities:

— 1.5°C: Rapid technological progress goes beyond solar, wind and batteries to include commercial-scale renewable gas and other fuels, providing opportunities to provide and/or transport renewable gas (including hydrogen) and to tailor energy solutions for customers. Consumer values are increasingly oriented towards sustainability and companies that lead in Environmental, Social and Corporate Governance (ESG).

— 2-3°C: Opportunities to invest in gas fired power stations to support energy generation and firming and to create bespoke products for selected customers. Scaling up opportunities within energy precincts could support further growth and development.

— >4°C: Opportunity for greater future investment in gas transmission pipelines and processing, as well as new energy technologies.

Weaknesses

Under a 1.5°C scenario, strong policy interventions will shift residential and commercial gas consumption to renewable energy supplies. Policy interventions are likely to impose a high carbon cost on APA's operations and, more significantly, our customers' operating costs, driving stronger demand for low- and zero-emissions energy.

There are no significant weaknesses for APA if a 2-3°C scenario were to eventuate due to the significant role of gas in power generation for firming capacity and the uplift in gas demand due to retirement of coal-fired generation. A slight decline in gas usage from industrial demand due to lower economic growth inherent in this scenario, is insignificant.

Under a >4°C scenario, buoyant demand for gas could begin to exhaust current reserves from 2050. A lack of incentive for business model innovation in the period to 2050 could make it more challenging to adapt to supply constraints.

Threats

Under a 1.5°C scenario, increased public opposition to fossil fuels will be supported by strong policies to rapidly reduce emissions across the economy. This rapid market change could result in customers wanting shorter and more flexible contracts and faster adoption of industrial electrification options, particularly in low temperature heat uses such as leaching and concentrating (metals processing) and food processing.

A 2-3°C scenario contains the threat of a disorderly transition. Decarbonisation suddenly becomes a higher priority for selected customers while there is reduced preparedness to adapt. Climate policy uncertainty continues. Imposition of international trade barriers to carbon-intensive products is possible.

In a >4°C scenario, APA's customers and communities will likely experience increasing physical impacts of climate change and rising adaptation costs. There are potential impacts on our workforce and the demand for gas, particularly in vulnerable locations and from businesses that require substantial adaptation costs.

scenario analysis and resilience testing.

1.5°C scenario

In Australia, all sectors must innovate to reduce emissions, with less reliance on fossil fuels and increased use of carbon offsets and commercialised alternative technologies.

While this scenario presents some challenges, there are growth opportunities and the value of APA assets remains above the CVC[20].

Key characteristics
Context: Rapid, deep decarbonisation; economy-wide commercialisation of low-emissions technologies; consensus to achieve Paris Agreement goals.
Economy: Sustained moderate growth; increased investment in low-emissions technology.
Emissions: Aligned with Paris Agreement's stretch target; advanced economies decarbonise faster than emerging economies.
Energy: Increased fossil fuel in Asia, with a rapid switch from coal to gas; Australia reduces coal and gas consumption; healthy economic growth, fast progression in low-emissions technologies and energy efficiency.

Insights

— Modelling shows emissions reductions in all sectors (Figure 4), mostly in electricity initially.

— Emitters need carbon offsets to keep within the emissions budget, with 131 $MtCO_2e$ issued on average per year (compared to 15 $MtCO_2e$ Australian Carbon Credit Units issued in FY2020[21]).

— Procuring offsets becomes more costly and risky, with prices rising to drive greater use of abatement technology and reflecting greater offset demand for hard-to-abate emissions sources.

— Industry faces decarbonisation obstacles that impact gas demand (Figure 5). Alternative technologies are commercially viable (but costly), except for processes without electrification options. This scenario assumes rapid progress in technological and commercial viability but is cautious about widespread uptake, anticipating a 'floor' for industrial gas demand.

— Another industrial decarbonisation lever, renewable or carbon-neutral gas (Table 3), comprises 30% of pipeline supply by 2050[22]. If renewable gas made up a greater percentage, it could play a bigger role in decarbonisation.

Table 3 – 1.5°C scenario: Impacts on key gas-using sectors

Sector	Impacts
Electricity	Strong demand for new renewable capacity and storage, driven by the fast-tracked retirement of coal fired generators and widespread electrification of vehicles and heating processes.
Industry	Several trends facilitate industrial decarbonisation. — Electrification of lower temperature heating processes begins immediately and technology to electrify energy uses at higher temperatures advances over time. — Industries using coal for heating switch to gas. — Renewable gas plays a growing role, reaching 30% of pipeline supply by 2050. — Energy productivity improvements in line with historical best performance are sustained.
Commercial and residential heating	Existing trends towards electrification accelerate when grid electricity emissions intensity falls below the emissions intensity of gas (2030), reaching net zero in 2050.
LNG export	LNG exports grow short-term then plateau for the rest of the period based on the scenario outlook for Asia.

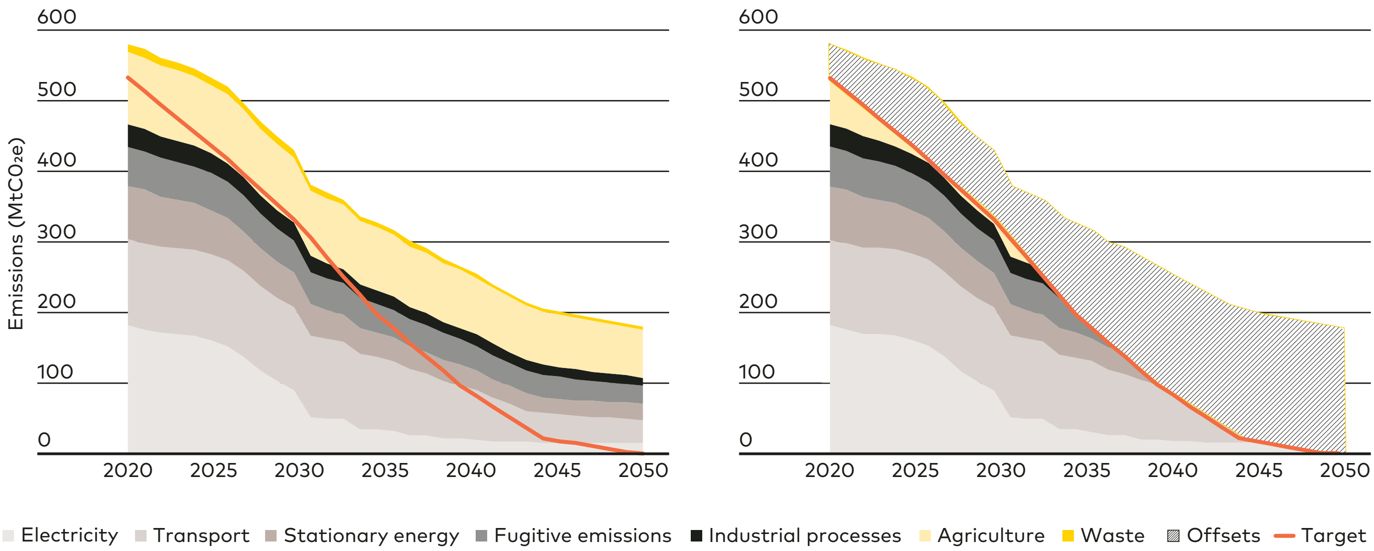

Figure 4 - 1.5°C scenario: National emissions projections to 2050. Left: without offsets. Right: with offsets.

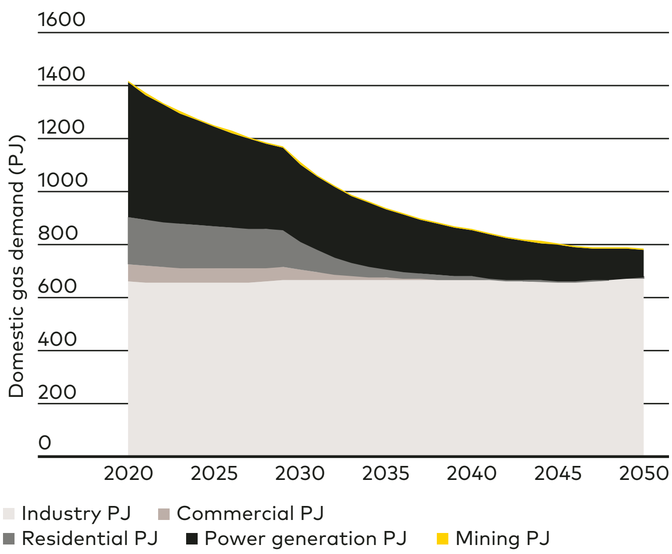

Figure 5 - 1.5°C scenario: Domestic gas demand to 2050

By FY2040, if the 1.5°C scenario pathway were to eventuate, revenue would be somewhat reduced when compared to revenue forecast under APA's CVC due to declines in gas demand.

20. Forecast of revenue and costs associated with APA's existing asset portfolio as at FY2020. This case has been used to assess asset impairment as detailed in FY2020 Financial Statements Note 13. For the purpose of this report and analysis, this case is used as the baseline case to test resilience. The CVC assumes business as usual within the existing asset portfolio with no strategic acquisitions or decisions made by APA during the period, including maintaining a consistent asset footprint and cost base throughout.
21. Clean Energy Regulator, accessed 12/8/20 http://www.cleanenergyregulator.gov.au/ERF/project-and-contracts-registers/project-register/Historical-ACCU-data
22. Based on the IEA's Sustainable Development Scenario.

scenario analysis and resilience testing.

2-3°C scenario

Lower economic growth in this scenario slows the growth in emissions, limits the drivers for innovation, and lowers investment in new technology. Overall, gas use declines slowly then grows as coal use for power generation reduces. Emissions targets are comparatively easy to meet and offsets play a minor role.

Demand changes are reflected in APA's revenues, but we stay financially resilient, with little impact on our NPV.

Key characteristics

Context: International cooperation is fragmented; security and safety are national policy priorities; short-term needs are prioritised over emissions reduction; limited business alignment to Paris Agreement targets.

Economy: Sustained low economic growth and barriers to international trade; slower progress in technology and innovation.

Emissions: Climate change is a lower priority although countries reduce emissions in line with current 2030 pledges and continue on that trajectory thereafter, in part due to lower economic and population growth.

Energy: In advanced countries, coal declines significantly and gas remains an important part of the energy mix. In developing Asia, coal increases until 2030 and gas demand grows steadily, but slower than in the 1.5°C scenario. The use of existing renewable energy technologies continues to grow, but major breakthroughs are not achieved.

Insights

- The analysis shows constrained economic growth results in limited emissions growth across all sectors (Figure 6).
- Emissions reduction is concentrated in the electricity sector as retired coal fired plants are replaced by renewable energy, primarily for economic reasons.
- Slower advancement of electrification opportunities in high-temperature processes sees industrial gas use remain steady in the near-term, then a slight decline after 2035 (Table 4).
- In the residential and commercial sectors a sustained gas demand is observed with a modest uptake in electrification options (Figure 7).
- On average, offsets of around 60 $MtCO_2e$ per year are needed to keep within the scenario's emissions budget, with the annual offsets requirement reducing as electricity decarbonises.
- Gas continues to play a role in meeting the demand for electricity as coal generators exit by providing dispatchable generation and firming renewables, and its role increases towards the end of the modelled period.
- Pumped hydro comprises the majority of investment in new storage, with a minor roll out of batteries behind the meter and as virtual power plants.

Table 4 - 2-3°C scenario: Impacts on key gas-using sectors

Sector	Impacts
Electricity	Renewable energy provides the vast bulk of new generation coming in to replace coal fired generators, but gas generation plays a greater role post- 2035.
Industry	Some electrification of gas use occurs but is primarily driven by technologies that are already commercially viable and cost-effective. Electrification for high-temperature heating applications (>250°C) begins after 2035 but uptake is gradual.
Commercial and residential heating	Some gas to electricity switching occurs, primarily driven by potential cost benefits and generally reflecting the existing historical trend.
LNG export	LNG exports follow the Asian demand trend, growing steadily and requiring expansion of existing LNG terminals post-2030.

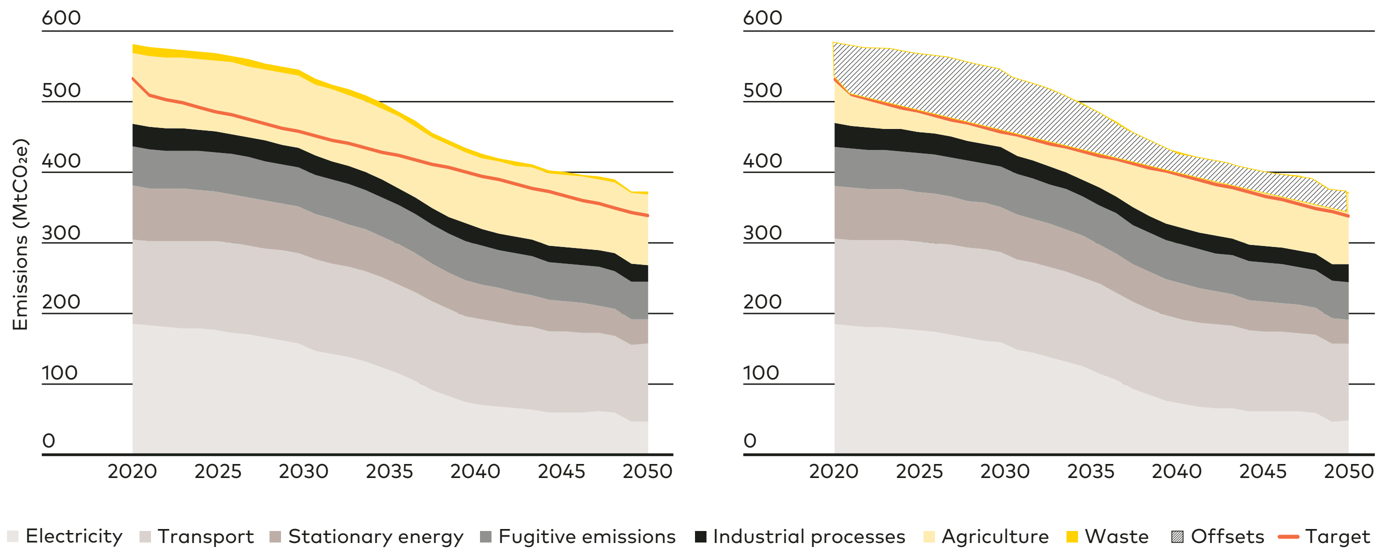

Figure 6 - 2-3°C scenario: National emissions projections to 2050. Left: without offsets. Right: with offsets.

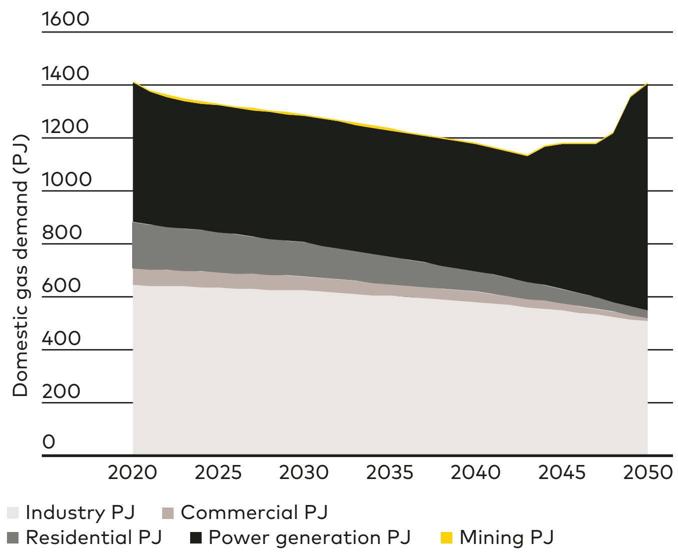

Figure 7 - 2-3°C scenario: Domestic gas demand to 2050

Under the 2-3°C scenario, there is a gradual impact on revenue, with most changes in the decade to FY2050. There would be a negligible contraction when comparing NPV to CVC.

scenario analysis and resilience testing.

>4°C scenario

Despite energy efficiency innovation, emissions increase in line with the impact of rising temperatures and a strong economy, and gas demand is high.

In this context, it is likely that further opportunities for growth will present themselves.

Key characteristics
Context: Economic growth is strong; lifestyles are resource-intensive; use of fossil fuels continues. Climate-related investment is directed towards adaptation rather than mitigation.
Economy: Strong growth; further globalisation; high rate of technological innovation.
Emissions: No emissions reduction attempts beyond initiatives that are otherwise commercially attractive; fossil-fuel-reliant growth; investment in climate adaptation.
Energy: In advanced economies, coal grows from 2030 and gas consumption more than doubles. In developing Asia, consumption of both fuels increases steeply.

Insights

- With no emissions target, strong economic growth and the implicit demands of global temperature rise (not modelled), emissions increase across most sectors (Figure 8) and carbon offsets are redundant.
- Acute weather events have broad community and workforce impacts for all scenarios but are potentially greater post-2050.
- Supportive policies and limited investment in firmed renewable energy encourage fossil fuel use.
- Fewer coal-fuelled power stations mean gas use increases as the electricity sector responds to higher energy demands (Figure 9).
- Fast technology development promotes widespread energy efficiency. In industry, economic growth drives gas use and alternatives to gas are generally adopted only when there is a process or cost efficiency gain.
- Despite high technological development, green hydrogen use is just 2% by 2050 as there is no government climate policy to incentivise greater uptake.
- There are many opportunities for the gas sector (Table 5) if Australia's gas reserves continue to meet demand. This analysis assumes rapid technological growth, high gas demand, enhanced exploration techniques and less stringent extraction policies would lead to greater supply. Otherwise, natural gas availability could be constrained after 2050, based on current reserves and contingent resources (1P, 2P, 1C, and 2C)[23].

Table 5 - >4°C scenario: Impacts and opportunities for key gas-using sectors

Sector	Impacts
Electricity	Strong demand for power drives growth in renewable energy and fossil fuel generation. Coal fired generators keep operating for longer periods and natural gas comes to dominate the electricity mix.
Industry	Industrial production growth leads to increasing demand for gas. Electrification is taken up, to the extent that it provides co-benefits.
Commercial and residential heating	Existing trends towards electrification of space heating do not outweigh demand growth.
LNG export	Strong Asian demand growth results in expansion of export capacity post-2030.

23. 1P is reserves proved, 2P is reserves proved plus probable. 1C is contingent resources low estimate, 2C is contingent resources best estimate.

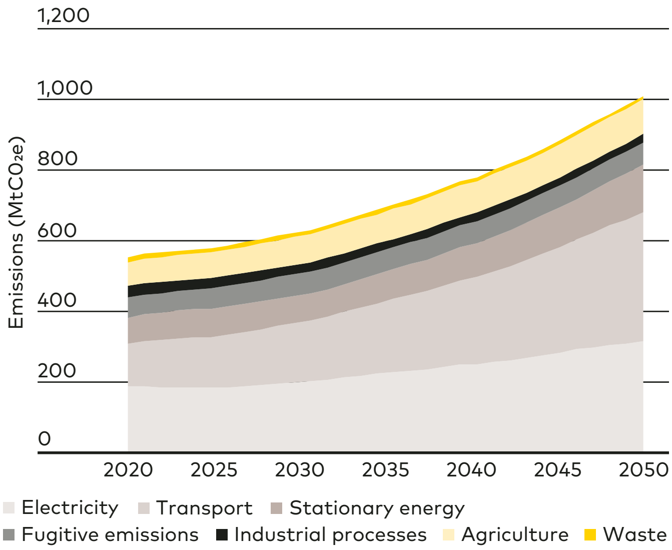

Figure 8 - >4°C scenario: National emissions to 2050

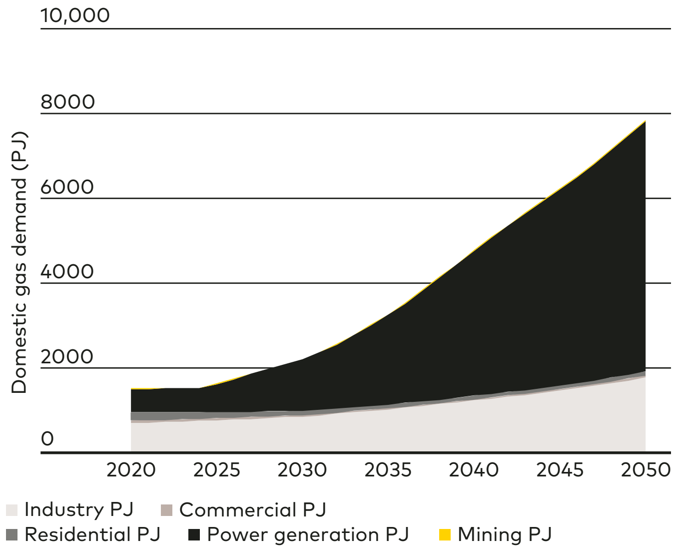

Figure 9 - >4°C scenario: Domestic gas demand to 2050

Under the >4°C scenario, APA's post-FY2030 revenue would rise because of increasing gas demand and NPV would also increase relative to CVC.

scenario analysis and resilience testing.

Craig Bonar, Head of Engineering and Planning, Networks and Yoko Kosugi, General Manager Investor Relations & Analytics.

Signpost indicators arising from scenarios

Signposts have been identified from each scenario (Table 6) and we will monitor them for indicators of which trajectory may be emerging, updating the information for our strategic analysis as required.

To achieve a **1.5°C** outcome, all policy, market and technological barriers would need to be addressed.

By contrast, a **2-3°C** outcome could result from several different paths; this scenario is only one. Two potential pathways are (1) ongoing uneven and/or insufficient action and (2) delayed action followed by a severe correction. The first pathway contains the possibility of switching to the second, as tension between the Paris Agreement goals and lack of a visible roadmap for achieving them could lead to sufficient social, economic or geopolitical pressure to force a drastic policy realignment. Uncertainty as to whether and when this might occur is implicit in this scenario.

In the **>4°C** scenario, climate change is something to be managed, not minimised. Widespread access to the benefits of fossil-fuelled growth and technology innovation creates confidence that adaptation can be effectively engineered. This may or may not be the case, and the greater the emissions, the greater the reliance we place on future adaptation actions. Socio political pressure to decarbonise could force a change in direction, presenting ongoing uncertainty.

Table 6 – Signposts to indicate scenario emergence

Signposts	1.5°C scenario	2-3°C scenario	>4°C scenario
Policy			
Political outlook	Bipartisan political acceptance of need for deep decarbonisation.	Decarbonisation remains politically contested/partisan.	Prioritisation of immediate economic growth over climate change risk management.
Political prioritisation	Decarbonisation is a very high priority.	Immediate economic concerns prioritised over long-term emissions reduction.	Prioritisation of adaptation for necessity. Mitigation is not prioritised.
Emissions restrictions	Strong and applied across the economy.	Imposed unevenly across the economy.	No effective restrictions.
Technology investment	Ongoing public investment in priority technologies and support to remove barriers to take-up.	Ad hoc and unsustained public investment in low-emission technologies.	Ongoing public investment in innovation pipeline for priorities: — Access to cheap energy — Climate-resilient infrastructure.
Regulatory frameworks	Ongoing evolution to facilitate new technology and business models.	Impede uptake of decarbonisation options.	Reduction of regulatory restrictions on innovation.
Market			
Effective carbon price	Effective (if not legislated) cost of carbon/reward for decarbonisation.	Carbon costs do not reflect value of decarbonisation and are not evenly applied.	Decarbonisation is a niche value proposition.
Competitiveness	Asset repricing to incorporate perceived climate risk profiles (may be gradual or sudden).	Hampered by low-investment environment and carbon policy uncertainty.	Rising consumer power of Asia drives fast growth in demand for goods and services and demand for Australian energy and resources.
Business innovation	New business models to access decarbonisation value and opportunities.	Minimal pressure to innovate.	Strong but not directed at decarbonisation except for niche customers.
Institutional investor priorities	Opportunities of decarbonisation.	Low-risk and low-cost investments.	Maximising growth
Technology			
Deployment	Virtuous cycle where rapid deployment reduces costs and enables further uptake.	Slower deployment and cost declines in established energy technologies.	Fast deployment for technologies supporting growth objectives.
Speed and range of advancement	Rapid technological progress includes commercial-scale renewable gas and other fuels, carbon capture, utilisation and storage (CCUS), land- and ecosystem-based sequestration.	Progress and uptake of new and emerging technologies is uneven.	Innovation is diffused across existing and emerging technologies. Adaptation is prioritised over mitigation.
Social license			
Social trust in institutions, including companies	High trust in institutions. Value placed on sustainability.	Low trust in institutions to uphold community values.	High trust in institutions that deliver rising living standards.
Social cohesion	Solidarity	Polarisation	Pluralism
Public view of fossil fuels	Disapproval becomes mainstream	Campaigns against fossil fuels produce support and backlash.	Approval is mainstream.

scenario analysis and resilience testing.

Testing portfolio financial resilience

APA's current asset portfolio remains resilient under all assessed scenario pathways, including the 1.5°C scenario.

Using the outputs of the climate scenario analysis, we tested the resilience of APA's existing asset portfolio [24] against the three scenarios described earlier.

This involved:

- using the APA forecast model that is used for our carrying value analysis
- mapping each scenario's gas demand groupings (see Supporting Information Chapter) to APA's existing assets and relevant customer industry groupings and incorporating the volume changes in the model
- calculating revenue and NPV of cash flows from the three scenarios.

The approach assumes business as usual within the existing asset portfolio, with no strategic acquisitions or decisions made by APA during the period, including maintaining a consistent asset footprint and cost base throughout.

The results of this scenario modelling were then assessed against the CVC revenue and NPV of CVC cash flows to FY2050.

The outcomes of this comparison are summarised in Table 7.

Scenario[25]		**1.5˚C**			**2-3˚C**			**>4˚C**	
Revenue (at year noted)	2030	2040	2050	2030	2040	2050	2030	2040	2050
	🔵	⚫	⚫	🔵	🔵	🟠	🔵	🟡	🟡
NPV of forecast cash flows to 2050		🟠			🔵			🟡	

Table 7 – Potential financial implications of each scenario (see key)

Key	**Revenue impact**	**NPV**[26] **impact**
🟡	Positive impact, above APA's CVC [27]	
🔵	Immaterial impact on APA's CVC [27]	
🟠	Somewhat reduced (5-15%) revenues relative to APA's CVC [27]	Somewhat reduced (5-15%) cash flows relative to APA's CVC [27]
⚫	Negative impact (15%+) Below APA forecast revenues under the CVC [27]	Not applicable

24. Forecast of revenue and costs associated with APA's existing asset portfolio as at FY2020. This case has been used to assess asset impairment as detailed in FY2020 Financial Statements Note 13. For the purpose of this report and analysis, this case is used as the baseline case to test resilience. The CVC assumes business as usual within the existing asset portfolio with no strategic acquisitions or decisions made by APA during the period, including maintaining a consistent asset footprint and cost base throughout.
25. Results refer to the year specified.
26. Assessment based on the pre-tax discount rates disclosed in FY2020 Financial Statements Note 13.
27. Further information on CVC and impairment analysis can be found in the FY2020 Financial Statements Note 13.

Financial insights

- APA's current asset portfolio remains robust under all scenarios – including the 1.5°C scenario - with the portfolio benefiting from contracts currently in place, despite the modelling assuming no strategic acquisitions or decisions made by APA during the period.
- By FY2040, if the 1.5°C scenario pathway were to eventuate, revenue would be somewhat reduced when compared to revenue forecast under APA's CVC due to the gas demand in this scenario.
- Under the 2-3°C and >4°C scenarios, the impact on revenue is more gradual. Most changes are seen in the decade to FY2050, corresponding to demand projection changes.
- Under the >4°C scenario, post-FY2030 revenue increases correspond to greater demand, mostly from the West Coast resources sector.
- When comparing NPV to APA's CVC, the impact of the 1.5°C scenario is somewhat reduced, while the contraction would be negligible under the 2-3°C scenario and there would be an increase under the 4°C scenario.
- Under all modelled outcomes, there is no impairment [28] impact on the APA asset portfolio [29].
- Across the scenarios, there is no material shift in the revenue mix of APA's asset portfolio. The most significant shift is the increase in contribution from our assets in Western Australia (WA) reflecting less elastic demand for gas in the WA resources sector.

Tim Penketh, Manager DLNG Storage Facility, atop Dandenong LNG, Victoria.

28. Further information on CVC and impairment analysis can be found in the FY2020 Financial Statements Note 13.
29. Further information on CVC and impairment analysis can be found in the FY2020 Financial Statements Note 13.

supporting information.

Gruyere Power Station, supplying power to the Gruyere Gold Project, Western Australia.

supporting information.

Scenario modelling assumptions and limitations

This commentary has been provided by Energetics to support the scenario modelling they completed for us.

Overall method

Scenario framework parameters to set model constraints were selected, including:

— **Representative Concentration Pathways (RCPs),** which define the degree of global warming and associated emissions constraints

— economic parameters, which are set by **Shared Socioeconomic Pathways (SSPs)** defined by the **Intergovernmental Panel on Climate Change (IPCC).** These dictate **Gross Domestic Product (GDP)** projections to 2050 and provide a high-level indication of technological growth and priorities in each scenario.

Sectoral emissions to 2050 were projected based on future GDP trends under each SSP and the historic relationship between GDP and sectoral emissions and energy consumption. This gave a 'base case' trajectory for each scenario which was adjusted based on scenario-specific assumptions (for example technology deployment) informed by the SSP scenario narratives and literature reviews of decarbonisation potential. This gave an adjusted pathway for each scenario and carbon offsets were assumed to fill the gap between projected emissions and the emissions constraint (explained in the next section).

Further detail

The three scenarios were produced using global and domestic data sources. Three emissions trajectories were defined based on the IPCC's RCPs 1.9 (for 1.5°C scenario), 4.5 (for 2-3°C scenario), and 8.5 (for the >4°C scenario).

These were combined with narratives and data from the SSPs developed by leading researchers for the IPCC's forthcoming assessment report. The SSPs establish societal conditions for each scenario, including technological progress, population, urbanisation, economic growth, lifestyles and education.

Of the five SSPs available, three were selected: SSP1 (for the 1.5°C scenario), SSP 3 (for the 2-3°C scenario) and SSP 5 (for the >4°C scenario). These were chosen for their ability to reproduce the emissions outcome (based on a consensus of global climate models) and their divergence in economic growth projections, narrative and challenges to mitigation and adaptation. The SSP data used included annual Australian GDP and Asian gas demand projections to 2050.

An additional sensitivity analysis was completed to understand the impact of selecting alternate SSP's (SSP1 and SSP5) for the 2-3°C scenario with the outcomes summarised in the text box below.

SSP Sensitivity Analysis

As SSP3 represents a much more challenging economic environment than the other two SSPs (with lower economic growth and slower technology development), two sensitivities were constructed, whereby the RCP for the 2-3°C scenario was combined with the other SSPs, to test the role played by the SSP characteristics.

The combination of RCP4.5 and SSP1 was termed 'green growth' as it represented a world where moderate emissions constraints were imposed on a socio-economic environment already trending towards declining emissions intensity.

The combination of RCP4.5 and SSP5 was termed 'fossil fuelled', as it represented a world where moderate emissions constraints were imposed on fast-growing, highly emissions intensive economy.

Relative to the central 2-3°C scenario, the 'green growth' sensitivity resulted in greater reduction of gas use in the electricity sector, but this was largely offset by economic growth in the industrial sector and reduced reliance on offsets.

However, the large share of renewable gas required to meet industrial demand while maintaining emissions constraints in this scenario could suggest that the 'green growth' sensitivity delivered too favourable an outcome for APA.

In comparison, the 'fossil fuelled' sensitivity also had a steep increase in gas use and heavier reliance on offsets to achieve the emissions constraint.

These factors made it less plausible as a mid-range scenario than the central 2-3°C scenario. Given the overall objective to stress-test the resilience of APA assets under three divergent scenarios, the 2-3°C scenario using SSP3 provided a more challenging scenario and was therefore used in this analysis.

In the 1.5°C and 2-3°C scenarios, an emissions constraint was established to translate the global emissions trajectory to an Australian context.

The 1.5°C scenario drew on the work of Dr Malte Meinshausen who, based on the Climate Change Authority's national emissions budget, proposed a cap on emissions for Australia consistent with a 50-65% chance of limiting temperature rise to 1.5°C.

For the 2-3°C scenario, the Commonwealth Government's current 2030 Paris Agreement Target was used and extended at the same rate to 2050. This was consistent with the view that current pledges would result in a trajectory in line with 2-3°C warming.

The >4°C scenario had no emissions constraint.

The current national emissions and the historical trend between GDP growth and emissions in each sector over the past 30 years to establish a starting point and trajectory for business as usual (BAU) emissions. For each scenario, we used the projected GDP growth to create a baseline emissions trajectory, to which we applied emissions reduction measures to reduce the gap between the emissions trajectory and the scenario emissions constraint.

The nature of the emissions measures deployed, and to what extent, was informed by the scenario narrative. In constrained emissions scenarios, offsets were used to fill the gap between the resultant emissions and the emissions constraint. The >4°C scenario had no emissions constraint, but some measures were applied to reflect BAU efficiency growth and opportunities that are currently cost-effective.

The scale and timing of measures were informed by desktop research. Pathways for the electricity sector, drew on the AEMO Integrated System Plan step change scenario (for the 1.5°C scenario), central scenario optimal path (for the 2-3°C scenario) and slow change scenario (for the >4°C scenario). For renewable gas projections the International Energy Agency's World Energy Outlook Sustainable Development, Stated Policies, and Current Policies for the 1.5°C, 2-3°C and >4°C scenarios were used, respectively. For measures in the other sectors, other credible sources such as CSIRO's Australian National Outlook 2019 and Low Emissions Technology Roadmap 2017, were drawn upon.

The output was a sectoral projection of gas and renewable energy demand in Australia under each scenario. This was combined with scenario projections of Asian gas demand (from the SSP database) and overlaid with the demand for gas from each of APA's assets. A projection of annual growth for each asset was used in APA's CVC to understand the potential financial impacts. Please refer to the APA modelling assumptions and limitations section for how relevant variables were addressed.

Assumptions related to overall scenario modelling method

— Economic activity is a key driver of energy demand that drives emissions across the economy.

— Economic growth is an indicator of capacity for investment and technology development in sustainable solutions.

— GDP data is sourced from the International Institute for Applied Systems Analysis (IIASA) SSP Database (v2.0)[30], which provides GDP data at an OECD level at 5-year intervals. GDP data has been downscaled to produce GDP projections for Australia and linear interpolation has been used to calculate the year-on-year change.

— The impact of physical climate on economic growth is excluded from the analysis.

— Energy and emissions data is sourced from the Australian Government Department of Industry, Science, Energy and Resources[31].

— Future BAU improvements in energy productivity are captured by the relationships derived from historical data. These BAU trends are assumed to capture the impact of significant disruptions, given that the historic data covers the impacts of events such as the global financial crisis of 2008, the imposition and removal of the carbon tax, the rise of renewable power generation at rooftop and utility scale and the emergence of LED lighting.

— Major technological disruptions, which are those we considered more disruptive than events captured in the BAU trends, are applied according to a cost-based merit order of decarbonisation technologies.

30. Keywan Riahi, Detlef P. van Vuuren, Elmar Kriegler, Jae Edmonds, Brian C. O'Neill, Shinichiro Fujimori, Nico Bauer, Katherine Calvin, Rob Dellink, Oliver Fricko, Wolfgang Lutz, Alexander Popp, Jesus Crespo Cuaresma, Samir KC, Marian Leimbach, Leiwen Jiang, Tom Kram, Shilpa Rao, Johannes Emmerling, Kristie Ebi, Tomoko Hasegawa, Petr Havlík, Florian Humpenöder, Lara Aleluia Da Silva, Steve Smith, Elke Stehfest, Valentina Bosetti, Jiyong Eom, David Gernaat, Toshihiko Masui, Joeri Rogelj, Jessica Strefler, Laurent Drouet, Volker Krey, Gunnar Luderer, Mathijs Harmsen, Kiyoshi Takahashi, Lavinia Baumstark, Jonathan C. Doelman, Mikiko Kainuma, Zbigniew Klimont, Giacomo Marangoni, Hermann Lotze-Campen, Michael Obersteiner, Andrzej Tabeau, Massimo Tavoni.

The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview, Global Environmental Change, Volume 42, pp 153-168, 2017, ISSN 0959-3780, DOI:110.1016/j.gloenvcha.2016.05.009.

31. Australian Government Department of Industry, Science, Energy and Resources, Data Tables, https://ageis.climatechange.gov.au/QueryAppendixTable.aspx (multiple tables downloaded)

supporting information.

Assumptions related to overall scenario modelling method (continued)

- The technology merit order was based on the outlook for current and emerging technology. The long-term outlook of the assessment means technologies that have not yet been developed yet were not considered.
- Decarbonisation of power generation is driven by the closure of ageing coal fired power stations and their replacement with firmed renewable generators.
- The replacement mix (the mix of generation that fills a gap in supply and demand) in WA (South West Interconnected System, or SWIS) is assumed to be equivalent to that in the National Electricity Market (NEM).
- The percentage uptake of technology is dictated at 10-year intervals. Linear interpolation was required to produce annual changes in energy demand resulting from new technology.
- Fugitive emissions growth is assumed to be based on the demand profile for coal and gas as this will drive extraction. As fugitive emissions from oil exploration comprise a small fraction of Australia's total fugitive emissions, emissions from gas are considered representative.
- Coal demand is based on Asian demand trends derived from the selected RCP-SSP datasets.
- Gas demand is based on Asian demand (derived as above) combined with domestic demand. Gas demand is assumed to be independent of the availability of gas reserves in Australia.
- Carbon capture and storage (CCS) is available for use in gas production as this already exists in Australia, but not assumed in other industry sectors.
- Year-on-year changes in LNG exports from Australia assume a 1:1 ratio with the projected growth of gas demand in Asia, as dictated by the SSPs. Constraints on capacities of existing LNG terminals are assumed to be removed after 2030.
- The impact of LNG developments in other parts of the world and its impact on Australia's competitiveness in the LNG market is considered outside the scope of the assessment.
- Carbon offsets are treated as a last-resort option, used only to fill the gap between emissions projections and target levels once more feasible abatement have been taken up.
- Carbon offset availability is assumed to be unrestricted and not confined to any specific sector.

APA staff at Diamantina Power Station, Mount Isa, Queensland.

Assumptions related to specific scenarios

Table 8 – Key references

Parameter	1.5˚C	2-3˚C	>4˚C	Source
Constraining parameters				
Emission trajectory	RCP 1.9	RCP 4.5	RCP 8.5	
Carbon budget	National carbon budget consistent with a 50% probability of 1.5°C	National target of 26% below 2005 levels by 2030	None required	**1.5°C:** Derived from the Climate Change Authority's national carbon budget, as analysed and updated by Meinshausen et al (2019)[32] **2-3°C:** Commonwealth Government's current 2030 Paris Agreement target[33] **>4°C:** N/A
Key social/political characteristics	SSP1: Sustainable approach, global cooperation	SSP3: Nationalist, security-focused.	SSP5: Materialist, highly globalised	O'Neill et al. 2017[34]
Key economic characteristics	SSP1: Strong growth, rapid decarbonisation tech development	SSP3: Low growth, slow tech development	SSP5: Fast growth, rapid tech innovation	O'Neill et al. 2017[35]
Economic growth projections	3.5%	1.7%	5.5%	IIASA's SSP Database (v2.0), downscaled for Australia
Asian gas demand	Growing demand to 2030, fast transition from coal	Slow growth, slow transition from coal	High demand for gas supported by high population growth	IIASA's SSP Database (v2.0)
Carbon offsets	Dictated by difference between emission trajectory and emissions budget	Dictated by difference between emission trajectory and emissions budget	No offset requirements assumed due to absence of emissions budget	Energetics assumption based on scenario narratives

32. Malte Meinshausen (2019) Deriving a Global 2013-2050 Emission Budget to Stay Below 1.5°C Based on the IPCC Special Report on 1.5°C.

33. Based on Australia's Nationally Determined Contribution (NDC) to reduce emissions by 26-28% compared to 2005 levels by 2030. This target is assessed as broadly consistent with global warming of up to 3°C by Climate Action Tracker. See Climate Action Tracker, 'Australia – Fair Share' at https://climateactiontracker.org/countries/australia/ . Similarly, countries' current NDCs are considered to be consistent with global warming of 3°C, according to UNEP, 2019. 2019 Emissions Gap Report. https://www.unenvironment.org/resources/emissions-gap-report-2019

34. O'Neill, et al (2017). The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. Global Environmental Change, 42, 169–180. doi:10.1016/j.gloenvcha.2015.01.004

35. O'Neill et al. (2017). The roads ahead: Narratives for shared socioeconomic pathways describing world futures in the 21st century. Global Environmental Change, 42, 169–180. doi:10.1016/j.gloenvcha.2015.01.004

supporting information.

Assumptions related to specific scenarios (continued)

Table 8 – Key references

Parameter	1.5˚C	2-3˚C	>4˚C	Source
Renewable gas				
Renewable gas in pipeline by 2050	30%	3%	2%	**1.5ºC:** IEA's Sustainable Development Scenario (for selected regions – China and EU) **2-3ºC:** IEA's Stated Policies Scenario **>4ºC:** Current Policies (global average)
Energy productivity				
Rate of energy productivity improvement across each sector	Consistent with highest rates of historical performance	Consistent with average rate of historical performance	Consistent with average rate of historical performance [36]	Energetics assumption based on scenario narratives
Electricity				
Coal-fired station closure	Assumes policy drives a phase-out of coal generation by 2040. Generators' lives are progressively shortened, to a limit of 30 years by 2040. Where available, generator closure dates occur in line with disclosed net zero/1.5ºC scenario assessments released by companies (AGL/Origin).	Closure at the end of a 40-year technical life. An exception to this rule is if generators have publicly announced a closure date.	Closure at 60 years unless a different closure date is publicly announced.	**1.5ºC:** Energetics assumption based on action by other OECD countries to phase out coal-fired plants within a certain time (e.g., UK, Germany) **2-3ºC:** Energetics assumption based on the average age at which coal generators retired during the last 8 years (40 years) [37] **>4ºC:** Energetics assumption, does not consider the economic feasibility of refurbishment
Replacement generation mix (the electricity mix used to fill gaps in supply to meet demand)	AEMO Step Change, 100% renewables plus storage.	AEMO Central, averages to 98-99% renewables plus storage and 1-2% gas.	AEMO Slow Change, averages to 95-96% renewables plus storage, and 5% gas.	AEMO 2020 Integrated System Plan [38]
Phase-out of gas fired generators	Assumes a phase-out of gas at 5% per year.	N/A	N/A	**1.5ºC:** Energetics assumption, gas fired generators close at the end of a 20-year technical life **2-3ºC and >4ºC:** Replacement mix in the selected AEMO scenario dictates the role of gas

36. Assumes energy abundance reduces the incentive for efficiency despite strong technology innovation.
37. Jotzo, F., Mazouz, S. and Wiseman, J. et al (2018), Coal transition in Australia: an overview of issues, CCEP Working Paper 1903, Sep 2018. Crawford School of Public Policy, The Australian National University.
38. AEMO, '2020 Integrated System Plan (ISP)' https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2020-integrated-system-plan-isp

Assumptions related to specific scenarios (continued)

Table 8 – Key references

Parameter	1.5°C	2-3°C	>4°C	Source
Stationary energy				
Uptake of electrification of high-temperature heating[39]	3 to 4% per year driven by decarbonisation goals.	2 to 3% per year driven by co-benefits (cost savings) and weak decarbonisation.	2 to 3% per year driven by access to co-benefits.	Energetics assumption based on the following sources: — CSIRO Australian National Outlook 2019[40] — CSIRO Low Emissions Technology Roadmap 2017[41] — McKinsey & Co, Decarbonization of industrial sectors – the next frontier 2018[42] — ITP Thermal, Renewable energy options for industrial heat. Report for ARENA, 2019[43] — Energetics' internal project database
Switching from coal to gas or biomass	5 to 10% uptake rate across relevant industries. Industries take up the option (biomass or gas) dominant in their industry.	0% uptake, high fuel costs make this option unappealing in this scenario.	0% uptake, absence of emissions constraint removes the incentive to switch.	Energetics assumption based on industry knowledge
Electrification in residential and commercial buildings	Assumes this would be an area of policy focus as a relatively low-cost abatement measure. However, electrification would not be strongly accelerated by policy until the emissions intensity of the electricity grid declines to below that of natural gas (2030). Thereafter gas use declines to reach zero emissions from this source by 2050.	Assumes replacement rate is 5% per year, reflecting less pressure to decarbonise but co-benefits of switching to electric air conditioning.	Assumes the replacement rate is 5% per year, reflecting co-benefits of switching to electric air conditioning.	Energetics assumption based on: — CSIRO Australian National Outlook 2019 — CSIRO Low Emissions Technology Roadmap 2017 — GBCA Carbon Positive Roadmap for the Built Environment 2019[44] — Energetics' internal project database, which includes assessments of electrification costs, opportunities and trends across a wide range of commercial building types

39. Limits of 20-25% capacity to switch applied to electrification options for high temperature heating bands across all scenarios due to technical and cost barriers.

40. Brinsmead TS, Rendall A, Baynes T, Butler C, Kelly R, Adams PD, Hayward J, Reedman L, Nolan M, Lennox J, Hennessy K, Wynn K, Ahmad ME, Marcos-Martinez R, Collins L, Lu Y, Che N, Qiu J and Kanudia A (2019) Australian National Outlook 2019: Technical report. CSIRO, Australia.

41. Campey, T., Bruce, S., Yankos, T.*, Hayward, J., Graham, P., Reedman, L., Brinsmead, T., Deverell, J. (2017) Low Emissions Technology Roadmap. CSIRO, Australia.

42. Available at: https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/our%20insights/how%20industry%20can%20move%20toward%20a%20low%20carbon%20future/decarbonization-of-industrial-sectors-the-next-frontier.pdf

43. Available at: https://arena.gov.au/assets/2019/11/renewable-energy-options-for-industrial-process-heat.pdf

44. Available at: https://gbca-web.s3.amazonaws.com/media/documents/carbon-positive-roadmap-discussion-paper-fa.pdf

supporting information.

Assumptions related to specific scenarios (continued)

Table 8 – Key references

Parameter	1.5˚C	2-3˚C	>4˚C	Source
Transport				
Renewable fuels in heavy vehicles	18% by 2030 60% by 2050	3% by 2030 10% by 2050	No switch assumed	**1.5°C:** Renewable share of transport fuels based on IPCC Special Report on 1.5°C [45] **2-3°C:** Renewable share based on aviation share in IEA Stated Policy scenario **>4°C:** N/A
Electric Vehicles (EVs) by 2050	100%	40%	20%	**1.5°C:** Research by Climateworks [46] and Kuramochi et al. 2017 [47] **2-3°C:** AEMO's growth in EV assumptions for the Central scenario **>4°C:** AEMO's growth in EV assumptions for the Slow scenario
Electrification of mining fleets [48]	3% uptake per year as of 2020. Rapid electrification starts immediately.	1.5% uptake per year from 2023. Electrification of mining fleets proceeds at half the speed of the 1.5°C scenario, reflecting the slower pace of technological development and lesser pressure for decarbonisation.	3% uptake per year from 2023. Electrification of mining fleets occurs due to the co-benefits it provides, but as the electricity supply is more emissions intensive, this has a reduced decarbonisation effect.	Energetics assumption based on industry knowledge and scenario narratives.

45. IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R.
46. ClimateWorks Australia, 2020. Decarbonisation Futures Technical Report. https://www.climateworksaustralia.org/wp-content/uploads/2020/04/CWA-DECARBONISATION-FUTURES-2020-TECH-REPORT.pdf
47. Takeshi Kuramochi, Niklas Höhne, Michiel Schaeffer, Jasmin Cantzler, Bill Hare, Yvonne Deng, Sebastian Sterl, Markus Hagemann, Marcia Rocha, Paola Andrea Yanguas-Parra, Goher-Ur-Rehman Mir, Lindee Wong, Tarik El-Laboudy, Karlien Wouters, Delphine Deryng & Kornelis Blok (2017): Ten key short-term sectoral benchmarks to limit warming to 1.5°C, Climate Policy, DOI: 10.1080/14693062.2017.1397495.
48. Electrification is capped at 75%. Mining fleets that are not electrified are switched to renewable fuels at the same rate as the rest of transport.

Assumptions related to specific scenarios (continued)

Table 8 – Key references

Parameter	1.5˚C	2-3˚C	>4˚C	Source
Fugitive emissions				
Coal and gas	Emissions reduction technologies are applied. Technologies are assumed to be supported by stringent regulation and possibly government assistance around the oil and gas sector.	No emissions reduction technologies applied. It is assumed that the cost of installing technologies is higher than the cost of offsets.	No emissions reduction technologies applied. It is assumed that there is no incentive to implement emissions reduction solutions.	Energetics assumption
Industrial processes	Emissions reduction measures are applied to the mineral, chemical and metal industry.	No emissions reduction measures applied, the cost of installing technologies is higher than the cost of offsets.	No emissions reduction measures applied. There is no incentive to implement emissions reduction solutions.	1.5°C: Emissions reduction measures based on — OECD Green Growth research papers [49] — Chatham House [50] — ClimateWorks Australia [51]
Agriculture	Based on emissions reduction potential described in CSIRO's MLA "Beyond Methane" scenario and CSIRO's ANO "Green and Gold" scenario.	Based on emissions reduction potentials described in CSIRO's MLA "Feedlot Futures" scenario and CSIRO's ANO "Slow Decline" scenario.	Based on emissions reduction potentials described in CSIRO's MLA "BAU" scenario and CSIRO's ANO "Slow Decline" scenario.	Agricultural emissions trajectories were derived from the scenarios produced by CSIRO for the Meat and Livestock Association (MLA) [52] in 2015 and by CSIRO in the Australian National Outlook (ANO) 2019. [53]
Waste	Emissions reduction measures applied, assumes a 57% reduction in waste emissions by 2050.	No emissions reduction measures applied.	No emissions reduction measures applied.	**1.5°C:** Energetics assumption based on current research on emissions reduction potential from better waste management practices [54]

49. Bataille, C. 2020. Low and zero emissions in the steel and cement industries: Barriers, technologies and policies. OECD Green Growth Papers, No. 2020/02, OECD Publishing, Paris.
50. Johanna Lehne and Felix Preston, 2018. Making Concrete Change: Innovation in Low-carbon Cement and Concrete. Chatham House, London.
51. ClimateWorks Australia, 2020. Decarbonisation Futures Technical Report. https://www.climateworksaustralia.org/wp-content/uploads/2020/04/CWA-DECARBONISATION-FUTURES-2020-TECH-REPORT.pdf
52. CSIRO, 2018. GHG mitigation potential of the Australian red meat production and processing sectors. Meat and Livestock Association Australia, North Sydney.
53. Brinsmead, Thomas; Rendall, Andrew; Baynes, Tim; Butler, Cameron; Kelly, Rob; Adams, Philip; Hayward, Jenny; Reedman, Luke; Nolan, Martin; Lennox, James; Hennessy, Kevin; Wynn, Katherine; Ahmad, Maryam; Marcos Martinez, Ray; Collins, Lyle; Lu, Yingying; Che, Nhu; Qiu, Jeremy; Kanudia, Amit. Australian National Outlook 2019 Technical report. Australia: CSIRO; 2019. https://doi.org/10.25919/5d0934b82e649
54. Abu Qdais, H., Wuensh, C., Dornack, C., & Nassour, A. (2019). The role of solid waste composting in mitigating climate change in Jordan. Waste Management & Research, 0734242X1985542. doi:10.1177/0734242x19855424.

supporting information.

APA financial modelling assumptions and limitations

APA made the following key assumptions when undertaking the financial modelling using the scenario inputs generated by Energetics.

Carrying Value Case (CVC):

— APA's forecast model that has been used for assessing carrying value of its existing asset portfolio has been utilised.

— FY2020 CVC is used as base line. This case incorporates assumptions for APA's existing asset portfolio as at FY2020 with their associated asset lives, contract terms, renewals, operating and maintenance costs; for further details refer to FY2020 Financial Statements Note 13.

— CVC assumes business as usual within the existing asset portfolio with no strategic acquisitions or decisions made by APA during the period, including maintaining a consistent asset footprint and cost base throughout.

Revenue:

— At the expiry of existing revenue contracts, each dollar of revenue to be recontracted is assumed to be impacted by the cumulative gas demand change projected since FY2020; as such, recontracted revenue in a particular year is calculated by the amount of revenue for recontracting multiplied by the cumulative percentage change since FY2020.

— From such expiries, annual recontracting is assumed and reflected as annual demand/ revenue change.

— Demand projections applied are limited to the appropriateness of demand group mapping and where Energetics' scenarios provided 'average' demand projection – APA has assumed this to have a direct (one-to-one) correlation to capacity contracting behaviour.

— Unit price for APA's services is assumed to be held constant (real 2020$ terms) to 2050.

— In the case of power generation assets, the demand growth in the >4°C scenario has been capped by the current generation capacity of the assets.

Net Present Value (NPV):

— Based on discounting ungeared pre-tax cash flows derived from the approach described.

— Discount rate used is in line with APA's current impairment testing of assets as detailed in FY2020 Financial Statements Note 13.

— Pre-tax cash flows is derived by subtracting asset costs as per the CVC from revenue per above, where:

  — Asset costs are related to maintaining asset integrity and assumed to remain unchanged from revenue and volume changes.

  — Other operating and capital expenditure is assumed to remain as per the CVC.

Orbost Gas Processing Plant, Victoria.

glossary.

Adaptation	Anticipating the adverse effects of climate change and taking appropriate action to prevent or minimize the damage they can cause or taking advantage of opportunities that may arise. Refer to TCFD Technical Supplement
AEMO	Australian Energy Market Operator
APA	APA Group. Comprises two registered investment schemes – Australian Pipeline Trust (APT) and APT Investment Trust (APTIT) – and their controlled entities
APT	Australian Pipeline Trust
APTIT	APT Investment Trust
ARENA	The Australian Renewable Energy Agency
Business as usual (BAU)	Business-as-usual projections are based on the assumption that operating practices and policies remain as they are at present. Although baseline scenarios could incorporate some specific features of BAU scenarios (e.g., a ban on a specific technology), BAU scenarios imply that no practices or policies other than the current ones are in place. Refer to TCFD Technical Supplement
Capex	Capital expenditures
Carrying Value Case (CVC)	Forecast of revenue and costs associated with APA's existing asset portfolio as at FY2020. This case has been used to assess asset impairment as detailed in FY2020 Financial Statements Note 13. For the purpose of this report and analysis, this case is used as the baseline case to test resilience. CVC assumes business as usual within the existing asset portfolio with no strategic acquisitions or decisions made by APA during the period, including maintaining a consistent asset footprint and cost base throughout. Refer to Supporting Information Chapter for further details
CSIRO	The Commonwealth Scientific and Industrial Research Organisation
EBITDA	Earnings Before Interest, Taxes, Depreciation, and Amortization
Emissions Scenario	A plausible future pathway of man-made emissions (e.g. greenhouse gases and other pollutants,) that can affect climate. These pathways are based on a coherent and internally consistent set of assumptions about determining factors (such as demographic and socioeconomic development, technological change) and their key relationships. Refer to TCFD Technical Supplement
GDP	Gross domestic product
Greenhouse Gas (GHG)	Gases that have the ability to trap heat when emitted within the atmosphere. The greenhouse gases included under the GHG protocol are: carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PCFs), sulphur hexafluoride (SF6) and nitrogen trifluoride (NF3). Refer to TCFD Technical Supplement
IIASA	International Institute for Applied Systems Analysis
International Energy Agency (IEA)	An autonomous organization that works to ensure reliable, affordable, and clean energy for its 29 member countries and beyond. The IEA has four main areas of focus: energy security, economic development, environmental awareness, and engagement. Refer to TCFD Technical Supplement
IPCC	Intergovernmental Panel on Climate Change. An international forum of experts established in 1988 and used by the United Nations to undertake periodic assessments that address how climate will change, what its impacts may be, and how we can respond. Refer to TCFD Technical Supplement
ISP	The AEMO '2020 Integrated System Plan' Access: https://aemo.com.au/en/energy-systems/major-publications/integrated-system-plan-isp/2020-integrated-system-plan-isp
LNG	Liquefied natural gas

Mitigation	Refers to efforts to reduce or prevent emission of greenhouse gases. Mitigation can mean using new technologies and renewable energies, making older equipment more energy efficient, or changing management practices or consumer behaviour. Refer to TCFD Technical Supplement
MW	Megawatt
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
Paris Agreement	In 2015, Parties to the UNFCCC agreed in Paris to keep the global temperature rise this century well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5°C. The agreement requires all Parties to put forward "Nationally Determined Contributions" (NDCs). There will also be a global stocktaking every five years to assess the collective progress towards achieving the agreement and to inform about further individual actions by Parties. Refer to TCFD Technical Supplement
Physical scenario / physical climate risk assessment	Physical climate scenarios typically present the results of global climate models (referred to as "general circulation models") that show the response of the Earth's climate to changes in atmospheric GHG concentrations. Model results are frequently "downscaled" to derive potential local-level changes in climate, which are then used to generate scenarios of impacts from climate change (first order impacts such as flooding or drought, second order impacts such as loss of crop production, and third order impacts such as famine). Refer to TCFD Technical Supplement
PJ	Petajoule
Representative Concentration Pathways (RCPs)	Four independent pathways comprising sets of projections of radiative forcing that serve as inputs to climate modelling, pattern scaling and atmospheric chemistry modelling. These are based on the forcing of greenhouse gases and other forcing agents. Refer to TCFD Technical Supplement
Scenario	A plausible description of how the future may develop based on a coherent and internally consistent set of assumptions about key driving forces (e.g., rate of technological change, prices) and relationships. Note that scenarios are neither predictions nor forecasts, but are useful for providing a view of the implications of developments and actions. Refer to TCFD Technical Supplement
Shared socioeconomic pathways (SSPs)	Used alongside the Representative Concentration Pathways (RCPs) to analyze the feedback between climate change and socioeconomic factors, such as world population growth, economic development and technological progress. Refer to: IIASA SSP Scenario Database
TCFD	G20 Financial Stability Board's Taskforce Recommendations on Climate-related Financial Disclosures. Visit: https://www.fsb-tcfd.org/
Transition risk(s)	Risks related to the transition to a lower-carbon economy. The risks can be grouped into four categories: policy and legal risk; technological risk; market risk (e.g., consumer preferences); and reputational risk. Refer to TCFD Technical Supplement
Transition scenario	Transition scenarios typically present plausible assumptions about the development of climate policies and the deployment of "climate-friendly" technologies to limit GHG emissions. Transition scenarios draw conclusions, often based on modelling, about how policy and technology regarding energy supply and GHG emissions interact with economic activity, energy consumption, and GDP among other key factors. Refer to TCFD Technical Supplement
TWh	Terawatt-hour