CCAG
Climate Crisis
Advisory Group

COP26:

The Decisive Moment

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What do we mean when we talk about the consequences of global warming – and the climate change it brings?

Just look at one specific impact: sea-level rise. Suppose seas 'only' rise by one metre by the end of the century; what happens? The rise continues and within decades that rise will be two metres. The truth is, even a one metre rise does too much damage to ignore.

How will we cope if major cities are regularly flooded with the loss of homes and livelihoods, unable to sustain public transportation, health, and infrastructure systems? For coastal cities like Jakarta, Mumbai, London, New York – and so many others – this will be the new reality.

We need a comprehensive strategy to head off the worst, that focuses on 'Reduce, Remove and Repair'.[1]

- **A rapid and deep reduction of Greenhouse Gas (GHG) emissions**, coming out of COP26 and going beyond current promises, that delivers global net-zero in short order.
- **Removal of GHGs at scale from the atmosphere** – starting immediately. Use multiple Nature Based Solutions (NBS), with sharing of monitoring, learning and impacts around the world. NBS is land- and ocean-based, and in the margins between: replanting and rewilding (and preserving) forests, Blue Carbon, peatlands and mangrove. GHGs must reduce from current levels of 500 to a safe 350 ppm.
- **Repair of the Arctic sea-ice**, again with NBS, arresting the cascading consequences of summer sea-ice loss.[2] Much extreme weather across the globe can be calmed, and sea-level rise reduced – even stopped – to buy time for a complete global transition to a manageable future.

The legacy of COP26 must go far beyond the formal negotiations. We often talk about 'time running out' but the simple truth is that it has run out.
It's now or never.

Sir David King

CCAG Founder and Chair

COVER PHOTO: IVAN BANDURA, 2019

PHOTO: BING HUI YAU, 2021

CCAG: Our Five Climate Commitments

COP26 is an opportunity for the global community to accelerate meaningful action on climate change. We must, however, remember that the COP itself is a legal, formal and limited process. So we must be careful to demand of the formal processes only those things that it can formally deliver. However, the moment of a COP meeting, with the great gathering of influential and committed participants, offers huge opportunities for side activities and agreements. CCAG looks to the moment of COP26 to deliver important climate commitments alongside the formal COP processes.

The COP 21 Paris Agreement produced the global commitment 'to hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and if possible to 1.5°C.'[3] To ensure these commitments and targets are met, COP26 has a small number of big issues it needs to address formally and obtain global agreement. There is hope that the largest greenhouse gas (GHG) emitters – the USA, China and EU (supported by the UK in the Chair) – will give clear leadership to the COP meeting. India's position is also important (see 'India – a climate leader with greater potential page 12). This COP will be the first meeting at which a net zero carbon emissions target is the primary global ambition. To support the wider fulfilment of the Paris Agreement, CCAG lays out five climate commitments that must be made in addition to the formal COP processes:

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1. AGREEMENT TO END USE OF COAL, OIL AND GAS: ORDERLY, EFFICIENT, RAPID – AND FAIR

40% of the world's energy is still provided by coal-fired power. However, since the Paris Agreement the market for coal has begun to subside and 76% of proposed coal-fired power stations have been cancelled. China will no longer fund overseas coal power. Australia, which continues to approve new coal mines for domestic use and export, remains an outlier.

A single deadline for the end of coal is not fair or just: some countries will need time in order to sustain their development whilst making the energy transition. However, the commitments to reduced emissions and net-zero targets of the leadership group provide impetus for those countries to end coal use as quickly as possible – thereby accelerating the global transition, and also developing strategies and technologies that will help those nations who make a later switch. An important strategy is likely to be a universal price on carbon emissions.

2. AGREEMENT TO PUT A PRICE ON CARBON EMISSIONS ACROSS MARKETS, ECONOMIES AND GEOGRAPHIES

This will be a central part of assisting the transition process away from coal to renewable energy sources. Perverse subsidies for coal-based energy must not survive such an agreement. An important piece of this puzzle is to develop connections and synergies between different trading systems to avoid gaps. There is an 'overhang' of unsold and unissued 3.91 billion Certified Emissions Reductions (CER) credits under the Clean Development Mechanism. A compensation fund is required to clear this and resolve a negotiation logjam to enable a market mechanism under Article 6.4 of the Paris Agreement (for a mechanism to mitigate emissions).[4]

3. AVIATION AND SHIPPING FUEL TO BE TAXED GLOBALLY IN LINE WITH OTHER FOSSIL FUELS

The anomaly of aviation fuel falling outside carbon tax programmes must be ended at COP26. The same is required for shipping. Together they emit some five percent of global GHGs.[5] An announcement and a timetable are the essential first steps to kick-start the transition to low-carbon global aviation and shipping. The experience with automotive transportation shows how regulation, incentivisation and statements of intention pull forward the necessary technologies, and make their development economically viable and sustainable.

4. AGREEMENT FOR DEVELOPED COUNTRIES TO FUND GHG REMOVAL TO BRING CO_2 EQUIVALENT GHGS DOWN FROM 500 PPM TODAY (INCLUDING METHANE, ETC.) TO 350 PPM BY 2100[6]

The current level of CO_2 equivalent GHGs already exceeds 500 ppm. 450 ppm was the upper limit set before the Paris Agreement, because that was thought to be the maximum possibly consistent with limiting global temperature rise to 2.0°C. IPCC AR6[7] shows that the IPCC expects a temperature rise by 2100 of between 2.0°C and 3.5°C on a 'medium emissions' scenario, and even on a very low emissions scenario (for which time and transitions are needed) temperature rise by the end of this century will be up to 1.8°C.[8]

Although emissions reductions are crucial for long-term survival, CCAG also supports action to remove CO_2 from the atmosphere, at scale, in a variety of ways. The technological development to help make this possible needs to begin now.

Nature Based Solutions (NBS) are also to be favoured. Whether this is achieved through conservation, extending reforestation and afforestation (while acknowledging that not all places are suitable for afforestation) or by adopting and supporting regenerative farming methods, there is a huge opportunity for increasing the size of land-based 'carbon-sinks'. NBS approaches usually offer win-win outcomes: they improve the sustainability of food production and livelihoods; they support and extend biodiversity and ecosystems; they enhance human and planetary health. See 'The potential of nature based solutions' on page 15.

In addition to land-based NBS, there are opportunities for deep-ocean-based regeneration, or 'Blue Carbon promotion'. Simple processes seen in nature (especially following sand-storms or volcanic activity) scatter micro-nutrients (especially iron) on the surface of the ocean. These nutrients rapidly generate the production of living micro-organisms, and within a matter of months fish stocks, green forests and even whales, are found in previously barren areas. Where this marine life is able to sink to the deep ocean, their carbon is able to be captured in the deep ocean beds. There is potential for billions of tonnes of carbon to be locked in each year via these processes. At the same time fish stocks could be raised to levels not seen since pre-industrial times, offering economic benefits and sustainable protein supplies to humanity, as well as enhanced biodiversity.

CO_2 removal is not an alternative to emissions reductions, and it is not within the scope of the Paris Agreement. But if it is pursued strategically alongside emissions reductions, CO_2 removal will help to keep global temperature and sea level rises within a range of manageability for humanity into the future. See 'The why and how of carbon removal' on page 16.

ILULISSAT ICEFJORD, GREENLAND. PHOTO: TINA ROLF, 2018

5. AN AGREEMENT FROM DEVELOPED ECONOMIES TO FUND THE DEVELOPMENT AND ROLL-OUT OF METHODS TO REPAIR THE ARCTIC CIRCLE, SO THAT THE ARCTIC SEA IS ONCE AGAIN COVERED WITH ICE DURING THE POLAR SUMMER

The disproportionately rapid temperature-rise in the Arctic is amplifying rapid changes across the globe.[9] As sea-ice melts, and the huge area of reflective surface is lost, the ocean absorbs more and more of the sun's heat. Thus, there is a built-in feedback loop that increases and accelerates the loss of ice, and the heating. Temperature changes in the Arctic drive many of the Earth's weather systems, bringing the extreme weather patterns that are already challenging human livelihoods. They also, of course, drive sea-level rise. See 'How real is the threat of sea level rises?' on page 11.

Future threats are greater; the Arctic is 'ground zero' for the most rapid changes on Earth. It has critical connections with 'tipping points' across Earth-systems, with the risk of cascades and domino climate-effects. For example, melting Arctic ice slows down the Atlantic Meridional Overturning Circulation (AMOC). The AMOC acts as a huge conveyor belt bringing warm, relatively light, surface water from low latitudes poleward, while sending denser, deep cold water towards the equator, warming the climate of northern Europe. When meltwater discharges in Arctic regions, it makes seawater less salty (because ice is made of fresh water), hampering formation of dense, deep water, and slowing the AMOC, with repercussions for the climate system.[10]

Arctic sea ice could recover if global temperature rise is limited in line with the goals of the Paris Agreement and then brought back down again by removal of greenhouse gases from the atmosphere. But until that point urgent intervention is needed to repair the damage already done to the Arctic and the global implications this would have if allowed to continue. If the heat of the summer sun can be deflected successfully away from the surface of the Arctic Ocean, then the ice developed over it in the Polar winter would survive the summer – as it has done for many thousands of years until the last decade or so. That step alone would begin to calm the volatility of extreme global weather, and would support the deep ocean current, buying time for long-term climate change mitigation actions to take effect.

Complicated engineering projects have been dreamed up to bring about this sunlight deflection – such as mirrors in orbit about the Earth. However, once again, there are nature-based options that are more promising, more intuitively manageable – and incrementally scalable. The NBS approach uses salt particles from the ocean itself, scattered in mist created by pumps, to brighten clouds in the sky. The brighter clouds do the work previously performed by the ice: they reflect the energy of the sun away from the Earth's surface, so that further heating is prevented.

The principles of cloud-brightening are well-understood, and have been modelled to show that they work.[11] The costs of a programme for a systematic study and movement to scale would be negligible compared with the damage they would prevent if successful. This falls outside the scope of the COP, but it offers a last chance to buy time, to keep the temperature rise within 1.5°C (therefore aligning perfectly with the Paris Agreement) and the COP26 Moment offers a chance for leading nations to step up and make this happen.

The Arctic is 'ground zero' for the most rapid changes on Earth.

COP26 - The context for commitment

In the years leading up to COP26, there have been many lost chances for action at the scale that is required. However, as we approach this latest summit, there are grounds for optimism.

1. China recently announced to the UN that its emissions will peak before 2030. The US has pledged to halve its emissions by 2030, and to achieve net-zero GHGs by 2050.[12] The EU has committed to a legal agreement to deliver net-zero GHGs by 2050, with a 55% cut by 2030. The UK has committed to a 78% reduction of emissions by 2035. These announcements signal a desire to lead on the part of big emitting economies. The hope is that COP26 will support a swift transition to renewable energy sources, even though all of these countries are all still working out **how** they can deliver.
2. There is a strengthening alignment between climate requirements and the commercial realities of energy generation. Taking the UK as an example, the **need** to depend on coal for energy since the beginning of the industrial revolution has been diminished to near-zero in recent years (see figure 1).

The rise of off-shore wind power (not even on the horizon when a climate change response was first discussed) is just beginning, and there are grounds for hoping that reliance on natural gas, also a fossil fuel, is following the pathway of coal.

The decrease of emissions using consumption-based accounting methods accounting for trade, is of course, not as significant.[13]

FIGURE 1

UK Historical Annual Electricity Production showing dwindling reliance on coal

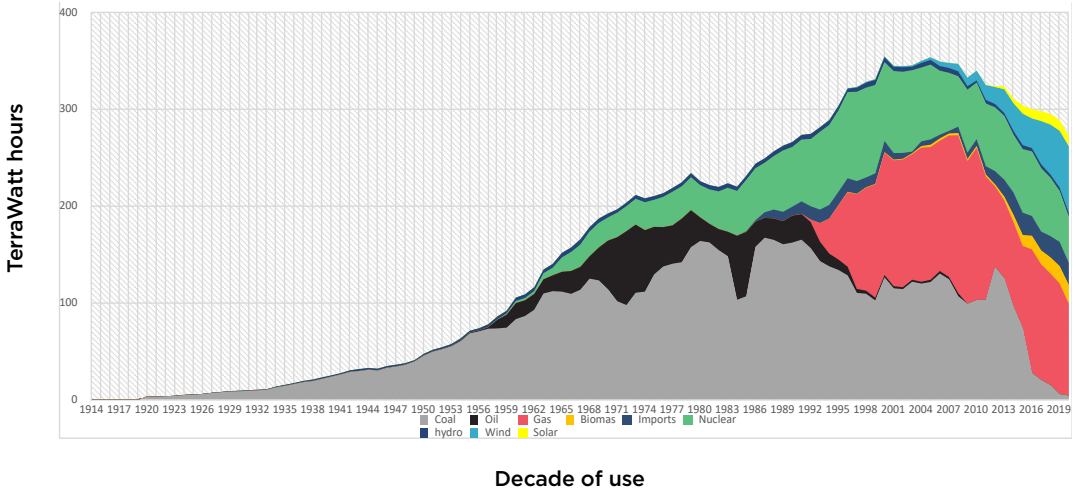

Figure 1

UK Historical Annual Electricity Production in TerraWatt Hours By Fuel Type, showing dwindling reliance on coal[14]

WIND TURBINES. PHOTO: ARTEUM.RO, 2018

3. A positive economic 'tipping point' has been reached in the switch from fossil fuels to renewable energy. Thanks to early subsidy of solar energy generation, via feed-in tariffs, Germany led the way (in the late 1980s) towards a wider adoption of solar power for domestic use. It was an expensive option, but the feed-in prices made it economically viable for householders. The German example of creating deployment incentives was emulated in various forms by Scandinavian countries, the UK, and others.

   Spurred by the certainty of a critical mass of demand initially abroad, China began to scale up production of solar power generation technology, and prices for photovoltaic panels fell more and more rapidly, and quality improved, until solar power energy for homes and buildings became financially viable in its own right.

4. As solar power became a direct competitor with coal on a cost-basis for installation of new power generation, China has committed to a pathway of constructing no new coal-fired power stations. India is exploring the transition from fossil fuel to renewables for its energy programmes (See Box 1). The economic tipping point we see is that there is no economic or other justification to go backwards and deepen our reliance on coal.

5. Meanwhile, climate change has moved decisively up the domestic agenda in the USA. Barack Obama was only able to take part in negotiating the Paris Agreement because its structure – a series of independent national commitments – made it unnecessary for the Senate and House of Representatives to ratify specific targets. Joe Biden has a little more political leeway.

   With a strong leadership group, COP26 has new opportunities. At the same time, the urgency of the situation is coming home to almost all nation participants in the COP.

What else should COP26 give us?

ADDU NATURE PARK, ADDU, MALDIVES. PHOTO: MOHAMED SAMEEH, 2019

In addition to the five commitments noted above, the following are three items that fall within the scope of the COP26 summit:

1. SCRUTINY AND ALIGNMENT BETWEEN SHORT-TERM AND LONG-TERM EMISSIONS-REDUCTION GOALS

Each country will submit its proposals for increased commitments on CO_2 (and CO_2 equivalent) GHGs emissions reductions. This is the Paris Agreement process. Each nation is required to make a submission. However, there is no Paris Agreement requirement for submissions to align with the goal of 1.5°C – 2.0°C limit on temperature rise. It is to be hoped that strong leadership will encourage and enable bold undertakings to be given.

It is within the scope of the Paris Agreement for each country to submit its short-term intentions and also its long-term commitments.[15] A well-organised COP discussion will allow scrutiny of the alignment between short-term steps and avowed long-term goals. This is important to ensure that longer-term ambition is more than merely a series of announcements, and that transparency is built in to the process. CCAG advocates strongly for this alignment, transparency, and scrutiny, arguing that it will add weight to the formal outcomes of the COP26 process.

Strong commitments will ensure that decarbonisation accelerates development in the least developed economies

2. COMMITMENT TO STEP UP TO DELIVER ON EXISTING FUNDING PROMISES, AND TO CONTINUE TO DEVELOP FUNDING ARRANGEMENTS FOR THE FUTURE

COP26 must secure the funding arrangements agreed in 2009, and ratified in 2010, for a Green Climate Fund (GCF) of at least USD $100 bn per annum from the world's developed economies to support the developing and least developed economies, while making it less onerous for developing countries to access funds. The GCF supports the rapid phase-out of fossil fuels, building of energy infrastructure, and mitigation strategies against climate change. Strong commitments will ensure that decarbonisation accelerates development in the least developed economies, ensuring that COP26 outcomes align fully with the Sustainable Development Goals.[16]

Money has flowed into the GCF, based in Seoul, but never at the rates required to achieve these annual targets. CCAG argues that the promises to the GCF (current and any new ones) should be met – but that additional mechanisms are possible. Mission Innovation[17], for example, consists of a 'fund of funds', so that each contributing country controls the due diligence of its own cash flows – and can hold others to levels of accountability that are satisfactory for its own processes.

Funding commitments from COP26 must be framed as a floor, not a ceiling, on what is required. CCAG argues that, as the pathway is cleared to delivering USD $100 bn a year, mechanisms for ratcheting the process for raising public funds must also be agreed. The emphasis would be on adaptation funding, in the face of climate impacts that are in the pipeline, which is not currently a strong focus of the GCF.

In addition, the GCF is insufficient as a mechanism for de-risking all the types of investments that will be needed. The process could consider creating a separate Global Climate Resilience Fund focussed on demonstrating and deploying riskier technologies, decreasing financing costs and/or addressing major climate risks. De-risking is essential to attract private institutional capital into clean energy infrastructure projects at the colossal scale required in developing countries by 2030.[18]

3. POLICY AGREEMENT ON SAFEGUARDING CARBON SINKS IN NATURE

Nature, on land and in the oceans, takes up more than 50% of CO_2 equivalent GHG emissions. Nature stores more carbon than we currently burn, and these critical environmental services must be secured and enhanced.

Foremost, we must reduce the conversion and degradation of natural ecosystems (such as forests, savannas, grasslands, peatlands, mangroves). The UNFCCC REDD+ process has supported the conservation, restoration, and sustainable management of forests. Carbon-rich ecosystems in the Global South are also hotspots for biodiversity conservation.

Supporting climate action must also strengthen the synergies with avoiding and reverting biodiversity decline while minimizing potential trade-offs. Building sustainable food systems also provide climate change mitigation and biodiversity benefits. Sustainable livestock production and farming practices, restoring and strengthening the carbon-sink capacity of farmland and topsoil, regenerative agriculture, and food management (to avoid waste and secure nutritional equity) are already available options.

COP26 has the chance to reharmonize the various schemes and activities and give them new impetus.

Conclusions

THE LEGACY OF COP26 MUST GO FAR BEYOND ITS FORMAL NEGOTIATIONS.

COP26 is the last major climate event with a chance to create real change, and head off the worst effects of climate change, aiming to secure a safe planet for humanity.

Alongside the formal process, critical goals are:

- End the use of coal.
- Put a price on carbon in all sectors, markets and geographies.
- Always include shipping and aviation in carbon pricing and taxations schemes.
- Remove GHGs in the atmosphere, to reach a level of 350 ppm by 2100 (from 500 ppm today, CO_2 equivalent).
- Repair the Arctic Circle to re-establish summer sea-ice, using nature based solutions.

> The formal COP26 must deliver:

- A means of scrutiny and alignment of national commitments – both short and long-term – so that commitments to meet deep and rapid emissions reductions are actually delivered.
- All existing funding promises without further delay. Leading economies must step up to their existing financial commitments, and be prepared to go further.
- Clear policy agreement on preserving nature based carbon sinks. Existing schemes and programmes must be harmonised to align with this policy agreement.

These critical goals all require global commitment and engagement. But they must all be pursued fairly, as well as rapidly, efficiently and in an orderly manner. Wealthy nations must be prepared to fund processes and projects that will benefit all of humanity.

STUDENT MARCH FOR CLIMATE CHANGE ACTION, SAN FRANCISCO, USA. PHOTO: LI-AN LIM, 2019

How real is the threat of sea-level rises?

The IPCC AR6 regards the ice-sheet instability this century as low-likelihood (AR6 p41). However, others are less optimistic, and mean sea-level rise of 2 metres by 2100 must be considered a real possibility. (See Englander 2021; Kulp and Strauss 2019; and Wanless 2021, for examples).[19] Uncertainty about the effects of ice sheets on sea-level rise has increased in recent years, giving wide ranging possible outcomes in the short term to the end of the century.[20] However, there is no doubt about the longer-term devastating impacts by, say, 2200.

A 1.75 metre rise is enough to render whole global regions very vulnerable – all of South Asia and South East Asia, for example, as well as the East Coast of the USA (particularly New York and Florida). Bangladesh, Vietnam and large parts of Indonesia will lose land to such an extent as to aggravate food insecurity, migration (internal and external) and livelihood pressures of escalating intensity. And without extraordinary interventions, the sea-level rise will not stop there.

The IPCC AR6 acknowledges that a tipping point has been passed and that melting of ice in the northern polar region (including the land ice of Greenland) and of global land-based glaciers is now inevitable.[21] This means that in the long run 20 metres of sea-level rise is conceivable.

From well over 1 metre by the end of this century, each year will be more difficult to manage than the previous. At 20 metres it is hard to imagine humanity surviving in any meaningful way. Moreover, this is before we consider the catastrophic potential of other tipping points, such as Amazon forest dieback and monsoonal shifts.

FIGURE 2

Global mean sea level change relative to 1900

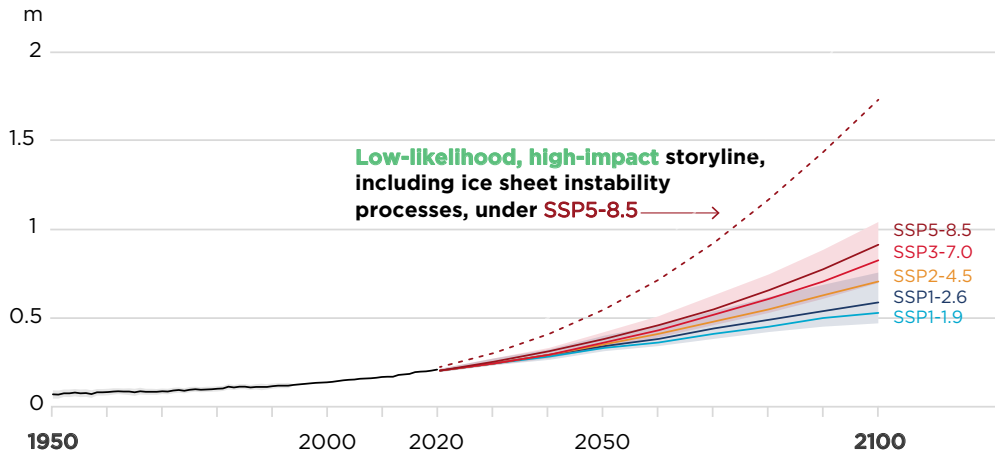

Figure 2

Human Activities affect all Major Climate Systems Panel d) – Sea Level Change (Source IPCC AR6 2021, p 29)

India – a climate leader with greater potential

India has already installed electricity generation capacity of 38.5% from non-fossil sources, on track for its 40% NDC target. India has reduced emissions intensity of GDP by 24%, weakening links between GDP growth and rising emissions. As a potential climate-response leader, India can raise its game in three ways:

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1. BRING INDIA'S DOMESTIC RENEWABLE TARGET TO THE INTERNATIONAL TABLE

Its Energy Compact for the UN High-Level Dialogue on Energy 2021 sets out a target of 450 GW of renewable capacity by 2030. India has committed to a 'double leapfrog' in electricity, connecting all households, whilst shifting rapidly to cleaner sources. Decarbonisation of heavy industry is supported separately with a focus on costs-reduction for green hydrogen via its ambitious National Hydrogen Energy Mission.

2. SET OUT A LONG-TERM NET-ZERO TARGET, UNDERPINNED BY SHORT-TERM SECTORAL PATHWAYS

This would send signals to trigger systematic investment from public and private sectors. The transition from peak-emissions to net-zero will be shorter than for the largest GHG emitters. The action of setting out the pathway to net zero would demonstrate commitment to fairness without shying away from the energy transition.

3. BUILD RESILIENCE AGAINST CLIMATE SHOCKS, AND DEVELOP GOOD PRACTICE IN DOING SO

As one of the most climate-vulnerable countries, three-quarters of India's districts are in hotspots for extreme climate events. India has promoted the multi-country Coalition for Disaster Resilient Infrastructure. It must also focus on deepening local administrative capacity not only to save lives but also secure livelihoods, and offer international leadership in building resilience.

THOOTHUKUDI THERMAL POWER STATION, THOOTHUKUDI, INDIA. PHOTO: HASSAN AFRIDHI, 2019

Australia – falling short of global requirements?

Australia has given no indication of an intention to ratchet up its NDCs at COP26. In 2015 the NDCs of Australia committed to reduce emissions by 26 - 28% below 2005 levels by 2030. In the final days before COP26 it appears that the Australia will now bring a national commitment to net-zero emissions by 2050 to Glasgow. Any net-zero promises given at Glasgow will have to be evaluated against Australia's inadequate shorter term NDC commitments to 2030 and the extent to which the 2050 net-zero plan uses an unrealistic dependence on carbon offsets to avoid real emission reductions.

If it sticks to its NDC commitments, Australia will emit some 4,800 million tonnes of GHGs between 2021 and 2030, and would then have to reduce emissions by 12.9% a year to reach net-zero by 2037, in order to contribute fairly[22] to global efforts to limit warming to no more than 2°C.

There is no scientific support for Australia's current NDCs being compatible with the Paris Agreement targets. A more realistic, science-based target would be for the NDCs to be ratcheted to a 50% reduction below 2005 levels by 2030, reaching net-zero by 2045.

Despite the national position, every Australian State and Territory is already independently working towards net-zero emissions by or before 2050. Many Australian companies are also increasing their emission reduction targets to be more ambitious than the national position, demonstrating the possibility of working with sub-national commitments, as was achieved in the USA during the Trump Presidency.

QUARRY IN BAROSSA VALLEY, SA, AUSTRALIA.. PHOTO: DION BEETSON, 2019

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WOODLAND IN MARIDALEN, OSLO, NORWAY. PHOTO: RONALD BAARS, 2019

The potential of nature based solutions

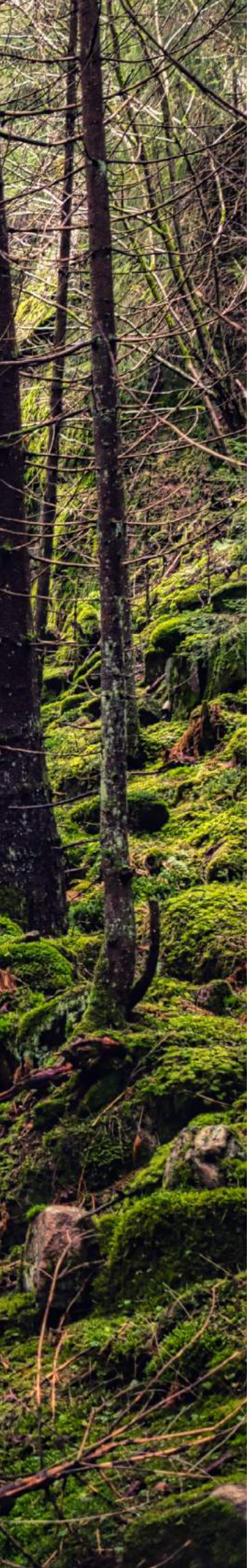
Nature-based solutions (NBS) come in many forms, including conservation, which should always be the first option. Blue Carbon is described in this report, and reforestation is mentioned, too. Conservation of the tropical rainforests in South America, Africa and Asia must be a priority, but another promising NBS approach is the rewilding and restoration of peatlands. These terrains are found in over 180 countries around the world, stretching from the tropics to the High Arctic. All such activity must allow for the role of traditional communities and indigenous people in the conservation and sustainable management of natural ecosystems.

Peatlands in the north (boreal and the Arctic) contain one third of the world's soil-based carbon. Sadly, some of the Arctic peatlands are now subject to permafrost thaw, and there is no local management strategy that will prevent this; methane and CO_2 release will continue from these areas. However, there is great potential for quick and affordable action in non-permafrost peatlands: Northwest Russia, Finland, Sweden, Northern Europe, Canada and Alaska all have terrain that can be targeted.

A simple calculation will show how worthwhile preservation of peatlands can be. Onkineva is a northern boreal peatland complex which was very recently transferred into a rewilding programme in Finland, thereby securing its future as peatland. With an area of about 210 hectares, it functions as a natural carbon sink, drawing some 500 tonnes of CO_2 from the atmosphere each year.[23] Over the next century Onkineva will **capture** some 50,000 tonnes of CO_2 – close to 240 tonnes per hectare. Conversely, if Onkineva were to have been allowed to go to commercial use it would have **released** 2.1 million tonnes of CO_2, showing a huge net benefit to preserving the peatland. This is something like the equivalent of 450,000 private car emissions in a year. If the calculation is translated into a financial one, then the value is also clear. Today's carbon emissions trading price is approximately €61 per tonne. This implies that the prevented emissions from Onkineva have a 'cash value' of over €128 million. The cost of buying and rewilding the land is in the region of €150,000. The figures speak for themselves.

Similar calculations in areas that are to be rewilded, once mining operations have ceased, show significant benefits in reduced emissions, or in financial value for those reductions. Linnunsuo is a 110 hectare peat-mining site which emitted about 400 tonnes of CO_2 each year from its soil. After a massive rewilding process, it now sinks about 100 tonnes of CO_2 each year instead. The net benefit of the programme is, therefore, about 500 tonnes of CO_2 sequestration each year.

Each boreal and Arctic peatland is a massive bird, pollinator, water quality, mammal and insect hotspot, showing the synergy between rewilding, carbon sink creation and biodiversity preservation.



The why and how of carbon removal to manage climate change

Climate change is driven by anthropogenic GHGs. Some GHGs remain for a long time in the environment, capable of existing in different forms. Carbon, for example, appears in the atmosphere as CO_2, as carbonic acid in the ocean, and as biomass on land. Once released from its fossil source, carbon lingers in the environment for tens of thousands of years, with about half of it found in the atmosphere as CO_2. It is not enough to stop dumping fossil carbon into the environment. The world must also remove at least some of what has already been dumped – and will continue to be dumped in the next few decades. The world needs to go beyond net-zero emissions to actual negative emissions if climate change is to be managed at all.

In other words, carbon must be removed directly from the environment to reduce the intensity, especially, of CO_2 in the atmosphere. There are various possible ways of achieving this removal – which must include safe and permanent storage. Some NBS approaches are available: regenerative farming, reforestation and Blue Carbon all contain a storage element – and with strategic management this can be regarded as safe and permanent enough to be useful. Other approaches include the formation of stable carbonate minerals. In Finland, for example, the CarbFix project combines deep underground storage with the formation of carbonate materials: CO_2 is injected deep underground in basalt formations, where it rapidly forms stable carbonates. All of these approaches need to be deployed to achieve the scale of carbon removal required to bring the global temperature back under control.

REFERENCES

[1] For further discussion, see 'The Global Climate Crisis and the Action Needed' 2021 CCAG https://static1.squarespace.com/static/60ccae658553d102459d11ed/t/60d421c67f1dc67d682d8d29/1624515027604/CCAG+Launch+Paper.pdf

[2] 'The Final Warning Bell' discusses the case for climate repair, and also an approach to greenhouse gas removal. 2021 CCAG https://static1.squarespace.com/static/60ccae658553d102459d11ed/t/612f491253769c13f5e52b1d/1630488861782/CCAG+Beyond+Net+Zero_V2.1.pdf

[3] The Paris Agreement 2015 UN https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

[4] For further discussion about the role of carbon pricing, see 'What role can carbon pricing play in a just transition to net zero?' 2021 CCAG https://static1.squarespace.com/static/60ccae658553d102459d11ed/t/6155720a2344d15c2d4efd0d/1632989716684/CCAG+Carbon+Pricing.pdf

[5] Center for Climate and Energy Solutions https://www.c2es.org/document/greenhouse-gas-emissions-from-aviation-and-marine-transportation-mitigation-potential-and-policies/

[6] There are several greenhouse gases. CO_2 is the largest by volume, but methane, nitrous oxide and water vapour are also important. To understand atmospheric warming effects, account must be taken of all GHGs. The aggregate impact of all GHGs can be given as a 'CO_2 equivalent' figure – as if only CO_2 was at play. The calculation of CO_2 equivalence of other GHGs is explained in the IPCC Special Report on keeping within a 1.5 degree temperature rise (IPCC 2019, p.66 https://www.ipcc.ch/sr15/). We refer to all GHGs throughout, and use 'CO_2 equivalent' when discussing concentrations in the atmosphere. Some commentators refer only to CO_2, thereby producing much lower figures, and mis-representing the advanced level of climate heating.

[7] IPCC AR6 refers to the most recent formal report of the Inter-governmental Panel on Climate Change. We draw on the 'Summary for policymakers' in: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [MassonDelmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press.

[8] The detail of these projections under different 'scenarios' is set out in the 'Possible Climate Futures' section of IPCC AR6 at Section B.1 p. 17.

[9] See CCAG 'A Global State of Emergency: Amplification of temperature change in the Arctic' to show how temperature rises in Polar region are hugely exceeding global averages. https://static1.squarespace.com/static/60ccae658553d102459d11ed/t/6102596bc768697d04731d55/1627543921216/CCAG+Extreme+Weather.pdf

[10] 'Current Atlantic Meridional Overturning Circulation weakest in last millennium' 2021 Caesar, McCarthy, Thornalley, Cahill, and Rahmstorf. Nature Geoscience DOI: 10.1038/s41561-021-00699-z

[11] See, for example, 'Marine Cloud Brightening' 2012 Latham, Bower, Choularton and others, https://royalsocietypublishing.org/doi/pdf/10.1098/rsta.2012.0086; Can marine cloud brightening reduce coral bleaching?' 2013 Latham, Kleypas, Hauser, Parkes and Gadian https://rmets.onlinelibrary.wiley.com/doi/full/10.1002/asl2.442; 'The Marine Cloud Brightening Project: An atmospheric intervention research program' 2019 Doherty, Wood, Wanser and others https://ui.adsabs.harvard.edu/abs/2019AGUFMGC31B..09D/abstract

[12] In this report GHGs – Greenhouse Gases – encompass all atmospheric emissions that contribute to global warming. The main GHGs are CO_2, methane and nitrous oxide.

[13] See https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/979588/Defra_UK_carbon_footprint_accessible_rev2_final.pdf

[14] Courtesy of Dr David Watson; data at https://electricinsights.co.uk/, drawing on Elexon, National Grid and Sheffield Solar.

[15] Article 4.19 of the Paris Agreement allows this.

[16] The UN Sustainable Development Goals are intended to ensure a more equitable and sustainable human, economic and environmental development pathway for all people. https://sdgs.un.org/goals

[17] Mission Innovation (MI) is a global initiative to catalyze action and investment to make clean energy affordable, attractive and accessible to all. MI accelerates progress towards the Paris Agreement goals and pathways to net zero. MI agreement was reached during the COP21 meetings in Paris in 2015, alongside the Paris Agreement, although it sits outside the formal processes of the COP. The opportunity was taken to make an international agreement to which there are now 22 country members, plus the European Commission on behalf of the EU. MI members represent over 90% of global public investment in clean energy innovation. http://mission-innovation.net/about-mi/overview/

[18] '...the institutional capital pool is simply too large and too important to remain on the sidelines of the energy transformation.' 'Mobilising institutional capital for renewable energy' 2020 IRENA https://www.irena.org/publications/2020/Nov/Mobilising-institutional-capital-for-renewable-energy

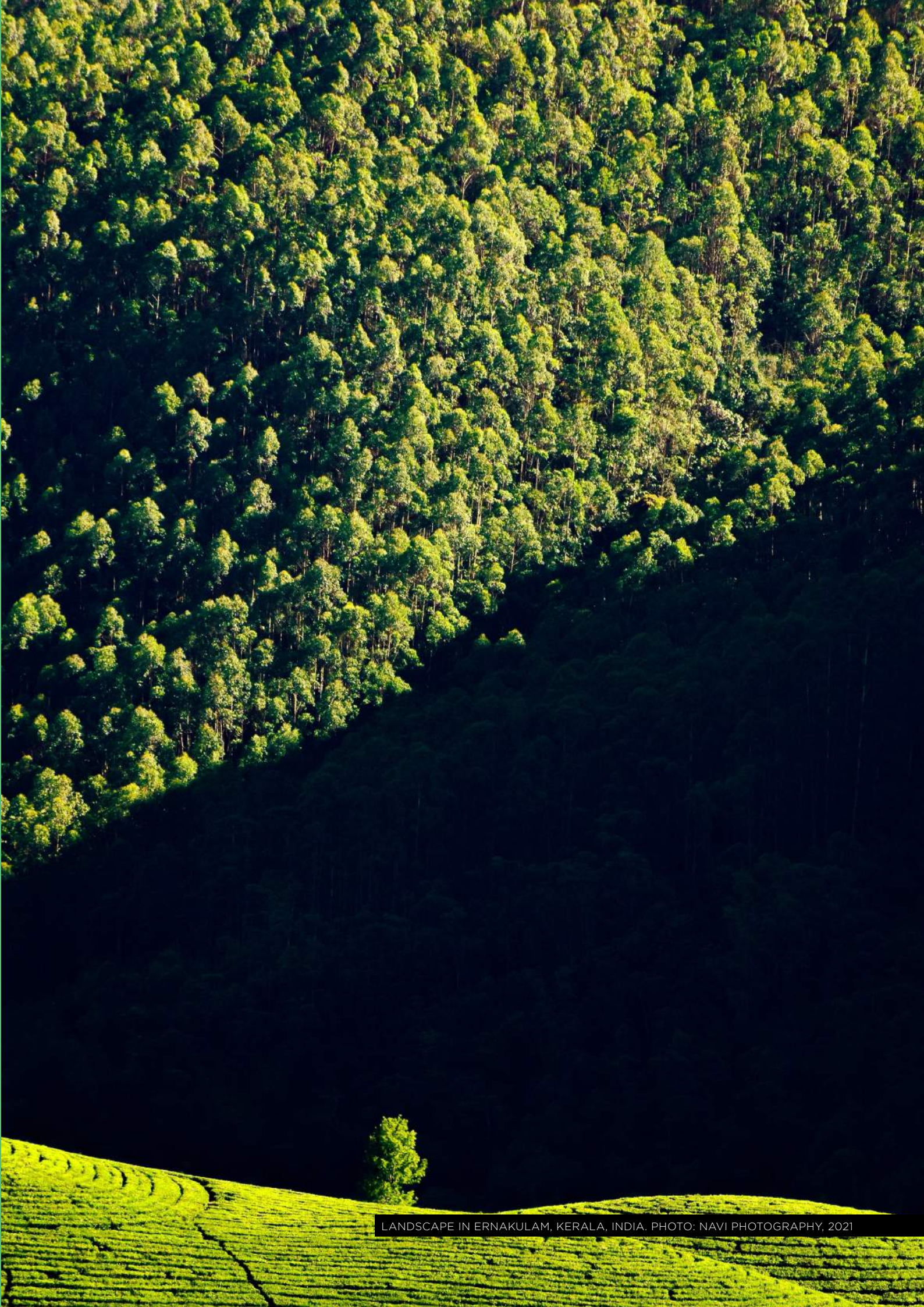
[19] There are structural reasons for IPCC reports erring on the side of caution in the severity of their predictions – and a history of being behind the pace on sea-level rise as a result, so wise policy makers will take the possibility of higher sea-level rise seriously. The reasons for this IPCC cautious tendency are explained in 'Moving to Higher Ground' (Englander 2021; The Science Bookshelf, Florida ISBN 978-1-7334999-0-3).

[20] See 'Ice sheet contributions to future sea-level rise from structured expert judgment' 2019 Bamber, Oppenheimer, Kopp, Aspinall and Cooke DOI 10.1073/pnas.1817205116 for further explanation.

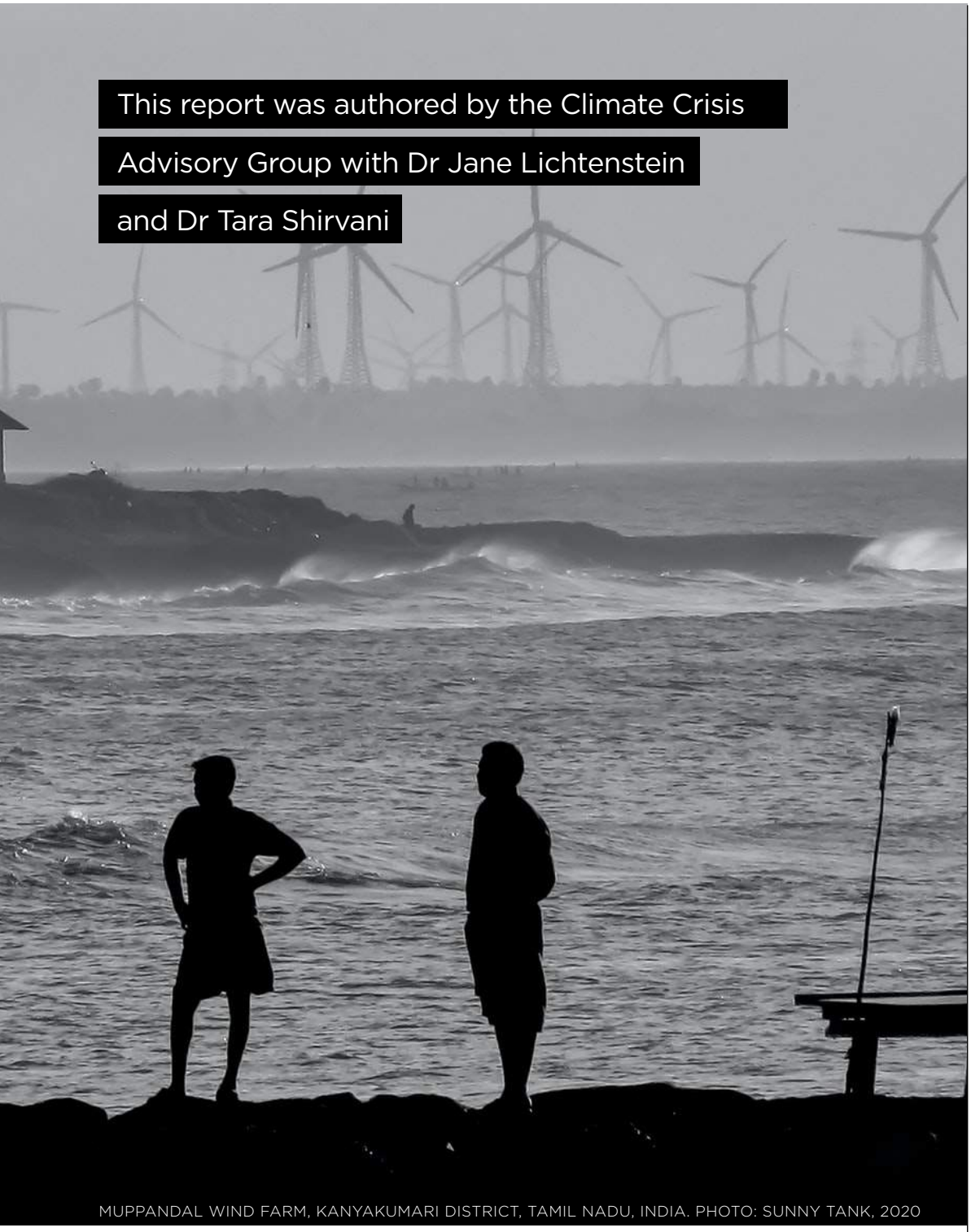
[21] IPCC AR6 carefully lays out changes that are 'irreversible for centuries to millennia, especially changes in the ocean, ice sheets and global sea level.' (IPCC AR6 2021, p 28)

[22] The Australian Government has previously determined that it should hold a 0.97% share of the remaining global carbon budget, despite its population accounting for only 0.33% of the world's total.

[23] All of the figures in these examples are indicative only. Each site will show different results that can only be determined by field studies. However, these figures are consistent with literature and earlier accounts. See for example, 'Restoration of drained peatlands in southern Finland: initial effects on vegetation change and CO_2 balance' 2001 Jukka Laine https://doi.org/10.1046/j.1365-2664.1999.00430.x; 'Rewilding the small stuff: the effect of ecological restoration on prokaryotic communities of peatland soils' 2020 Andras, Rodriguez-Reillo, Truchon and others https://doi.org/10.1093/femsec/fiaa144.



LANDSCAPE IN ERNAKULAM, KERALA, INDIA. PHOTO: NAVI PHOTOGRAPHY, 2021



This report was authored by the Climate Crisis Advisory Group with Dr Jane Lichtenstein and Dr Tara Shirvani

MUPPANDAL WIND FARM, KANYAKUMARI DISTRICT, TAMIL NADU, INDIA. PHOTO: SUNNY TANK, 2020

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