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## The 1.5°C climate objective: A guide for businesses and investors

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May 2017

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# Summary

## **1 How feasible is the Paris Agreement's objective of limiting global warming to 1.5°C?**

It will be more challenging than limiting warming to less than 2°C, but not significantly so. Many measures required to achieve 1.5°C mitigation are similar in strength to those targeting <2°C. Some then diverge from a <2°C path around 2050; others need to begin sooner and ramp up more quickly.

## **2 Can 1.5°C scenarios be credibly modelled today?**

Adequate information exists for businesses and investors to begin analysing 1.5°C scenarios.

The lack of an IEA scenario or a clear IPCC-published mitigation pathway for 1.5°C is not a significant barrier to analysing implications of this objective under the Paris Agreement.

## **3 Why isn't the <2°C objective enough?**

The <2°C limit does not represent a “safe” level of warming. Limiting warming to 1.5°C by the end of the century will significantly lessen, but not eliminate, the threat of extremely disruptive climate change.

## **4 Why do businesses and investors need to consider 1.5°C?**

Businesses that seek to understand and disclose their climate risk without addressing the 1.5°C objective are ignoring shifts that are both plausible and foreseeable. The 1.5°C objective is central to the Paris Agreement and is likely to attract increasing attention from investors, regulators, and those seeking to avoid liability risk.

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# Introduction

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The Paris Agreement, which was adopted in December 2015 and came into force in November 2016, saw almost every country in the world commit to holding “the increase in the global average temperature to well below 2°C above preindustrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels.”<sup>1</sup>

This goal requires that total global greenhouse gas emissions start declining rapidly and reach net zero emissions by around 2070. Global energy sector emissions would need to reach zero by around 2050.

The objective of limiting warming to less than 2°C had been reasonably well anticipated, as it was specified in the 2009 Copenhagen Accord.

Although some governments expressed surprise at the inclusion of the 1.5°C objective, it was based on some 25 years of improvements in scientific understanding of the effects of climate change, and more than 100 countries had pushed for its inclusion in the 2009 Copenhagen Accord<sup>2</sup>.

The Intergovernmental Panel on Climate Change (IPCC) is currently undertaking a special review of the implications of limiting warming to 1.5°C. As a result, resources relating to 1.5°C are rapidly becoming available, and build on the already available detailed, peer-reviewed scenarios that exist.

Pathways to achieving 1.5°C objective, while onerous, are in many ways not dramatically more difficult than achieving the <2°C objective.

Achieving either goal will require decisive action; but limiting warming to 1.5°C by the end of the century will significantly reduce many of the worst impacts and risks posed by climate change.

This paper outlines why the 1.5°C objective is important and what it entails, and it provides key resources for businesses and investors to begin understanding the implications of the 1.5°C objective.

# 1. How feasible is the 1.5°C objective?

*Achieving the 1.5°C objective will be more challenging than limiting warming to less than 2°C, but not significantly so.*

Modelling of numerous mitigation scenarios demonstrates that many parameters of 1.5°C mitigation will be similar to those targeting 2°C<sup>3,4</sup>. Of those that diverge significantly from <2°C, some measures will need to begin sooner and ramp up more quickly; while some others will not need to diverge greatly from a <2°C scenario until around 2050.

Most of the additional effort to limit warming to 1.5°C by 2100 comes from limiting the emissions of carbon dioxide from the energy system. Table 1 provides a simple overview of the key sectoral differences between 1.5 and <2°C scenarios:

**Table 1: Key differences between <2°C and 1.5°C scenarios. Approximate difference between scenarios that hold warming to below 2°C (>66% probability) during entire 21st century and that return warming to below 1.5°C by 2100.** Based on mid-range scenarios. Low is defined as around a >25% increase in ambition, Moderate is defined as around a 26-100% increase in ambition, High is defined as greater than 100%.

MEASURE	DIFFERENCE RANGE
2010-2050 pace* of energy decarbonisation	MODERATE
Total CO2 reductions by 2050 from electricity	LOW
Total CO2 reductions by 2050 from industry	LOW
Total CO2 reductions by 2050 from transport	MODERATE
Total CO2 reductions by 2050 from buildings	HIGH
Cumulative negative emissions technologies	LOW

Source: The Climate Institute, 2017, using data from Rogelj et al, 2015

## Pace of energy system decarbonisation:

**MODERATELY FASTER UNDER 1.5°C THAN 2°C**

Both 1.5°C and likely 2°C scenarios require the electricity system is almost completely decarbonised by 2050. However under 1.5°C scenarios, the global decarbonisation of the energy system needs to be faster; about one-third more advanced in 2030 than in likely 2°C scenarios.

## Total CO2 reductions by 2050 from transport:

**MODERATE**

Emissions reductions to be achieved via transport are up to 50 per cent higher in most 1.5°C scenarios compared to likely 2°C scenarios.

This comes primarily from increased use of biofuels and from reduced demand, rather than from assuming a higher rate of electrification (both the likely 2°C and the 1.5°C scenarios assumed about 25 per cent electrification by 2050, with a range of 5 – 30 per cent).

## Reductions in CO2 from buildings:

**HIGH**

Energy demand from the built environment is particularly important for maintaining a 1.5°C-consistent budget, as buildings are long-lived (in some cases over a century). In most 1.5°C scenarios, the reduction in CO2 from buildings is at least double that of likely 2°C scenarios.

## Cumulative negative emissions technologies:

**LOW**

Most 2°C-consistent scenarios rely on some negative emissions technology deployment during the 21st century (see Box 1). Most 1.5°C scenarios do not assume a much larger quantity of negative emissions, relative to likely 2°C scenarios.

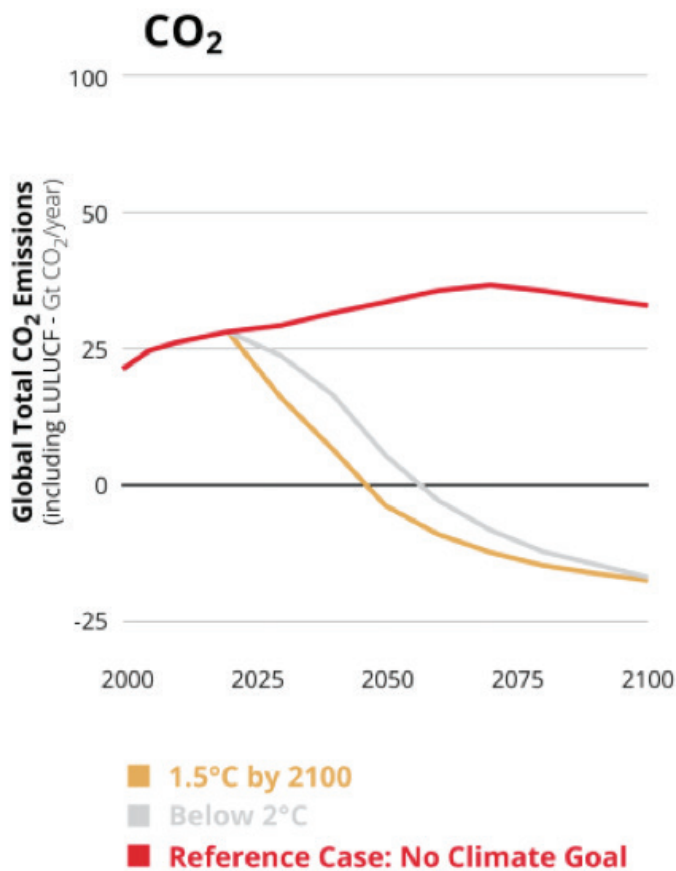
## Total CO2 reductions from electricity:

**LOW**

Electricity CO2 reductions are already high in likely 2°C scenarios, and consequently not much more can be achieved in 1.5°C degrees.

FIGURE 1

The difference between 1.5°C (yellow) and 2°C scenarios (grey): Global CO<sub>2</sub> emissions for baseline, 1.5°C and 2°C scenarios from the MESSAGE integrated assessment model (IAM).



Source: International Institute for Applied Systems Analysis/Joeri Rogelj; Climate Action Tracker; Climate Analytics/The Climate Institute<sup>5</sup>

## Box 1: The role of negative emissions technologies in achieving the 1.5°C and <2°C objectives:

For the world to get onto a 1.5°C or <2°C pathway over the next 15 years, it is critical that deployment of energy efficiency becomes more rapid and other low and zero emission energy supply technologies are deployed. This will also require the retirement of existing emission-intensive energy infrastructure, like coal fired generation.

Post-2030, technologies that remove carbon dioxide from the atmosphere play a significant role in emission scenarios that achieve either 1.5°C or 2°C. The presence of such high concentrations of greenhouse gases that are now in the atmosphere means the need for negative emissions has become virtually unavoidable, even with very rapid emissions reductions between now and 2050. These negative emissions technologies include bioenergy with carbon, capture and storage (bioCCS), or direct air capture. Both could directly withdraw carbon dioxide from the atmosphere and store it on geological timescales. The Climate Institute has previously assessed the role these technologies could play in meeting an Australian carbon budget<sup>6</sup>. This research found that, used appropriately, negative emissions technologies could play a significant role in Australia, with a capacity to remove and displace up to 65 million tonnes of carbon dioxide annually by 2050. However, given the uncertainties as to whether negative emissions technologies can be deployed at the required scale, policy should aim to minimise the need for their use. It is therefore critical that the initial, and most urgent focus should be on the rapid deployment of renewable and other low or zero carbon energy systems, as well as rapid improvements in energy efficiency and the electrification of transport systems.

# 2 Can 1.5°C scenarios be effectively modelled today?

## Research exists to either develop full 1.5°C scenarios or to modify 2°C scenarios

Although many companies have relied upon IEA scenarios, increasingly companies are conducting more diverse and detailed scenario analyses (see Appendix for examples). Research published in Nature Climate Change in 2015 modelled about 200 scenarios from two integrated assessment models, which were divided into “medium 2°C”, “likely 2°C” and “1.5°C”.

Medians for 38 1.5°C-consistent scenarios were identified. In Table 2 and Table 3, we demonstrate how key features of

these 1.5°C scenario medians compare with other existing scenarios tabulated by the Financial Stability Board’s Task force on Climate-related Financial Disclosure (FSB-TCFD).

Work exploring the key features of a 1.5°C scenario has also been published by Climate Analytics<sup>7</sup> and Climate Action Tracker<sup>8</sup>. These and similar projects establishing the feasibility of 1.5°C pathways have recently been reinforced by researchers from 14 European institutions developing a new generation of Integrated Assessment Models<sup>9</sup>.

**Table 2: Underlying assumptions of 1.5°C scenarios compared with scenarios included in FSB-TCFD reports**

	TEMP IMPACT RANGE AND % LIKELIHOOD	SOURCE AND DATA VISUALIZATION	MODEL	UNDERLYING ASSUMPTION: POPULATION	UNDERLYING ASSUMPTION: ECONOMICS	DETAILS: NON-ENERGY EMISSIONS SOURCES <sup>22</sup>	DETAILS: TIMEFRAME
IEA WEO 450 Scenario	2°C, with a likelihood of around 50%	IEA Special Report: Energy and Climate Change and WEO 2014	IEA World Energy Model (WEM)	World population to grow by 0.9% per year, from 7 billion in mid-2012 to 9 billion in 2040 (WEO 2014, pp. 42-44)	World GDP assumed to grow at a rate of 3.4% over 2012- 2040 (WEO 2014, pp. 39-42)	No (p. 35)	2012-2040
ETP 2DS Scenario	2°C, with a likelihood of around 50% (p. 29)	ETP (Energy Technology Perspectives) 2016 <a href="http://www.iea.org/etp/explore">http://www.iea.org/etp/explore</a>	ETP Model	Population to grow from 7.1 billion in 2013, to 9.4 billion in 2050 (p. 385)	Average World GDP growth for 2013-2050 is 3.2% (p. 385)	Yes (p. 29)	2013-2050
Deep decarbonization Pathways Project (DDPP)	Consistent with... warming to less than 2°C with a “better than even” chance	DDPP 2015 Report <a href="http://deepdecarbonization.org/countries/visualization-of-xcountryscenarios/">http://deepdecarbonization.org/countries/visualization-of-xcountryscenarios/</a>	[blank]	Population growth between 2010-2030 for 8 significant countries is in table 3 of the IRENA ‘Synergies’ paper	GDP change between 2010-2030 for 8 significant countries is in Table 3 of the IRENA ‘Synergies’ paper	“Some of the individual country analyses consider sources of carbon emissions other than energy” (p. 4)	2010-2050
IRENA REmap	2°C, if the lower end of CO2 emissions reductions are achieved (p. 42)	IRENA: Roadmap for a Renewable Energy Future (Remap): 2016 edition & IRENA Working Paper: Synergies between Renewable Energy and Energy Efficiency <a href="http://resourceirena.irena.org/gateway/dashboard/">http://resourceirena.irena.org/gateway/dashboard/</a>	[blank]	Population growth between 2010-2030 for 8 significant countries is in table 3 of the IRENA ‘Synergies’ paper	GDP change between 2010-2030 for 8 significant countries is in Table 3 of the IRENA ‘Synergies’ paper	“The energy use of agriculture, forestry, and fishing, as well as nonenergy use is excluded” p. 27, 2016 REmap Paper	2010-2030
Greenpeace Advanced Energy [R] evolution	Aim to hold temperature increase to under 2°C (p. 59)	Greenpeace Energy [R] evolution (5th Ed)	[blank]	Population expected to grow by 0.8% per year on average over the period of 2015-2050 from 7.3 Bn in 2009 to nearly 9.5 Bn in 2050	Average annual GDP growth rate of 3.1% between 2012-2050	Yes - Final energy demand includes nonenergy use (p. 317)	2012-2050
Rogelj et al	All scenarios limit warming to 1.5C by end of 2100 with some overshoot and with >50% chance.	Energy system transformations for limiting end-of-century warming to below 1.5 °C	MESSAGE and REMIND integrated assessment models, derived from MAGICC climate model. (See Methods, pp. 528)	9.2bn in 2050	Average of around 3% assumed by the models from 2010 - 2100	Yes - both CH4 (methane) and N2O (nitrous dioxide). See Supplementary Figure 2; pp 4, Supplementary paper	2010 - 2100

<sup>22</sup> This aligns to Table 1 of the FSB-TCFD’s “Technical Supplement: Scenario Analysis”, page 19, <https://www.fsb-tcfd.org/wp-content/uploads/2016/11/TCFD-Technical-Supplement-A4-14-Dec-2016.pdf> ■ denotes 1.5C scenarios drawn from model runs in Rogelj et al, 2015.

Table 3: Key parameters of 1.5°C scenarios compared with scenarios included in FSB-TCFD reports

	IEA WEO 450 SCENARIO	ETP 2DS SCENARIO	DEEP DECARBONIZATION PATHWAYS PROJECT (DDPP)	IRENA REMAP	GREENPEACE ADVANCED ENERGY[R] EVOLUTION	ROGELJ ET AL 1.5C	
POLICY & DEMAND	<b>ENERGY EFFICIENCY</b>	Strong efficiency related policy action	– Around 5100 GW of new capacity is avoided between 2016 and 2050. – A decrease in energy intensity is of almost two thirds is assumed from 2013 to 2050. (p. 31)	Average energy intensity of GDP for the 16 DDPP countries as a whole falls 64% from ~8.2 MJ/\$ in 2010 to 3 MJ/\$ in 2050. (p. 9) – Average Carbon Intensity of electricity falls from ~530 gCO <sub>2</sub> /kWh in 2010, to ~40gCO <sub>2</sub> /kWh in 2050. (p. 9)	Building sector has the greatest energy savings. (p. 22, Synergies paper) – Efficiency gains from the deployment of REmap would keep the global Total Primary Energy Supply 5% below 2010 level. (p. 27, Synergies paper)	– Efficiency measures in the industry, residential and service sectors avoid the generation of about 16,700 TWh/a (by 2050) (p. 13)	Average energy intensity rate reduces by an average of about 2.5% per year from 2010 to 2100, compared with an average of 1.3% in 1970 - 2010
	<b>CO<sub>2</sub> PRICE</b>	– After 2020, a CO <sub>2</sub> price is adopted in OECD countries. – Fossil fuel subsidies removed in all regions except the Middle East by 2035. CO <sub>2</sub> prices in most OECD markets reach \$140/ton in 2040, up from ~\$20/ton in 2020 (p. 45, WEO 2014)	Assumptions are that in the US Carbon taxes begin in 2020 at \$35/tCO <sub>2</sub> , and increase linearly to \$210/tCO <sub>2</sub> by 2050. – Where the current level of taxation is greater than this, taxes are maintained until this schedule catches up with them.	Note: “The choice of policy instruments depends on societal preferences;” therefore in the DDPPs, the importance of carbon pricing does vary, although it is of importance in all. (pp.39-41)	A range of USD 17-80/t CO <sub>2</sub> is assumed for carbon prices (p. 26-27, 2016 REmap paper)	– In contrast to the 2012 edition, the 2015 Energy [R]evolution analysis, CO <sub>2</sub> pricing is set aside. (p. 67)	2020 median: \$87, \$159 in 2030, \$422 in 2050 (all 2005USD)
	<b>ENERGY DEMAND</b>	Global energy demand grows on average by only 0.6% per year; in 2040 demand is up 17% on 2012.	Final energy demand to grow to 455EJ by 2050, up from 390 EJ in 2014. (p.32)	– Medium emissions/ moderate income countries: Energy consumption peaks 2030-40. Fossil fuel consumption in 2050 = 2010 levels. (p.15) – High emissions/ high-income countries: Final energy demand falls 10% below 2010 levels by 2050.(p. 17)	– Global energy demand grows 30% in 2030 compared to levels today. (p. 14, Remap 2016 Paper)	Primary energy consumption 433,000 PJ/a in 2050 (excluding non- energy consumption), down from 534,870 PJ/a today. (p.92) – Peak final energy demand reached in 2020 with a total of 355,000 PJ/a. (pp.12-13)	“final” energy: In most 1.5 °C scenarios the average energy demand is below 400 EJ yr <sup>-1</sup> , reflecting an increase from today’s 350 EJ yr <sup>-1</sup> to about 450 EJ yr <sup>-1</sup> by 2100
KEY DRIVERS/SIGNPOSTS	<b>SOLAR PV DEPLOYMENT</b>	[blank]	In 2050, urban rooftop solar PV is assumed to account for around 47% of global electricity generated by solar PV, and 9% of the electricity consumed in cities. (p. 284)	– Cumulative production of decarbonized energy(GW) from Solar PV, in all DDPP countries, grows as follows: 2010: 1GW, 2020: 275GW, 2030:823GW, 2040: 1752GW, 2050: 3254GW (p. 29)	– Solar PV power generation capacity is 1760 GW by 2030, up from 180GW in 2014 and 780 GW in the reference case (p. 67, 2016 REmap paper) – Solar PV power capacity increases at a rate of 99 GW/year in 2012- 2030.	Solar PV provides 14% of total electricity generation by 2030, employing 10.3 million people. – Total generation rises from 1,090 TWh in 2020, to 2,659 TWh in 2025, and 5,067 TWh in 2030. (p. 202)	Median values of all 1.5C scenarios modelled: 8.5EJ/year in 2020; 25.7EJ/year in 2030; 82.4EJ/year in 2050
	<b>EV DEPLOYMENT</b>	Sale of EVs exceed 40% of total passenger car sales worldwide in 2040. (p. 109, WEO Special Report) – – Advanced biofuels and EVs reduce oil consumption by 13.8 mboe per day in 2040 (p. 123, WEO Special Report)	– 100 million EVs by 2030, up from 1 Million in 2016. (p. 253) – Annual sales growth of EVs assumed to be sustained, from 53% in 2014, to 66% through 2020 and to 39% through 2025. (p. 104)	Production of EVs (per million): 2010: 0, 2020:32, 2030:134, 2040:333, 2050: 650 (p. 29)	The number of electric vehicles reaches 160 million units in 2030 under the Remap scenario, up from 60 million in the reference case and 0.8 million in 2013/2014. (p. 102, 2016 REmap paper)	[blank]	By 2050 about 25% (5–30%) of the energy required in the transport sector comes from electricity. In 2030 it is about 5%. (p.7 supplement)
	<b>CCS DEPLOYMENT</b>	80 GW of CCS equipped Oil & Gas capacity to be operating by 2025. Between 2030 and 2040, 580 GW of coal-fired power generation equipped with CCS. – By 2040, 80% of coal-fired generation capacity has CCS equipped, compared with 4% in the new policies Scenario.	Assumed 540 MtCo <sub>2</sub> being stored per year in 2025. (p.96) – CCS assumed to provide 12% of cumulative emissions reductions, capturing around 3.5 GtCo <sub>2</sub> worldwide in 2050. (p. 39)	– Assumed growth in CCS deployment from ~3GW in 2020 to ~20 GW in 2030, rising to ~56 GW in 2040, and 76.7 GW in 2050. (p.37)	– (Credits CCS as important, but no discussion of specific impact in scenario)	‘CCS Technologies are not implemented.’ (p.60) – CCS technologies are not included in the Energy Revolution, due to the speculative nature of assumptions around costs, effectiveness and environmental effects (p.67)	Bio-energy with CCS (BECCS) features in 2050-2100 as a key tool for atmospheric carbon dioxide removal (CDR). Median share of all low-carbon electricity (renewables, CCS, and nuclear) is 50% by 2020, 70% by 2030 and close to 100% by 2050.
	<b>BIO-ENERGY</b>	– The fuel mix is much more diversified by 2040, biofuels consisting of 17% of world transport demand (p.124, WEO Special Report)	Assumed production of 56.8 billion liters of biofuels by 2025. (p. 108)	Cumulative production of decarbonized energy (GW) from Biomass, in all DDPP countries, grows as follows:2010: 1 GW, 2020: 26 GW,2030: 105 GW, 2040: 221GW, 2050: 270 GW	Demand for liquid biofuels reaches 500 billion liters per year in 2030 if all REmap options are implemented. (p. 108, 2016 Remap paper) – Bioenergy power generation capacity is 430 GW by 2030. (p. 67, 2016 REmap paper)	Heat supplied by Biomass increases from 31,404 PJ in 2020, to 34,909 PJ in 2025, and 36,623 PJ in 2030. (p. 203)	Bio-fuels account for a median of 2% of liquid energy carriers in 2020; about 5% in 2030; and about 40% in 2050. Biomass, median usage: 58.8EJ/year in 2020; 86.1 in 2030 and 141EJ/yr in 2050.
	<b>EMERGING TECHNOLOGIES</b>						



KEY DRIVERS/SIGNPOSTS	SCENARIOS					
	IEA WEO 450 SCENARIO	ETP 2DS SCENARIO	DEEP DECARBONIZATION PATHWAYS PROJECT (DDPP)	IRENA REMAP	GREENPEACE ADVANCED ENERGY[R] EVOLUTION	ROGELJ ET AL 1.5C
ENERGY MIX % RENEWABLES	– Variable renewables increase from 3% of global electricity generation in 2015 to more than 20% by 2040. (p. 109, WEO Special Report)	CO2 intensity of electricity falling from 528 gCO2/kWh in 2013 to less than 40gCo2/ kWh in 2050. Achieved through deployment of low-carbon generation.	– Annual investment in low carbon technology as a share of GDP (%) expected to grow across the DDPP countries: 0.8% in 2020, 1.2% in 2030, 1.3% in 2040, 1.3% in 2050. (p.32)	– 45% of Power generation in the REmap scenario in 2030 uses renewable technology (up from 23% in 2014), compared to 30% in the Reference case. (p. 54, 2016 REmap paper)	45% of Power generation in the REmap scenario in 2030 uses renewable technology (up from 23% in 2014), compared to 30% in the Reference case. (p. 54, 2016 REmap paper)	Median values of 1.5C scenarios: Share of all low-carbon electricity (renewables, CCS, and nuclear) is 50% by 2020, 70% by 2030 and close to 100% by 2050.
ENERGY MIX NUCLEAR	Global nuclear capacity more than doubles to 862 Gw in 2040, 38% higher than in the New Policies Scenario. (p. 406) – Development depends on some \$81 billion/year in investment in new nuclear plants over 2014- 2040. (p. 406)	Assumed growth in global nuclear capacity from 403GW in 2016 to 553 GW by 2025. (p. 90)	Cumulative production of decarbonized energy (GW) from Nuclear technology, in all DDPP countries, grows as follows: 2010: 2GW, 2020: 53GW, 2030: 259GW, 2040: 632GW, 2050: 1053GW (p. 29)	Under the REmap scenario, Nuclear power generation capacity is 600GW by 2030, up from 370GW in 2014, but less than the Reference Case in 2030, at 650GW. (p. 67, 2016 REmap paper)	No new nuclear power plants will be built worldwide in the Energy [R]evolution Scenarios. (p. 122)	Median nuclear generation from all 1.5C scenarios: 12.5EJ/year in 2020; 16.2 EJ/year in 2030; 27.3 EJ/year in 2050
OUTCOMES CO2 EMISSION	Energy-related CO2 emissions peak at 33Gt before 2020, then fall back to 25.4 Gt in 2030 and 19.3 Gt in 2040 (almost 50% lower than New Policies Scenario).	CO2 emissions in the 2DS are reduced to 15 Gt in 2050, less than half the current value. (p. 28)	Range of cumulative energy-related emissions of 805-847GtCO2 by 2050. (pp. 17-18)	– The lower end of this (CO2 reduction) range is sufficient to keep the world on a 2oC pathway” (pp. 41-42, 2016 REmap paper)	– 100% Renewable energy decarbonization – of the entire energy system by 2050. – Global CO2 emissions stabilize by 2020 and then constantly reduce. – Total cumulative CO2 emissions between 2012 & 2050 are 667 Gt CO2. (p. 15)	Median budget of 797 Gt from 2010 to 2050, of which 288 Gt is for 2016 to 2025. Negative budget of 479 Gt from 2050 - 2100. Median global annual emissions of CO2e of 41 Gt to 2020; 37 Gt to 2025; 33 Gt to 2030; 13 Gt to 2050.

This aligns to Table 2 of the FSB-TCFD's "Technical Supplement: Scenario Analysis", page 20, <https://www.fsb-tcfd.org/wp-content/uploads/2016/11/TCFD-Technical-Supplement-A4-14-Dec-2016.pdf>. ■ denotes 1.5C scenarios drawn from model runs in Rogelj et al, 2015.

## Box 2: IEA and IPCC scenarios

### The IEA 450 Scenario

The IEA's World Energy Outlook 450 scenario<sup>10</sup> is heavily relied upon by companies undertaking climate scenario work<sup>11</sup>. However the IEA acknowledges that its 450 Scenario, and its 2DS scenario, are not consistent with the Paris Agreement, in part because they do not limit warming to “well below 2°C”, but rather are pathways for a 50 per cent chance of limiting warming to 2°C. A more recent scenario developed by the IEA and the International Renewable Energy Agency (IRENA) examines a 55% percent change of limiting warming to 2°C<sup>12</sup>.

The IEA is developing scenarios more consistent with the Paris Agreement, including limiting warming to well below 2°C and 1.5°C by 2100.

However, it should be noted that IEA scenarios to date have featured several shortcomings, including:

- They do not extend beyond 2040, at which point a significant increase in speed of emission reduction will be required to meet Paris Agreement targets. The IEA itself describes the decade between 2040 and 2050 as likely to be “increasingly challenging” as remaining emissions would be in areas that are more difficult to decarbonise<sup>13</sup>.
- Only energy sector emissions pathways are modelled, and options central to achieving well below 2°C and 1.5°C scenarios (for example, carbon removal technologies) are excluded
- The TCFD notes<sup>14</sup> that IEA scenarios have significantly under-estimated the growth rate of renewables deployment<sup>15</sup>.

### The IPCC scenario database

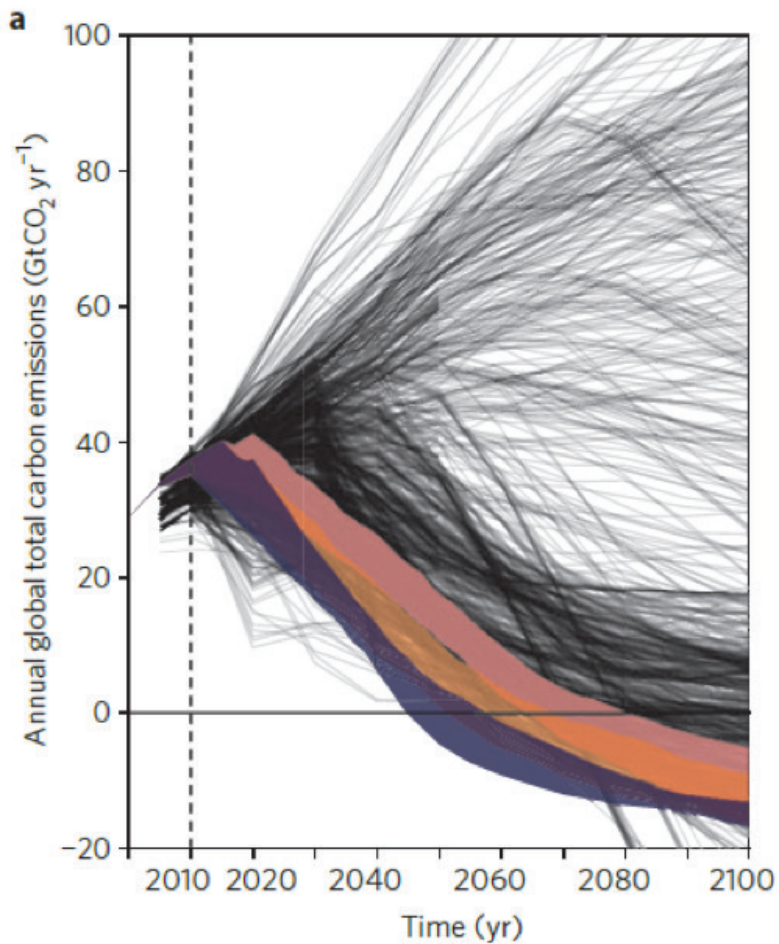
The IPCC's most recent assessment, the Fifth Assessment Report, (AR5), does not explicitly specify a 1.5°C outcome in its key climate change mitigation pathways. However, scenarios in the IPCC database are available that achieve this outcome (See Tables 2 and 3, and Figure 2).

The IPCC will publish a Special Report in September 2018 on the 1.5°C objective<sup>16</sup>. This will provide additional insights that can be drawn upon in the future.

**FIGURE 2**

Projected total global annual carbon emissions over time. Coloured areas represent the 15th–85th percentile range of the three scenario groups used in Rogelj et al, 2015. Pink: medium 2°C scenarios—limiting warming during the twenty-first century to below 2°C with 50–66% chance;

orange: likely 2°C scenarios—limiting warming during the twenty-first century to below 2°C with >66% chance; blue: 1.5°C scenarios—limiting warming in 2100 to below 1.5°C with >50% chance. Thin black lines are scenarios included in the IPCC AR5 scenario database.



Source: Rogelj et al, 2015.

# 3 Why is 2°C not adequate?

*The 2°C limit does not represent a “safe” level of warming. Limiting warming to 1.5°C by the end of the century will significantly lessen, but not eliminate, the threat of extremely disruptive climate change.*

Warming of up to 2°C is often described as within a “safe limit”.

However, scientific research has for decades indicated this limit being too high and would likely mean significant impacts. The UN Environment Programme Advisory Group on Greenhouse Gases (AGGG), the precursor to the IPCC, stated in 1990 that:

**“Temperature increases beyond 1 degree Celsius may elicit rapid, unpredictable and non-linear responses that could lead to extensive ecosystem damage.”**

The AGGG noted that a total 2°C increase was:

**“viewed as an upper limit beyond which the risks of grave damage to ecosystems, and of non-linear responses, are expected to increase rapidly”.**<sup>17, 18</sup>

Climate modelling advances and observations of changes in the years since have increasingly highlighted that even 2°C of warming would likely have very serious impacts for many geographies, populations, and industries. This was reaffirmed in 2015 by a comprehensive assessment of the differences in impacts between 1.5°C and 2°C which was undertaken as part of the review of the long-term global goal of the UNFCCC<sup>19</sup>.

While 2°C has provided a pragmatic and clearly articulated goal, and would be far better than a higher increase, it is far from being a “safe” level of warming in many ways (see Table 2). For example, even warming of 1.5°C would have significant extra costs. If the world warms by 1.5°C, currently rare climate related extremes (extreme heatwaves, unusual dry spells, extreme rainfall, massive global coral bleaching events) would become the new normal condition. If global mean warming were to reach 2°C, the climate system would move into uncharted territory<sup>20</sup>.

Table 4: Estimated impacts of climate change for 1.5-2°C scenarios.<sup>21</sup>

IMPACT	1.5°C	2°C
<b>Coral reefs</b>	Severe impacts; some potential for limited adaptation remains	Virtually all tropical coral reefs will be severely degraded
<b>Heat extremes</b>	On average, south and central Australia would experience heatwaves of two weeks of the year; heatwave length for the northern regions would be around a month	Extreme heatwaves are much more severe than current experience and occur annually. Heatwave length extends to about 3 weeks in south and central Australia, and around two months in the north
<b>Water availability</b>	Declines (~10 per cent) across most of Australia (more severe in west); up to 30 per cent reductions in some scenarios	Greater declines across southern Australia. Up to 40 per cent reductions in some scenarios
<b>Sea level rise</b>	~40cms to 2100; declining rates of sea-level rise towards the end of the 21st century reduce the long-term sea-level rise commitment; risks to multi-metre increases still exist due to loss of ice from major ice sheets	~50cms to 2100; multi-metre sea-level rise commitment over centuries to come

# 4 Why do businesses and investors need to consider 1.5°C?

*Businesses that seek to understand and disclose their climate risk without addressing the 1.5°C objective are ignoring shifts that are both plausible and foreseeable. The 1.5°C objective is central to the Paris Agreement and is likely to attract more attention from investors, regulators, and those seeking to avoid liability risk.*

The “foreseeability” of climate-related risks has been highlighted by Noel Hutley SC, the Australian Prudential Regulatory Authority (APRA), and the Financial Stability Board’s Task force on Climate-related Financial Disclosure (FSB-TCFD).

## **APRA**

In February 2017 Geoff Summerhayes, one of the three top officials at APRA, delivered a speech about climate risk for entities regulated by APRA.

*Some climate risks are distinctly ‘financial’ in nature. Many of these risks are foreseeable, material and actionable now.*

*The agreement provides an unmistakable signal about the future direction of policy and the adjustments that companies, markets and economies will need to make.*<sup>22</sup>

As with other financial authorities in Australia and overseas, prepared speeches delivered by officials are used by APRA to signal to their regulated entities areas of growing interest and focus.

## **Hutley view on director liability**

A memorandum of opinion published in October 2016 and written by Noel Hutley SC and Sebastian Hartford Davis pointed out that climate change-related risks need to be considered by company directors along with any other foreseeable risk that could lead to a loss if not mitigated or adapted to.

*“Company directors certainly can, and in some cases should, be considering the impact on their business of “climate change risks”.*<sup>23</sup>

The memorandum was subsequently referenced by APRA, the Senate Economics Committee’s inquiry into Carbon Risk Disclosure, and the Australian Institute of Company Directors’ Governance Leadership Centre<sup>24</sup>.

Hutley and Hartford Davis clearly pointed to the importance of the foreseeability of losses that might arise:

*“A risk is “foreseeable” if it is not “far-fetched or fanciful”.*

They also point to the importance of policy risks arising from Australia’s need to meet its commitments made in the Paris Agreement:

*“At the moment, the regulatory environment in Australia would appear to be insufficient to meet the commitments made at the Paris climate change conference in December 2015.*

*[...] It is obvious that if the emissions reductions targets are going to be achieved, there will be a major process of transition, presenting risks (as well as opportunities) to businesses.”*

## **Financial Stability Board's climate task force**

The FSB-TCFD states the scenarios should be “plausible”. It identifies the Paris Agreement objectives of limiting warming to 1.5-2°C as a key basis of its work devising a climate risk disclosure framework for companies, asset owners, and asset managers<sup>25</sup>. The task force includes as a core recommendation that scenario analysis be conducted by organisations assessing the potential implications of climate-related risks and opportunities. It specifies a “2°C scenario” as a key transition risk scenario: “A 2°C scenario provides a common reference point that is aligned with the objectives of the Paris Agreement”<sup>26</sup>.

Scenarios are the topic of an entire technical supplement document published by the task force, which outlines how a scenario should be plausible:

***“Scenario analysis, therefore, evaluates a range of potential outcomes by considering a variety of alternative plausible future states (scenarios) under a given set of assumptions and constraints.***

***A scenario describes a path of development leading to a particular outcome. Scenarios are not intended to represent a full description of the future, but rather to highlight central elements of a possible future and to draw attention to the key factors that will drive future developments. It is important to remember that scenarios are hypothetical constructs; they are not forecasts or predictions nor are they sensitivity analyses. A key feature of scenarios is that they should challenge conventional wisdom about the future. In a world of uncertainty, scenarios are intended to explore alternatives that may significantly alter the basis for “business-as-usual” assumptions.”***

The inclusion of the 1.5°C objective in the Paris Agreement, and the impacts and risks from failing to limit warming to 1.5°C, suggest that such a scenario is at least plausible.

## **Investor expectations**

Investors are asking more exacting questions around climate risk, and it is foreseeable that 1.5°C will begin to receive more attention.

Investor expectations were listed as a key driver for companies undertaking internal and external work to understand the implications of a future in which warming is limited to below 2°C, in research by KPMG and The Climate Institute<sup>27</sup>.

In 2016 and early 2017, large asset managers have rapidly raised expectations for robust climate-related risk disclosure from the companies in which they invest.

Recent examples include Blackrock<sup>28</sup> (the world’s biggest asset manager), State Street<sup>29</sup> (world’s third-largest asset manager), and Legal & General Investment Management<sup>30</sup> (LGIM; the UK’s largest asset manager) have all identified companies’ recognition and response to climate risk as a key criteria across their general portfolios. Blackrock and LGIM stated that they may vote against re-election of company directors who demonstrate they cannot address these risks.

Although most investor expectations relating to climate “transition” risk have focused on the <2°C objective, the rate at which these expectations are being raised suggests that information on risks arising from the world pursuing a 1.5°C pathway will be increasingly sought.

Plans by the IEA to release a 1.5°C scenario in mid-2017, and the IPCC’s special report due in September 2018, will further raise expectations that are already anchored to the Paris Agreement.

# Endnotes

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## Appendix: Parameters of selected corporate 2°C scenarios

ORGANISATION	HAS A <2°C SCENARIO	LEVEL OF TRANSPARENCY / DISCLOSURE	KEY SCENARIO POINTS	HORIZON OF ANALYSIS
AGL <sup>(1)</sup>	Maybe	<ul style="list-style-type: none"> <li>· Discloses carbon budget</li> <li>· Discloses trajectory</li> <li>· Discloses own sectoral budget allocation</li> <li>· Discloses a 2050 point</li> </ul>	<p>Budgeted response, using the Climate Change Authority's 10.1Gt budget to 2050. Derives a National Electricity Market budget of 3,026Mt.</p> <p>PLEXOS modelling for 3 NEM reduction pathways (1. no carbon reduction; 2. 26-28% reduction from 2005 levels by 2030; and 3. 2°C budget based on CCA analysis).</p> <p>Discusses marginal abatement cost of carbon at AUD\$40/t for a new coal power plant, and &gt;AUD\$100/t for an existing coal plant.</p> <p>Annual sectoral emissions reductions of c.7% p/a from 2020-2050.</p>	2030, 2050
BHP BILLITON <sup>(2)</sup>	Maybe	<ul style="list-style-type: none"> <li>· Discloses 2030 reductions by region</li> <li>· Does not disclose global budget or trajectory; states "in line with levels indicated by the IPCC" to 2030</li> <li>· Discloses carbon prices</li> <li>· Does not disclose 2050 point</li> </ul>	<p>Four scenarios including 'signals' which show that the world is moving towards or away from each scenario.</p> <p>'Global accord' 2°C carbon price of US\$50 in 2030.</p> <p>Supplementary "shock" stress test includes price of \$US80 in 2030.</p>	2030
WESTPAC <sup>(3)</sup>	Maybe	<ul style="list-style-type: none"> <li>· Discloses net zero endpoint by 2050 for Australia; a necessary achievement for &lt;2°C</li> <li>· Doesn't disclose budget or midpoint/trajectory</li> <li>· Implies carbon price in one scenario but doesn't specify level</li> </ul>	<p>Three 2°C scenarios which all achieve net zero emissions by 2050:</p> <ul style="list-style-type: none"> <li>- Strong national action: countries act on their own and there is rapid domestic action on climate change;</li> <li>- Combined global action: international carbon markets facilitate a smooth transition; and</li> <li>- Delayed action: initial delays in action lead to a rapid mitigation post-2030.</li> </ul>	2050

Table 2: \*IEA's 450 scenario uses a carbon budget based on a 50 per cent chance of staying below 2C of warming, goes to 2040, and is limited to energy emissions. It is not consistent with the Paris Agreement objectives.

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