*Analysis*

# Do not draw false comfort from the IPCC report

- *Any serious decision-maker may hope for the best, but plans for a most realistic outcome*
- *The IPCC report has some scenarios in which temperature rise is contained to below $2^0$C*
- *But the politics of China, the US, India, and Russia make such outcomes unlikely*
- *A rise of 3 or even 4 degrees seems much more probable*
- *Two conditionally optimistic scenarios might, just might, limit temperature increases*

**The latest IPCC report is now unequivocal**

The Intergovernmental Panel on Climate Change (IPCC), in its Sixth Assessment Report,[1] has now come out unequivocally, saying *inter alia* that:

- Global warming is man-made.
- Seriously damaging events will become increasingly common unless the rise in temperature globally is limited to 1½ to $2^0$C above 1900 levels.
- It is possible to draw emission paths that achieve this.

All well and good – but there are two reasons to not draw false comfort from these paths.

## Two problems

**Some governments have hidden behind IPPC's past caution**

**First**, **standard of proof**. The IPCC has always applied, and continues to apply, a scientific standard of proof, and requires that the scores of scientists nominated by IPCC member governments around the world sign up to every word. No criticism of the IPPC for that. But that standard of proof is far higher than that appropriate for policymaking, let alone for business purposes, for which 'balance of risk' is the generally appropriate criterion.

Thus it has been that politicians in many countries have been able to hide behind uncertainties that the IPCC has until now been unable to reject, and that some hydrocarbon producers have gone to great lengths to promulgate.[2] Policy in important emitting countries has thereby largely frittered away 30-odd years;[3] and many businesses have been slow to come to grips with what inevitably climate change means for them.

**Second, likelihood.** The purpose of the IPCC report is to *"…address the most up-to-date physical understanding of the climate system and climate change, bringing together the latest advances in climate science, and combining multiple lines of evidence from paleoclimate, observations, process understanding, and global and regional climate simulations."* And in the course of so doing, various paths of greenhouse gas (GHG) emissions, with associated temperature increases, are simulated.[4] In some of these, temperature rise globally is limited to 1½ to $2^0$C above 1900 levels.

However, just because a path can be specified, does not mean that it is likely to happen. Any committee of government representatives has no realistic option but to say, right up to the 11th hour, that it remains possible to save the day, if policymakers act forthwith.

The question for investors and business is whether it is realistic to suppose that the governments of the four countries that produce over half of global GHGs – China with its development imperatives,[5] the US with its fractured politics, India with its undirected governance, and Russia with its fundamental ambivalence[6] – are about to move to the demanding emissions-reduction path that a 1½ to $2^0$C limit requires.

**Our best guess is that the world is set to warm by 3 to $4^0$C**

Our best guess is that, when the likely behaviour of major governments is factored in, there is little realistic prospect of temperature increase being held to 1½ or $2^0$C: 3 degrees seems the likely minimum; and 4 degrees a real possibility.

That said, there are always outlying possibilities, whose likelihood cannot be estimated with anything like scientific standards of accuracy.

Three in particular are worth some consideration. One such – the 'runaway' case – produces markedly worse, indeed catastrophic, outcomes. The other two produce comparatively benign outcomes.

## The 'runaway' case

The cases simulated by the IPCC generally take it that equilibrium temperature is a near-linear function of GHG concentrations.[7] But there is a possibility – we put it no stronger than that − that the global climate system may evolve in a non-linear, 'runaway', mode the result of 'positive-feedback' mechanisms.

The greater the accumulation of $CO_2$ and other GHGs, the higher becomes the mean temperature: and the further that the system moves from the stable 'pre-industrial' configuration, the greater the chance of a 'tipping point'[8] and unstoppable runaway.[9]

One malign such mechanism (among several that are currently exercising some scientists and climate modellers) proceeds thus:

- Global warming melts the tundra, releasing methane, a particularly potent GHG;[10]
- The world thereby warms further, melting more permafrost;
- Additional methane is thereby released; and so on.

**There is even a chance of 'runaway' increases**

Under some model assumptions the positive feedback is so powerful that no reduction in man-made emissions can now prevent runaway temperature increase. Some scientists now advocate scaling up research into 'geoengineering', whereby large-scale interventions aim to cool the climate. This might involve injecting sulphate particles, or launching mirrors into the upper atmosphere or earth orbit to reflect sunlight back out into space.[11] Such moves remain controversial however, not least because they would introduce new risks.[12]

Moreover, in a complex system such as the atmosphere, and even if all the 'excess' $CO_2$ were to be sucked out of the atmosphere immediately, it is by no means certain[13] that conditions would revert to what they were before 1900: the system might find a second, and quite new, quasi steady state.[14]

None of this is by any means a certainty. But it is a possibility that is rated seriously by some, not least following improved measurement of methane emissions.[15]

## The first optimistic case – 'switching on the clean innovation machine'

**One hope is that the 'green machine' gets switched on …**

Perhaps the most plausible benign case rests upon the perception that new technologies are superior, this leading to behaviour that facilitates their successful adoption.[16]

There are already some signs that fear of climate catastrophe, aligned with self-interest and opportunity, is driving innovation and prompting a phase-shift to superior 'we should have done this anyway' behaviour.[17]

Once the 'clean innovation machine' has been 'switched on and is running,' it can be more innovative and productive than the conventional alternative[18], with a constructive impact on GDP (and GDP growth) and competitiveness.[19]

An example: in less than a decade, renewable energy generation and electric vehicles have gone from eye-wateringly expensive, to cheaper and superior to conventional fossil fuels.[20] And they are getting better (to understand the drivers of this process, see Box).

Market forces drive the implementation of the new technologies: companies and policymakers know that if they fall behind, they will see their competitiveness erode as competitors shift to low-carbon resource-efficient markets. Indeed, investors are already offloading assets that are likely to flounder in the 21st century and are at risk of being devalued and stranded.[21]

Because these processes are path-dependent, they are highly sensitive to initial conditions. Policy and leadership matter enormously at the outset. Any optimism is therefore conditional on early action to steer the future, and to finance the necessary investment.[22] As with climate impacts, delay raises costs and shrinks opportunities. Thus:

- Switching to the sustainable economy requires costly investment and generates social disruption and valuation losses across the economy.
- Yet the sheer scale of the low-carbon transition promises productivity-enhancing economies of scale in production and discovery, which generate new value and opportunities even in the near term.

The need for up-front investment to deliver uncertain longer-term gain has bred scepticism about the political practicality of such a transition. Yet the pace of change in some key sectors has caught many commentators by surprise; and this has been achieved with only minimal policy effort, exerted over the past few decades.[23]

### *Box: The story of the electricity and automobile sector*

The automobile and electricity sectors exemplify the way, and the degree to which, large-scale deployment can lower costs, in turn inducing large-scale deployment.[24]

Key amplifying feedback mechanisms, which rapidly reduce the costs of new technologies, include:

- **Learning-by-doing from experience**. Deployment allows lessons to be learned on how to manufacture, distribute, instal, run and maintain equipment more efficiently.
- **Economies of scale in production and distribution**. Once initial fixed costs have been incurred, unit costs fall as larger production and distribution networks are developed (think Chinese solar p.v. or battery gigafactories).
- **Network and coordination effects**. There are advantages to moving in tandem with others, such that the gains are higher the more economic agents are taking similar action (think EVs and charging networks).
- **Sector spill-overs**. Sustainable technologies been shown to have positive productivity spill-overs into other sectors of the economy, boosting total factor productivity growth.[25]
- **Social and institutional feedbacks**. Acceptable standards of behaviour and social norms change.[26] New political institutions such as ministries, agencies and business and trade union lobbies are created. These are accompanied by supportive policies: in the case of carbon, these include carbon taxes, deployment support, and new standards and regulations that are being deployed globally. Central banks, activist investors (including large institutional investors, not just individual investors or 'civil society' groups) are already pushing to steer finance and shape new markets.
- **Evolution of consumer behaviour.** Consumer tastes attribute value to goods and services and consumers routinely influence one another, leading to positive feedbacks and crowd effects.[27]

## The second optimistic case: the 'NASA moonshot'-type possibility

A second optimistic case, that cannot be dismissed, is that new, as yet undeveloped and uncertain or even unknown, technologies are invented that make it possible, for example, to remove $CO_2$ from the atmosphere at reasonable cost and using renewable sources of energy.

**… while another is that China or the US 'do a NASA'**

While this may seem unlikely, it should not be rejected out of hand: it is not possible to know what may be invented. The most likely – or least unlikely – candidate countries to develop such technologies would be the US and China. Both have an extraordinary ability, if those controlling and financing national institutions are so minded, to draw from an unrivalled pool of human knowledge and financial capital to develop 'mission oriented' new technologies and implement them with great speed.

## Watch fors

- On the pessimistic side: lack of early decisive action in the US, China, India, and Russia, making the path to $3^0$ to $4^0$C rise the most likely outcome, and increasing the risk of a positive 'runaway'; or
- On the optimistic side, either:
  - Leadership and policy that show signs of succeeding in 'switching on the green machine' and making it 'roar'; or
  - A national technological commitment to develop radical, even speculative new technologies.■

*A number of important observations on this general subject were offered by Martin Rees; and helpful comments on an earlier draft were given by Saul Eslake.*

[1] Sixth Assessment Report (ipcc.ch)

[2] Even more culpable are those in the petroleum industry who sought to claim, and spent considerable sums espousing, that the science was uncertain, and therefore should be disregarded.

[3] The first IPCC report was published in 1990. See ipcc_90_92_assessments_far_front_matters.pdf

[4] See for example Sixth Assessment Report (ipcc.ch) Table SPM.1, pp. 41-42.

[5] China's expansion of coal-powered steel mills accelerated sharply in the first half of 2021. Analysis of Chinese government approvals by the Centre for Research on Energy and Clean Air, a Finland-based advocacy group, found that 18 steelmaking blast furnaces and 43 coal-fired power plants were announced in the first half of this year [2021]. See China puts growth ahead of climate with surge in coal-powered steel mills | Financial Times (ft.com) 13 August 2021.

[6] Russia is one of a small number of countries whose economies stand to benefit from global warming – see Silja Sepping and John Llewellyn, *The effects of climate change on productivity*, Llewellyn Consulting, April 2021. Available on request. Moreover, being a significant producer of gas and oil, it is far from clear that Russia has any interest in limiting greenhouse gas emissions. On the contrary, in fact.

[7] Thus: *"… This Report reaffirms with high confidence the AR5 finding that there is a near-linear relationship between cumulative anthropogenic $CO_2$ emissions and the global warming they cause. Each 1000 $GtCO_2$ of cumulative $CO_2$ emissions is assessed to likely cause a 0.27°C to 0.63°C increase in global surface temperature with a best estimate of 0.45°C[41]. This is a narrower range compared to AR5 and SR1.5. This quantity is referred to as the transient climate response to cumulative CO2 emissions (TCRE). This relationship implies that reaching net zero[42] anthropogenic CO2 emissions is a requirement to stabilize human-induced global temperature increase at any level, but that limiting global temperature increase to a specific level would imply limiting cumulative CO2 emissions to within a carbon budget …[43]"*. Sixth Assessment Report (ipcc.ch) p. 42, para. D1.1.

[8] The IPCC report notes that "*Low-likelihood, high-impact outcomes are those whose probability of occurrence is low or not well known (as in the context of deep uncertainty) but whose potential impacts on society and ecosystems could be high. A tipping point is a critical threshold beyond which a system reorganizes, often abruptly and/or irreversibly."* See Sixth Assessment Report (ipcc.ch) p. 41, endnote 34.

[9] The IPCC report notes that "*Additional warming is projected to further amplify permafrost thawing, and loss of seasonal snow cover, of land ice and of Arctic sea ice (high confidence)*." See p. 41, para. B.2.5.

[10] Methane is around 28 times more potent a greenhouse gas than $CO_2$, mass for mass, over a 100-year horizon. See How Potent Is Methane? - FactCheck.org

[11] The UK Government's former chief scientific advisor Sir David King has been prominent in calling for research in this field, See: https://earth.org/climate-crisis-university-of-cambridge-to-launch-a-centre-to-explore-geoengineering/

[12] For one thing, it would potentially give fossil fuels a new lease of life, as well as blunt the incentive to decarbonise the system, Second, it would open up a whole new set of risks associated with unintended consequences, which would be hard to address as stopping the process would reveal a hothouse earth. It would not address other problems related to emissions, such as ocean acidification or particulate pollution. And finally, it would induce significant 'collective action' problems concerning who will undertake the intervention, and to what extent, in the presumed interest of the planet as a whole.

[13] Particularly important in reducing uncertainties in this area would be more powerful simulations that can cope with a finer 'mesh', and secondly a better understanding of the physics of ice melting and of cloud formation, which are perhaps the main uncertainty in the 'sensitivity factor' that links $CO_2$ rise with global temperature rise.

[14] This is somewhat analogous to the multiple equilibria' concept with which economists are familiar.

[15] See James Cameron and John Llewellyn, *Satellite methane detection. Llewellyn Consulting, 8 June 2020. Available on request.*

[16] See van der Meijden and Smulders (2017) https://onlinelibrary.wiley.com/doi/abs/10.1111/iere.12255, Zenghelils 2019 https://www.bennettinstitute.cam.ac.uk/blog/mind-over-matter-how-expectations-generate-wealth/, and Krugman, P., 1991 'History Versus Expectations' The Quarterly Journal of Economics, Vol. 106, No. 2. May, pp. 651-667.

[17] See Sharpe et al. 2020 https://eeist.co.uk/wp-content/uploads/Briefing_notes_2.2.pdf

[18] See Acemoglu et al. 2012 https://www.aeaweb.org/articles?id=10.1257/aer.102.1.131

[19] See Zenghelis, 2019 https://journals.sagepub.com/doi/10.1177/002795011925000118

[20] See Bloomberg New Energy Finance, New Energy Outlook 2019 https://about.bnef.com/new-energy-outlook/ see also Michael Liebreich's fascinating 2018 discussion of Scenarios for a solar singularity.

See also Nykvist et al. 2019 on battery and EV costs: https://ideas.repec.org/a/eee/enepol/v124y2019icp144-155.html; https://www.linkedin.com/pulse/scenarios-solar-singularity-michael-liebreich/

[21] See Task Force for Climate Related Disclosure https://www.fsb-tcfd.org/

[22] See Romer, 2018 https://paulromer.net/conditional-optimism-technology-and-climate/

[23] See Ekins, P. and Zenghelis, D., 2021, The costs and benefits of environmental sustainability, *Sustainability Science* The costs and benefits of environmental sustainability (lse.ac.uk)

[24] See Hepburn, C, and Mealy, P. (2017) https://www.researchgate.net/publication/333039741_Transformational_Change_Parallels_for_addressing_climate_and_development_goals

[25] Using data on 1 million patents and 3 million citations, Dechezleprêtre et al. 2014 found that productivity-enhancing spill-overs from low-carbon innovation are over 40% greater than from conventional technologies (in the energy production and transportation sectors) http://eprints.lse.ac.uk/60501/1/dp1300.pdf

[26] See Ostrom, 2000. https://www.aeaweb.org/articles?id=10.1257/jep.14.3.137 and See Posner, 1997. ( https://www.researchgate.net/publication/24015694_Social_Norms_and_the_Law_Why_Peoples_Obey_the_Law )

[27] Standard optimisation models assume a single representative consumer. Yet agent heterogeneity is important in the representation of real-world consumer behavioural diversity and behavioural biases. This is critical in the process of the diffusion of innovations, technologies and practices where technology adoption typically follows s-shaped patterns from pioneers and early adopters, through the majority to laggards. See Knobloch, F. and Mercure, J., 2016 https://www.researchgate.net/publication/282870518_The_behavioural_aspect_of_green_technology_investments_a_general_positive_model_in_the_context_of_heterogeneous_agents and Mercure et al. 2021 (forthcoming).