Investment Opportunities for Climate Change Technologies: A Landscape Study

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ABSTRACT

This report seeks to present a comprehensive landscape scan and overview of the current investment opportunities for climate change technologies as they pertain to key stakeholder groups i.e. investors in the field of climate change technologies; the sustainability business sector; and policymakers, focusing on how climate change will impact societies and where technology and investments in climate change technologies would be most important and efficient, including global and regional cases studies as examples.

The report will conclude with key recommendations that are oriented towards the stakeholder groups identified and will seek to envision a 'picture of success' in terms of the momentum on climate change technology opportunities.

EXECUTIVE SUMMARY

Climate change has been a symptom, for the greater part of the last century, of mankind's rapid expansion and growth without consideration of consequences. This paper presents a global perspective on modern policy suggestions and economic mechanisms that have the potential to salvage the situation by growing the investment market for climate change technologies.

Technological innovation has often been lauded as one of the key solutions to the climate crisis – with our global economy acting as the spine of the greater machine. The proposals in this report can improve the growth of investment in climate change technologies and provide the foundation for green industries to be a mainstay for our future economy.

First, we focus on promoting education as the foundation of a future world that is more receptive towards new green technologies vital to eliminating carbon emissions. This would be the impetus for transforming our society's behaviour, human capital, and innovation towards a climatically-stable future.

Second, we look towards integrating international and regional partnerships in providing climate change technologies with a suitable economic environment to grow. For example, developing countries with sustainable economic zones can provide an invaluable testbed for green tech industries to bloom and acclimatise to our modern society and markets.

Finally, we consider the circumstantial requirements for a green economic transition, with an emphasis on smoothening the transition from declining industries by protecting the rights of disenfranchised workers and developing communities. Re-training workers from sunset industries and equipping them with skills to contribute to climate change technologies is an essential concept in our policy selection that has a multitude of benefits ranging from an easier transition to ensuring socio-economic balance and human capital competency for a new economic structure.

The key proposals under the pillars of education, international cooperation and innovation in new economic structures present an opportunity for our leaders today across politics and business to capitalize on the advent of a climate sensitive world. The modern interconnectedness of public policy and business growth will set the stage for a mutually beneficial partnership that can help climate change technologies lead the way in the coming vital decade.

Although this report aims to be as thorough as possible in considering the limitations of policy recommendations, the ever-changing political and economic climate of the world, as well as the unique circumstance of each region should be taken into consideration before a holistic solution can be crafted to avoid the mistakes of our predecessors.

They may never be a silver bullet, but a combination of solutions and brave systematic changes will be essential in the fight against climate change.

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"There is nothing opaque about this new data. The illustrations of mounting impacts, the fast-approaching and irreversible tipping points are visceral versions of a future that no policy-maker could wish to usher in or be responsible for."

Christiana Figueres

Executive Secretary, United Nations Framework Convention on Climate Change, 2010-2016[1]

The urgency surrounding the climate crisis can be expressed in two statements.

1. Anthropogenic global warming is currently increasing at an estimated 0.2°C per decade, due to past and ongoing emissions.[2]

2. The concentration of carbon dioxide (CO_2) in the atmosphere at the time of writing, 419 part per million by volume (ppmv), is 50% larger than it was in 1850.[3]

The speed of increase is at least 100 times that of any period over the last million years and has led to a CO_2 concentration not witnessed for over 2 million years. The last time CO_2 levels were this high, the Earth was 2-3°C warmer than today[4] and sea-levels were 25m higher.[5] Such a world would be unrecognisable today; over 1 billion people would find their homes underwater.[6]

The scientific principles behind carbon dioxide's ability to increase the amount of energy absorbed by the planet are undisputed. Indeed, one of the first suggestions that CO_2 could raise the temperature of the planet was made in 1896 by Svante Arrhenius, long before complicated

[1] Fiona Harvey and Jonathan Watts, 'World Leaders Told They Must Act over Climate Change "Cliff-Edge"' (*The Guardian*, 8 October 2018) <http://www.theguardian.com/science/2018/oct/08/world-leaders-told-they-must-act-over-climate-change-cliff-edge> accessed 10 April 2021.
[2] Valérie Masson-Delmotte and others (eds), *Global Warming of 1.5°C* (Intergovernmental Panel on Climate Change 2018) 4 <http://www.ipcc.ch/report/sr15/> accessed 29 April 2021.
[3] NOAA and US Department of Commerce, 'Trends in Atmospheric Carbon Dioxide' (*NOAA Global Monitoring Laboratory*) <https://gml.noaa.gov/ccgg/trends/> accessed 23 July 2021.
[4] Marci Robinson, Harry Dowsett and Mark Chandler, 'Pliocene Role in Assessing Future Climate Impacts' (2008) 89 Eos, Transactions, American Geophysical Union 501.
[5] Gary Dwyer and Mark Chandler, 'Mid-Pliocene Sea Level and Continental Ice Volume Based on Coupled Benthic Mg/Ca Palaeotemperatures and Oxygen Isotopes' (2009) 367 Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences 157.
[6] Scott A Kulp and Benjamin H Strauss, 'New Elevation Data Triple Estimates of Global Vulnerability to Sea-Level Rise and Coastal Flooding' (2019) 10 Nature Communications 4844.

climate models existed.[7] There is, however, more uncertainty about how the Earth will respond to progressively greater levels of warming.

Since the pre-industrial period, generally taken to have ended in 1750, the average surface temperature across the planet has risen by 1.0°C[8] with some regions having warmed considerably more than this. While that might not sound like a lot, it is important to remember that the vast majority of that warming has taken place over the last 50 years.[9] Carbon emissions are not merely continuing - they are increasing year on year and the dynamics of the atmosphere mean that even if no more CO_2 were emitted, further warming would occur; the processes involved typically become more severe as CO_2 levels and temperatures increase.

I.I. THE MAJOR IMPACTS OF CLIMATE CHANGE

This sub-section provides an objective assessment of the current situation and the future projections while also describing the major impacts that climate change will have on the planet. This will provide context for investors in the specific technologies discussed as investment opportunities in subsequent sections. The bulk of the physical science assessment is based on the Intergovernmental Panel on Climate Change (IPCC) 2013 report[10] and the IPCC 1.5-degree report.[11]

i. Rates of Change

A major cause for concern and uncertainty regarding climate change stems from the speed at which humans are changing the planet. From gas extracted from ice cores and supported by other studies such as tree ring width, there exists a detailed record of atmospheric CO_2 concentration and temperature dating back around 800,000 years.[12]

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[7] Svante Arrhenius, 'XXXI. On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground' (1896) 41 The London, Edinburgh, and Dublin Philosophical Magazine and Journal of Science 237.
[8] NOAA, 'Assessing the Global Climate in June 2021' (*National Centers for Environmental Information (NCEI)*, 12 July 2021) <http://www.ncei.noaa.gov/news/global-climate-202106> accessed 23 July 2021.
[9] ibid.
[10] Thomas Stocker and others, *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of IPCC the Intergovernmental Panel on Climate Change* (Thomas Stocker and others eds, Cambridge University Press 2014) <https://boris.unibe.ch/71452/> accessed 29 April 2021.
[11] Masson-Delmotte and others (n 2).
[12] Dieter Lüthi and others, 'High-Resolution Carbon Dioxide Concentration Record 650,000–800,000 Years before Present' (2008) 453 Nature 379; Jean Jouzel and others, 'Orbital and Millennial Antarctic Climate Variability over the Past 800,000 Years' (2007) 317 Science 793.

While there is little dispute in the scientific community regarding the amount of warming experienced since the pre-industrial period, there is greater debate about future climate change. This is not as to whether the world will continue to warm, but rather as to precisely how quickly it will warm, how parts of the Earth's ecosystem which are extremely sensitive to temperature may respond, and when the Earth may reach tipping points which result in irreversible change to the climate.

The world is on course to reach 1.5 °C above the pre-industrial level between 2032 and 2050, and if all countries meet their National Determined Contributions (NDCs) - through climate actions such as greenhouse gas (GHG) reduction targets - a warming of 2.6-3.1°C by 2100 is expected.[13] Such an increase would cause tremendous disruption to society and the climate; these are discussed in the following sections. However, few, if any, countries are on course to meet their NDCs, suggesting much greater warming is not only possible, but also the most likely outcome.

ii. Sea Level Rise

One of the most devastating effects of rising temperatures is the rise in sea level. This is driven by the melting of land-based glaciers and ice sheets as well as the fact that water expands when heated.

Sea level rise will cause major destruction and disruption. More than 1 billion people live in regions less than 10 m above sea level.[14] A significant fraction of these people are in less-developed countries which are often ill-prepared to handle the rising sea levels stand to be worst-affected; for example, low-lying Bangladesh is expected to be one the worst affected countries.[15] The impacts are not limited to developing countries, however. Cities such as Miami, New York, New Orleans, Boston, Shanghai, and Mumbai would all feel the severe consequences of rising sea levels. The global economic costs will be immense: a sea level rise of 0.86m (3 ft) is predicted to have a monetary cost of US$14 trillion per year, while a 1.8m (6 ft) rise would cost up to US$27 trillion per year; around 30% of global GDP and resulting in a loss of around 1.70 million

[13] Joeri Rogelj and others, 'Paris Agreement Climate Proposals Need a Boost to Keep Warming Well below 2 °C' (2016) 534 Nature 631.
[14] Kulp and Strauss (n 6) 1.
[15] ibid 4.

km^2 of land, an area almost the size of western continental Europe.[16] Much of this would occur in important agricultural areas such as the Nile delta, thus threatening global food security. This loss of habitable land would also lead to the displacement of over 200 million people.

iii. Precipitation Changes & Droughts

Precipitation is vital for agriculture, biodiversity, and many other industries. It is also acutely linked to the climate. A change to the radiative balance of the atmosphere (the difference between the energy received from the sun and the energy lost to space) from increasing GHG concentrations results in a warmer atmosphere which can hold more water vapour. Overall precipitation is expected to increase in a warmer climate.[17][18]

Since the start of the 20th century, precipitation has increased in most areas, but has crucially decreased in others where precipitation is already sparse.[19] Even under a 2°C warming, the average length of droughts would increase by four months, exposing some 388 million people to water scarcity and 194.5 million to severe droughts.[20] Africa is predicted to be particularly affected by increasing droughts, particularly given the importance of subsistence farming. Southern Europe, North Africa and the Near East are anticipated to continue to become drier. A comparison of the predictions for 1.5°C and 2°C of warming also highlights the significant difference even an extra 0.5°C can make. The north-east region of Africa, encompassing Egypt's 95 million people who already face water security issues, is projected to have 30% less precipitation in the 2°C compared to the 1.5°C scenario.[21] In addition to general increases in average precipitation (with certain exceptions), extreme precipitation is projected to increase.

iv. Extreme Weather Events

[16] Svetlana Jevrejeva and others, 'Flood Damage Costs under the Sea Level Rise with Warming of 1.5°C and 2°C' (2018) 13 Environmental Research Letters 74014.
[17] Stocker and others (n 10) ch 2.
[18] ibid 1 and 2.
[19] ibid.
[20] Masson-Delmotte and others (n 2) ch 3.
[21] ibid.

With global warming, extreme weather events such as hurricanes and heatwaves are predicted to become both more frequent and severe.[22] Heatwave frequency is expected to increase the most in less developed regions which are less well-equipped to mitigate their effects.[23]

The strength of monsoon winds is projected to weaken in the future, but precipitation is expected to increase due to increased atmospheric moisture. These changes, alongside an anticipated lengthening of the monsoon season, are likely to have serious consequences for the billions of people who live in the affected regions.[24] Hurricanes are also likely to become more potent in a warmer atmosphere. This is because warmer air can hold more water, which releases significant quantities of energy (latent heat) when it condenses out of the gas phase in the atmosphere.[25] Such energy acts to increase the wind speed and the overall destructive power of a hurricane.

v. Wildfires

Wildfire frequency is expected to increase with warming.[26] The wildfires which devastated California in 2018, causing 100 confirmed fatalities[27] and US$150 billion in total economic damage,[28] were some of the most severe seen in the state in the last 100 hundred years. Meanwhile, in other parts of the world where wildfires were once a rarity, they are becoming more prevalent. There were 10 times as many forest fires in Sweden in 2018, coinciding with the hottest July on record, compared to the average over the 2010-2019 period.[29]

As with any natural event, it is difficult to attribute them solely to climate change but elevated temperatures and reduced precipitation in already relatively dry regions are making wildfires ever more common.

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[22] Peter Stott, Dáithí Stone and Myles Allen, 'Human Contribution to the European Heatwave of 2003' (2004) 432 Nature 610; Masson-Delmotte and others (n 2) ch 3.
[23] Masson-Delmotte and others (n 2) ch 3.
[24] Stocker and others (n 10) ch 1.
[25] Kevin Trenberth and others, 'Hurricane Harvey Links to Ocean Heat Content and Climate Change Adaptation' (2018) 6 Earth's Future 730.
[26] Masson-Delmotte and others (n 2) ch 3.
[27] '2018 Fire Season' (*California Department of Forestry and Fire Protection*) <https://www.fire.ca.gov/incidents/2018/> accessed 10 April 2021.
[28] Daoping Wang and others, 'Economic Footprint of California Wildfires in 2018' (2021) 4 Nature Sustainability 252.
[29] Madhumitha Jaganmohan, 'Sweden: Annual Wildfires 2008-2019' (*Statista*, 18 November 2020) <https://www.statista.com/statistics/991263/annual-wildfires-sweden/> accessed 10 April 2021.

vi. Biodiversity

Biodiversity is crucial for life on Earth. Damage to ecosystems from a rapidly changing climate can have far reaching consequences, rendering the region unsuitable for the wildlife it had previously supported. Humans have also derived many different compounds with medicinal properties from diverse habitats, and their destruction threatens the discovery of future drugs.

The predominant driver of biodiversity loss is the direct actions of humans. Deforestation, excess use of fertilisers and pesticides and poor waste management destroy or damage huge areas of terrestrial and aquatic ecosystems. This has severe consequences for wildlife, with more than 40% of insect species declining in population.[30] Insects in particular play a crucial role in nature through pollination, and thus their loss is likely to have severe consequences for humans too.[31] A recent report by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) warned that 1 million species risk extinction due to the actions of humans with the biomass of wild animals having fallen over 80% since the preindustrial period.[32] The economic consequences, while certainly not the only important factor, are staggering with the loss of pollinators putting over US$550 billion worth of crops at risk and land degradation reducing global land productivity by 23%.[33]

Climate change is likely to make any such biodiversity loss worse by further pushing ecosystems from their equilibria with a combination of increased surface temperatures and changing precipitation.[34]

vii. Water Security

Less than 3% of the water on Earth is freshwater and approximately 70% of that is locked up in the Greenland and Antarctic ice sheets,[35] which are losing mass at an accelerating rate.[36] Disruption to precipitation patterns, with droughts increasing in frequency and severity, and the

[30] IPBES, 'Summary for Policymakers of the Global Assessment Report on Biodiversity and Ecosystem Services' (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services 2019) <https://zenodo.org/record/3553579> accessed 11 April 2021.
[31] Ibid.
[32] Ibid.
[33] Ibid.
[34] Ibid.
[35] Michael Pidwirny, 'The Hydrologic Cycle', *Fundamentals of Physical Geography* (2nd edn, 2006) <http://www.physicalgeography.net/fundamentals/8b.html> accessed 23 July 2021.
[36] Romain Hugonnet and others, 'Accelerated Global Glacier Mass Loss in the Early Twenty-First Century' (2021) 592 Nature 726.

melting of glaciers and mountainous water supplies will likely worsen water security in future decades.[37] Combined with over-exploitation of groundwater supplies and growth in population and wealth, water security is likely to become a major international political issue. This has already been witnessed in the dispute between Egypt and Ethiopia regarding the damming of the Nile river.[38]

960 million people drink water from unimproved or unsafe sources while 2.4 billion lack proper sanitation.[39] As with many of the impacts of climate change, such change will be endured by some of the poorest and most vulnerable people on Earth.

viii. Geoengineering

Geoengineering is the practice of altering the Earth system (composed of the interacting components of the atmosphere, oceans, land surface and sea-ice) to produce a change in climate. In that sense, the rapid increase in atmospheric CO_2 due to fossil fuel combustion is a form of geoengineering, albeit a particularly dangerous and uncontrolled kind. Geoengineering has been heralded by certain groups as a 'silver bullet'; the solution to climate change, fostering the dangerous attitude that society can continue as usual, and a geoengineering solution will 'save the day' in the future. Geoengineering remains an active area of research[40] and there is considerable uncertainty about some of the unintended consequences that could result, for example change to precipitation patterns which could affect important phenomena like the Monsoon.[41]

Certain geoengineering schemes are relatively harmless. For example, efforts have been made in Peru to paint the mountains exposed by receding glaciers white to increase the amount of radiation reflected into the atmosphere and thus reduce increases in surface temperature. Overall, while harmless, this is unlikely to produce a major change to the climate.[42] However,

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[37] Catherine Allan, Jun Xia and Claudia Pahl-Wostl, 'Climate Change and Water Security: Challenges for Adaptive Water Management' (2013) 5 Current Opinion in Environmental Sustainability 625.
[38] 'Egypt-Ethiopia Row: The Trouble over a Giant Nile Dam' *BBC News* (13 January 2020) <https://www.bbc.com/news/world-africa-50328647> accessed 23 July 2021.
[39] 'Water and Climate Change' (UN Water) <https://www.unwater.org/water-facts/climate-change/> accessed 10 April 2021.
[40] Ben Kravitz and others, 'The Geoengineering Model Intercomparison Project (GeoMIP)' (2011) 12 Atmospheric Science Letters 162.
[41] Alan Robock, Luke Oman and Georgiy L Stenchikov, 'Regional Climate Responses to Geoengineering with Tropical and Arctic SO2 Injections' (2008) 113 Journal of Geophysical Research: Atmospheres <https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2008JD010050> accessed 23 July 2021.
[42] 'Can Painting a Mountain Restore a Glacier?' *BBC News* (17 June 2010) <https://www.bbc.com/news/10333304> accessed 23 July 2021.

other ideas, which deliberately perturb the atmosphere are likely to produce more uncertain consequences.

ix. Public Health

The effectiveness of our response to climate change will define health and wellness globally for generations to come. In 2009, the Lancet Commission on Managing the Health Effects of Climate Change called climate change "the biggest global health threat of the 21st century",[43] but also concluded in a later study that tackling climate change could be "the greatest global opportunity of the 21st century" as international climate change mitigation and adaptation policies are able to protect human health from climate change while resulting in "health co-benefits".[44] Since then, cumulative evidence has shown that climate change puts the lives and well-being of billions of people at increased risk, which is characterised by multicausal pathways, uncertainty and complex interactions between economic, social and ecological factors. At the same time, the physical and psychological health of billions is undermined.[45] The recognition that the foundations of long-term good health in the global population are greatly dependent on the continued stability and functioning of the biosphere's life-supporting systems combined with an appreciation of the scale and type of influence climate change has on health, requires a new perspective towards health and climate policy that sheds light on the complexity of the systems upon which we depend.[46]

While the impact of climate change on health is felt globally, certain countries are affected disproportionately with the highest burden placed on vulnerable populations (elderly, children, coastal populations) and low-income and middle-income countries (LMICs).[47] For example, between 2000 and 2016, an additional 125 million vulnerable adults have been exposed to heatwaves.[48] By undermining some of the key factors for good health, climate change exacerbates social, economic and demographic inequalities.[49] Concerns about how a changing climate will

[43] Anthony Costello and others, 'Managing the Health Effects of Climate Change: Lancet and University College London Institute for Global Health Commission' (2009) 373 The Lancet 1693.
[44] Nick Watts and others, 'Health and Climate Change: Policy Responses to Protect Public Health' (2015) 386 The Lancet 1861.
[45] Rajiv Chowdhury and others, 'Reducing NCDs Globally: The under-Recognised Role of Environmental Risk Factors' (2018) 392 The Lancet 212.
[46] 'Climate Change and Health' (*World Health Organization*, 1 February 2018) <https://www.who.int/news-room/fact-sheets/detail/climate-change-and-health> accessed 11 April 2021.
[47] Nick Watts and others, 'The Lancet Countdown on Health and Climate Change: From 25 Years of Inaction to a Global Transformation for Public Health' (2018) 391 The Lancet 581.
[48] Ibid
[49] Ibid.

affect health are reflected in the United Nations Framework Convention on Climate Change (UNFCCC), the Global Framework for Climate Services and the recently adopted World Health Organization Strategy on health, environment and climate change. The health hazards of climate change require a coordinated international public health policy integrated into international climate policy to build climate resilient health systems. To achieve this, decision makers and stakeholders at all levels need access to reliable and relevant scientific information on the connections between our environment and our health.[50]

x. Tipping Points

The Earth System is to some extent self-regulated, which normally prevents rapid change. For example, if the Earth warms slightly, it will radiate more energy back into space, opposing further temperature rise and preventing rapid warming. However, there is real danger that the natural responses to change in the Earth system will not be strong or fast enough to oppose the changes caused by man.

At the extreme end of this behaviour is the concept of tipping points, which are responses by the Earth to perturbations which cannot be reversed. One example is the triggering of methane release from beneath the Arctic Sea floor or permafrost in high latitudes due to rising temperatures. Methane, another potent greenhouse gas, would raise temperatures, potentially triggering even more methane release.[51]

Tipping points are difficult to incorporate accurately into climate models and many models differ in how they represent them, further increasing the uncertainty of predictions.[52]

xi. The Carbon Budget

Given the temperature change already witnessed and the inevitable further rise due to ocean warming, a significant reduction in carbon emissions is required. To put this in perspective, the concept of a carbon budget has been developed. This considers the amount of carbon emitted in human history and projects the limits of what can be emitted while keeping the temperature rise below 1.5°C. The complexity of the Earth system and the uncertainty surrounding how it

[50] Andrew Moran and others, '1990-2010 Global Cardiovascular Disease Atlas' (2014) 9 Global Heart 3.
[51] EaG Schuur and others, 'Climate Change and the Permafrost Carbon Feedback' (2015) 520 Nature 171.
[52] Timothy M Lenton and others, 'Tipping Elements in the Earth's Climate System' (2008) 105 Proceedings of the National Academy of Sciences 1786.

may respond means a range of values is generally calculated. Studies have concluded that to attain a 50% chance of meeting the 1.5°C target, no more than approximately 800-900 giga-tonnes of CO_2 ($GtCO_2$) can be released, corresponding to approximately 22 years' worth of current emissions.[53] To put this in perspective, total global cumulative emissions since 1890 have been approximately 2200 $GtCO_2$.[54] In other words, mankind, with a smaller population and lower global wealth, has already exhausted well over 2/3 of its budget.[55]

I.II CONCLUSION

This section has provided a brief overview of the scientific basis of climate change and some of the impacts it will have. Climate change will affect all aspects of society in all parts of the world. Despite some evidence that it may open new shipping lanes in the Arctic[56] and aid mid-latitude agriculture (40°-60° N)[57], in most cases, it will have deleterious effects, causing the greatest strife to the most vulnerable people on Earth.

However, times of threat also present opportunities as well. As with many of the challenges that mankind has encountered in its history, technology perhaps presents humanity's best chance of achieving solutions of the required scale and speed to combat global warming through effective climate mitigation and adaptation. Investment provides a strong catalyst for technological advances, and early adopters who are ahead of the curve will receive the greatest payoff.

[53] Zeke Hausfather, 'Analysis: How Much "Carbon Budget" Is Left to Limit Global Warming to 1.5C?' (*Carbon Brief*, 9 April 2018) <https://www.carbonbrief.org/analysis-how-much-carbon-budget-is-left-to-limit-global-warming-to-1-5c> accessed 11 April 2021.
[54] Ibid
[55] Ibid
[56] 'As Arctic Ice Melts, Polluting Ships Stream into Polar Waters' *Reuters* (28 August 2020) <https://www.reuters.com/article/us-climate-change-arctic-shipping-analys-idUSKBN25O0L8> accessed 23 July 2021.
[57] Morison, J. I. L. and Matthews, R. B. (eds.) (2016): Agriculture and Forestry Climate Change Impacts Summary Report, Living With Environmental Change <https://nerc.ukri.org/research/partnerships/ride/lwec/report-cards/agriculture/>, accessed 9 May 2021.

I. OPPORTUNITIES FOR INVESTING IN CLIMATE CHANGE TECHNOLOGIES – A GLOBAL SURVEY

On 23rd September 2019, the United Nations (UN) convened the Net-Zero Asset Owner Alliance – an international group of 33 institutional investors representing US$5.1 trillion assets under management, which seeks to deliver on a bold commitment to transition their investment portfolios to net-zero GHG emissions by 2050.[58]

Investors are taking a step in the right direction by adjusting their portfolios in two main ways. One approach is based on risk reduction, where passive funds are removing polluting companies from their portfolios to avoid exposure to companies that are less likely to do well in a world that is getting hotter. These might include oil and gas companies, or those heavily exposed to coal or more highly polluting industries. A very prominent example of this was an announcement earlier in 2019 that the world's largest sovereign wealth fund, the Government Pension Fund Global, which manages US$1 trillion of Norway's assets, would phase out oil exploration from its "investment universe".[59]

The second way is to consider climate change an investment opportunity and actively invest in companies that will aid or benefit from the transition to a low carbon economy. Investing in climate change does not have to mean surrendering returns. Rather, as governments and companies around the world face increasing pressure to change their behaviour, those seeking solutions to climate change will yield strong returns. The following section of this report seeks to highlight these opportunities for investment in climate change technologies that can significantly boost mitigation of and adaptation to climate change. It also seeks to point towards the need to protect the most vulnerable, who are already bearing the brunt of changes to the global climatic system.

[58] 'United Nations-Convened Net-Zero Asset Owner Alliance' (*UNEP Finance Initiative*) <https://www.unepfi.org/net-zero-alliance/> accessed 10 April 2021.
[59] Rob Davies, 'Norway's $1tn Wealth Fund to Divest from Oil and Gas Exploration' (*The Guardian*, 8 March 2019) <http://www.theguardian.com/world/2019/mar/08/norways-1tn-wealth-fund-to-divest-from-oil-and-gas-exploration> accessed 10 April 2021.

II.I CLIMATE CHANGE MITIGATION TECHNOLOGIES

Globally, the sectors which are the biggest contributors to GHG emissions include energy (electricity, buildings, transport, industries) (73%), industrial processes (20%) and land use for food and agriculture (6.5%).[60] The most effective technologies for mitigating climate change would aim at these sectors. The technologies highlighted below are anticipated to arguably be the focus of public policies, private initiatives, and academic research, and therefore constitute a fertile investment ecosystem, supported by a variety of stakeholders.

The future potential of these technologies is important. Capital costs, political barriers and incentives were all aspects taken into consideration when selecting the technologies to be suggested in this report. In addition, the social aspect was also considered for some of these technologies, as they can also deliver important social benefits. With the aim of addressing different sectors that contribute to GHG emissions, the suggested technologies are among the most effective for mitigation of GHG emissions at different scales.

Investments in climate change technologies not only make them more accessible to all those in need of them, but also bring these technologies into the mainstream, making it more and more profitable for businesses to adjust their portfolios. This in turn makes greener businesses more attractive than 'business as usual'. However, governmental and private investment must go hand in hand to ensure that the transition to a low emission 'green economy' remains a just one. Investments with social co-benefits are likely to yield a holistic and inclusive greening of our economies and this section is an attempt to highlight some of these opportunities.

i. Energy

Power generation from offshore wind energy has emerged as a promising way for countries to expand their renewable energy portfolios and advance the necessary transformation for a sustainable energy future.[61]

[60] Mengpin Ge and Johannes Friedrich, '4 Charts Explain Greenhouse Gas Emissions by Countries and Sectors' <https://www.wri.org/insights/4-charts-explain-greenhouse-gas-emissions-countries-and-sectors> accessed 23 July 2021.

[61] 'IRENA Points to Offshore Energy Benefits for Economies at G7' (*International Renewable Energy Agency*, 19 September 2018) <https://www.irena.org/newsroom/articles/2018/Sep/IRENA-points-to-offshore-energy-benefits-for-economies-at-G7> accessed 10 April 2021.

Global offshore wind investment reached a record US$30 billion in 2020, surpassing its previous high of US$22 billion in 2018.[62] Globally, investments in offshore wind are set to grow substantially over the next two decades.[63]

Despite being more expensive in the short-term, offshore production is a more sustainable investment from a holistic and long-term point of view. Onshore production causes significant negative environmental impacts in terms of aesthetic and noise pollution, and, more importantly, competes with other uses of land. With significant global population growth – albeit at a slower pace - expected in the coming decades, land use will have to be highly efficient to provide food for everyone.[65] Therefore, offshore generation presents itself as a more sustainable option, leaving land available for other important activities. In addition, appropriate locations for onshore generation are frequently located far from large electricity consuming centres. Offshore production, on the other hand, can overcome this issue as half the world's population lives in coastal areas, including large and economically important cities. As long-term investments usually generate the best results, offshore production appears to be a preferable option.

ii. Off-Grid Renewables

Off-grid renewable energy solutions, including stand-alone systems and mini-grids, have emerged as a mainstream, cost-competitive option for expanding access to electricity.

Illustrating the scalability of off-grid solutions, between 2011 and 2016, the number of people benefiting from such solutions increased six-fold, reaching more than 133 million.[67] This includes about 100 million using solar lights (<11 watts), 24 million using solar home systems (>11 watts) and at least 9 million connected to a mini grid. Concurrently, off grid renewables capacity witnessed a spectacular three-fold increase from under 2 gigawatts (GW) in 2008 to over 6.5 GW in 2017.[68]

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[62] '2020 "stellar Year" for Global Offshore Wind Investment' (*reNEWS - Renewable Energy News*, 15 February 2021) <https://renews.biz/66479/2020-stellar-year-for-global-offshore-wind-investment/> accessed 23 July 2021.
[63] Anmar Frangoul, 'Offshore Wind Set to Be a $1 Trillion Business by 2040, the IEA Says' (*CNBC*, 25 October 2019) <https://www.cnbc.com/2019/10/25/offshore-wind-set-to-be-a-1-trillion-business-by-2040-the-iea-says.html> accessed 23 July 2021.
[65] 'Growing at a Slower Pace, World Population Is Expected to Reach 9.7 Billion in 2050 and Could Peak at Nearly 11 Billion around 2100' (*United Nations Department of Economic and Social Affairs*, 17 June 2019) <https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html> accessed 23 July 2021.
[67] IRENA, *Off-Grid Renewable Energy Solutions* (International Renewable Energy Agency 2018) 1–2.
[68] ibid.

However, despite the impressive growth, the investment gap in the off-grid sector and in energy access remains large. Off-grid solutions, for instance, attracted no more than 1% of the USD 30 billion committed in 2015-16 for expanding electricity access.[69]

Both public and private sources of financing have an important role to play in bridging the financing gap. Public finance can close the funding gap through: i) direct financing for public services, rural enterprises and households that are unable to access available solutions and are at risk of being left behind;[70] and ii) financing instruments that de-risk investments and, thereby, attract private capital for enterprises and projects (e.g., high-risk innovation funds, funds for initial feasibility studies).

iii. Smart Grids and Smart Meters

Equally important as clean electricity generation is an efficient transmission and distribution system. Smart grids are energy networks that can automatically monitor energy flows and adjust to changes in energy supply and demand accordingly. Information on real-time consumption reaches consumers and suppliers through smart grids which are coupled with smart meters. With smart meters, consumers can adapt their energy usage (in terms of time and volume) to different energy prices throughout the day, saving money on their energy bills by consuming more energy during lower price periods.

The Central and Eastern European (CEE) region offers one of the most compelling smart grid investment opportunities among emerging markets. Supported by the EU smart grid regulations, the characteristics of the area include relatively high rates of electricity consumption and high non-technical losses, making it a ripe market for smart grid investment.[71] The largest markets of Poland and Turkey are in the early stages of smart grid infrastructure investment that will total US$28.6 billion over the period 2017-2027.[72] More advanced segments of the smart grid market will develop as more countries deploy distribution automation, wide area measurement, analytics, and battery storage, all of which offer a wide set of opportunities to make profitable

[69] SEforALL, 'Understanding the Landscape - Tracking Finance for Electricity and Clean Cooking Access in High-Impact Countries' (Sustainable Energy for All, Climate Policy Initiative 2018) <https://www.seforall.org/system/files/gather-content/EF-2018-UL-SEforALL.pdf> accessed 10 April 2021.
[70] Practical Action, *Poor People's Energy Outlook 2018* (Practical Action Publishing 2018) <https://practicalactionpublishing.com/book/1668/poor-peoples-energy-outlook-2018> accessed 11 April 2021.
[71] 'Central & Eastern Europe to Invest $28.6 Billion in Smart Grid Infrastructure' (*Utility Dive*) <https://www.utilitydive.com/press-release/20170927-central-eastern-europe-to-invest-286-billion-in-smart-grid-infrastructu/> accessed 23 July 2021.
[72] Ibid.

investments. Some of the players already in the field include large international smart grid vendors such as Honeywell, Oracle, and Siemens. The focus on emerging economies is also increasingly relevant. As projects in developed economies wrap up, vendors will shift their focus to opportunities in countries within emerging market regions, which include Sub-Saharan Africa, South Asia, and Latin America.

iv. Transport sector

Electric mobility is expanding at a rapid pace. In 2018, the global electric car fleet exceeded 5.1 million – this is an increase of2 million from the previous year and almost double the number of new electric car sales.[73] A crucial component of electric cars remains the quality of batteries, as they are expected to endure long distances. Lithium-ion (LI) batteries are already commercially used in the world but with some limitations that may not be overlooked. Meanwhile, alternatives are beginning to crop up. The price of LI batteries fell 80% between 2010 and 2017 ($/kWh) with costs projected to fall another 52% between 2018 and 2030.[74] Ultrafast charging is also a characteristic vital to helping electric cars go mainstream and there is a big scope of improvement in this area.

As energy production moves towards renewable and intermittent sources, it will be crucial to store large amounts of energy in an efficient way.[75] In this scenario, the electric vehicle sector can act as the driving force for investment and innovation in batteries, so as to achieve global mass production.

Just 10 countries are on course to represent almost three quarters of the global market in gigawatt terms, according to Bloomberg New Energy Finance's forecast.[76] South Korea was the lead market in 2019, but will soon cede that position, with China and the US taking the lead by 2040. The remaining significant markets include India, Germany, Latin America, Southeast Asia, France, Australia, and the UK.[77]

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[73] 'Global EV Outlook 2019: Scaling up the Transition to Electric Mobility' (*CityLogistics*) <http://www.citylogistics.info/research/global-ev-outlook-2019-scaling-up-the-transition-to-electric-mobility/> accessed 23 July 2021.
[74] Ariel Cohen, 'Charging Up: Battery Storage Investments To Reach $620 Billion By 2040' (*Forbes*) <https://www.forbes.com/sites/arielcohen/2018/11/21/charging-up-battery-storage-investments-to-reach-620-billion-by-2040/> accessed 23 July 2021.
[75] Johan Rockström and others, 'A Roadmap for Rapid Decarbonization' (2017) 355 Science 1269.
[76] 'Energy Storage Investments Boom As Battery Costs Halve in the Next Decade' (*Bloomberg New Energy Finance*, 31 July 2019) <https://about.bnef.com/blog/energy-storage-investments-boom-battery-costs-halve-next-decade/> accessed 23 July 2021.
[77] Ibid.

v. Industrial Processes

Carbon Capture and Storage

Carbon Capture and Storage (CCS) is the long-term underground storage of CO_2 as a means of reducing atmospheric CO_2 concentrations. Anthropogenic CO_2 is captured using chemical solvents at the point of formation, typically large industrial plants, or power stations. The CO_2 is then compressed and transported through pipelines into deep geological reservoirs suitable for storing the CO_2 permanently. Carbon dioxide removal (CDR) technologies, such as biofuels or direct air capture, which take CO_2 out of the atmosphere can be combined with CCS to permanently store any captured CO_2, resulting in net negative emissions.

Sectors other than industry that CCS could be applied to are the decarbonisation of fossil fuel power generation and hydrogen production by reforming natural gas. Production of zero-carbon hydrogen is especially important as hydrogen is viewed to be essential for decarbonising heating, industry and areas of transport, sectors accounting for a large fraction of global emissions.

Financial incentives for carrying out CCS must exist if developers are to invest in the infrastructure and operational costs. Financial incentives could either constitute a reward for capturing and storing the carbon or a cost incurred for emitting it. A total of 64 carbon pricing instruments are current in operation globally, covering over 20% of global greenhouse gas emissions.[78] However, this means that close to eighty per cent of global emissions are not covered by carbon pricing, with less than 5% of carbon prices above US$40per tonne CO_2.[79] The Sleipner Field in the North Sea is an example of when the financial cost of emission incentivised the capture and storage of CO_2. In 1991, Norway imposed a carbon tax penalty for venting CO_2 into the atmosphere.[80] At approximately US$17/t CO_2, it was cheaper to separate CO_2 from the extracted natural gas and inject it into the subsurface which made a good business case for CCS. Commercial use of CO_2 may also incentivise carbon capture. EOR is currently one of the few commercial opportunities available for captured CO_2. The price of CO_2 is linked to the price of

[78] World Bank, 'State and Trends of Carbon Pricing' (World Bank 2021) <https://openknowledge.worldbank.org/bitstream/handle/10986/35620/9781464817281.pdf?sequence=12&isAllowed=y> accessed 11 April 2021.
[79] ibid.
[80] J Sumner, L Bird and H Smith, 'Carbon Taxes: A Review of Experience and Policy Design Considerations' (National Renewable Energy Laboratory 2009) Technical Report NREL/TP-6A2-47312 10–11.

oil, and revenue from the sale of CO_2 for EOR may be sufficient to cover costs of capture and transport of CO_2.

Another barrier to deployment is that first movers in infrastructure development are disadvantaged over those who wait which increases the time taken to reach large scale deployment. Shared knowledge of the strengths and pitfalls of previous projects is beneficial for development of the technology but has a potential adverse effect. If second and third movers can improve the design and operation of future plants, this could result in stranding first movers' assets. For example, a capture plant may become uncompetitive over time as successive facilities become optimised.

Private sector funding needs to increase by orders of magnitude to achieve the scale of deployment required. However, the risk associated with projects is currently perceived by banks to be too high for debt financing.[81] In a disaggregated business model, there may be separate businesses handling the capture, transport, and storage stages of the project. Each part of the value chain relies on the delivery of the other parts, which introduces cross-chain risk for all members. Conversely, in a vertically integrated business model where one business takes responsibility for all stages of the project, knowledge of the full value chain is required. Controlling operations outside an area of expertise may introduce risk.

Although only two full-scale CCS plants were in operation in the power sector as late as 2018, making costs very difficult to estimate,[82] the Global CCS Institute has suggested that if technologies currently in development can be deployed, costs in the power sector will be reduced by up to approximately 30%.[83] Pressure must also be exerted on governments to create as many of these markets as possible, and as more investment goes into CCS, the requirement for capital support will diminish.

[81] Alex Zapantis, Alex Townsend and Dominic Rassool, 'Policy Priorities to Incentivise Large Scale Deployment of CCS' (Global CCS Institute 2019) <https://www.globalccsinstitute.com/wp-content/uploads/2019/04/TL-Report-Policy-prorities-to-incentivise-the-large-scale-deployment-of-CCS-digital-final-2019-1.pdf> accessed 23 July 2021.
[82] Sara Budinis and others, 'An Assessment of CCS Costs, Barriers and Potential' (2018) 22 Energy Strategy Reviews 61, 62.
[83] Lawrence Irlam, 'Global Costs of Carbon Capture and Storage' (Global CCS Institute 2017) <https://www.globalccsinstitute.com/archive/hub/publications/201688/global-ccs-cost-updatev4.pdf> accessed 23 July 2021.

II.II ADAPTATION AND RESILIENCE BUILDING TECHNOLOGIES

One of the most devastating manifestations of climate change are the increasingly frequent occurrence of disasters. Over the two decades 2000-2019, each year has accounted for an average of around 350 disasters, which have resulted in an average of 61,000 deaths and left 201.3 million people affected.[85] Economic losses from 'natural' disasters have now risen to US$250 and US$300 billion each year, compared to US$50 billion in the 1980s.[86] Future expected losses are estimated at a range of US$314 billion per year in the built environment alone.[87] Emerging technologies and the development of better disaster risk management techniques can help to abate damages to the most vulnerable populations through early warnings and predictions allowing adequate time for precautionary measures.

i. Disaster Risk Reduction Technologies

Investment in Disaster Risk Management (DRS) continues to be low and represents only a tiny percentage of international development assistance.[88] The majority of DRM-related development financing continues to go into emergency response, rather than prioritising investments to build resilience.[89]

The possibility of future disaster also impacts economic growth. High aversion to risk often restricts business operations and continues to discourage potential profitable investments that could improve the population's welfare. In contrast, action to manage disaster risk can encourage visionary planning, long-term capital investment and entrepreneurship. These secondary and tertiary dividends are expected to deliver benefits even in the absence of a disaster occurring for many years. Therefore, these additional benefits also become a strong reason for increased investment in disaster risk reduction and management.

[85] 'Disaster Year in Review 2020: Global Trends and Perspectives' (Centre for Research on the Epidemiology of Disasters 2021) 62.
[86] 'Sovereign Climate and Disaster Risk Pooling: World Bank Technical Contribution to the G20' (World Bank 2018) 3 <https://openknowledge.worldbank.org/handle/10986/28311>.
[87] 'Disaster Risk Management Vital for Private Sector' (*United Nations Office for Disaster Risk Reduction*, 2016) <https://www.undrr.org/news/disaster-risk-management-vital-private-sector> accessed 23 July 2021.
[88] Charlene Watson and others, 'Finance for Reducing Disaster Risk: 10 Things to Know' (Overseas Development Institute 2015).
[89] Ibid.

In the island nation of Vanuatu, aerial drones were deployed for disaster assessment following Cyclone Pam in March 2015. Drones were an effective tool for rapid and granular disaster recovery mapping, particularly since cloud cover obscured satellite images.[90] The images captured by the drones proved to be highly effective at identifying and mapping the most damaged terrain and allowed for easier emergency assistance to affected areas. Crops were also surveyed for damage to determine how much food people would require from other sources. The imagery was uploaded to an open-source mapping platform for volunteers to upload and geo-tag images from social media to overlay on the map.

Another example of the effective use of such technology was during the flooding of the Liboriana River in Colombia, which triggered a devastating landslide in May 2015, causing more than 80 deaths.[91] Following the event, the Colombian Government's National Unit for Disaster Risk Management hired Federmán Comunicaciones, a Colombian company with more than ten years of experience in telecommunications,[92] to implement an early warning system using IoT technology. As a result, five solar powered sensors were installed along the Liboriana river and two other rivers to monitor air temperature and water level using ultrasound. The use of solar energy ensured the sensors would continue functioning even in the event of an electricity outage. The system automatically sends a text message to village authorities if it detects a risk, and the data is also stored in the cloud for others to access.

[90] 'Drones for Good: New Technologies Address Old Challenges in Vanuatu' (*ITU News*, 22 October 2019) <https://news.itu.int/drones-for-good-new-technologies-address-old-challenges-in-vanuatu/> accessed 11 April 2021.

[91] Antonio Zaballos, Enrique Iglesias and Alejandro Adamowicz, 'The Impact of Digital Infrastructure on the Sustainable Development Goals: A Study for Selected Latin American and Caribbean Countries' (Inter-American Development Bank 2019) 33 <https://publications.iadb.org/publications/english/document/The_Impact_of_Digital_Infrastructure_on_the_Sustainable_Development_Goals_A_Study_for_Selected_Latin_American_and_Caribbean_Countries_en_en.pdf> accessed 23 July 2021.

[92] 'Early Warning System to Prevent Floods and Allow Disaster Management in Colombian Rivers' (*Libelium*, 12 September 2017) <https://www.libelium.com/libeliumworld/success-stories/early-warning-system-to-prevent-floods-and-allow-disaster-management-in-colombian-rivers/> accessed 11 April 2021.

II.III GLOBAL DISCUSSIONS ON CLIMATE CHANGE FINANCE AND INVESTMENTS – CASE STUDIES

The Principles for Responsible Investment (PRI) and the Task Force on Climate-related Financial Disclosures (TCFD) signalled to many investors that mainstream investments practices were no longer appropriate. Both initiatives clearly demonstrated that an integration between natural capital – the world's stock of natural resources, or environmental assets – and economic capital was fundamental, and have clearly shaped investment trends, leading towards a convergence of environmental aspects and financial outcomes.

As of 31 March 2020, the number of investor signatories to PRI increased by 29% from 2,092 to 2,701 between 2019 to 2020, while the number of asset owner signatories increased by 21% to 521.[93] The collective assets under management represented by PRI signatories have also increased by 20% over the same period, from US$86.3 trillion to US$103.4 trillion across 3,038 signatories – a sharp and steady increase in a period of little over ten years, with no drop recorded in the number of investors or for the invested value.[94] PRI works closely with United Nations Environment Programme Finance Initiative and United Nations Global compact, ensuring a close alignment with the United Nations Sustainable Development Goals, including mitigation of climate change.

While some private companies are already taking action, others have yet to make this shift. Private firms are hesitant to invest when climate-resilient investments present an added cost or a higher risk. In these cases, government action can help correct these market failures.

At this juncture, this report sets out some case-studies on how government and private sector partnerships can bring about significant investments in various technological innovations to address the consequences of climate change – these investments have occurred at both the micro and macro levels, as illustrated below.

[93] UNEP Finance Initiative, 'Annual Report - 2020' (*Principles for Responsible Investment*) <https://www.unpri.org/annual-report-2020/how-we-work/building-our-effectiveness/enhance-our-global-footprint> accessed 23 July 2021.
[94] ibid.

i. Norway

Enova SF is a company owned by the Norwegian Ministry of Climate and Environment which contributes to reduced GHG emissions, the development of energy and climate technology and a strengthened security of supply. As it is costly and risky for individual businesses to start using the newest and most climate-friendly technologies, Enova offers a financial contribution to eligible companies so that projects can be implemented even if it is not profitable in the short-term, and even if it does not fulfil the company's investment strategy. The goal for Enova is to support the project such that the net present value of the project is zero. Enova has two main areas of financial support: technology development and market development.

Enova therefore supports technologies and projects that are unprofitable but yield a positive result. The financial support from Enova is not only to support the specific project; it also makes more people use the technology. As soon as the technology becomes profitable over the investment period, Enova stops the financial support. Its financial support serves to hasten market development, and its ultimate goal is to help push ideas to the market and ensure innovations increase in both scope and speed, so as to bring about a low emission society.[95]

ii. Solar Energy - Sub-Saharan Africa & United Arab Emirates

Sub-Saharan Africa

Sub-Saharan Africa (SSA) is an example of a region where total carbon dioxide emissions released in 2014 amounted to 16% of those released by the United States.[96] However, in SSA there are multiple risk factors present. When combined, these have the potential to create even worse outcomes than any one factor alone would. This is exemplified by the influence of drought events on sectors such as health care, agriculture, and sanitation.

The historically low emission burdens of countries in SSA, in concert with their amplified vulnerability to the anticipated effects of global warming,[97] heighten the need for a primary focus on adaptation and a secondary focus on mitigation. Adaptation is often a more amenable strategy

[95] 'Norway's Long-Term Low-Emission Strategy for 2050' (*United Nations Climate Change*, October 2020) <https://unfccc.int/sites/default/files/resource/LTS1_Norway_Oct2020.pdf> accessed 23 July 2021.
[96] Doug Cogan, Megan Good and Emily McAteer, 'Addressing Climate Risk: Financial Institutions in Emerging Markets' (DEG, RiskMetrics Group and Ceres 2009) <https://firstforsustainability.org/media/Addressing%20Climate%20Risk.pdf> accessed 11 April 2021.
[97] Nothemba Kula, Andy Haines and Robert Fryatt, 'Reducing Vulnerability to Climate Change in Sub-Saharan Africa: The Need for Better Evidence' (2013) 10 PLOS Medicine e1001374.

in the context of SSA as it can be operationalised by augmenting existing technologies that span diverse sectors of society and the economy, and often utilise local knowledge.[98] In contrast, mitigation has been focused predominantly on the energy sector and the use of nascent, foreign renewable energy technologies (RETs) which need to be adapted to conditions in SSA. The larger sphere of influence of adaptation approaches positively mirrors the ubiquitous nature of climate change impacts, which are not confined to the energy sector but affect agriculture, water, health, and infrastructure. The breadth of focus for adaptation solutions enables less capital intensive, small-scale interventions tailored to local needs to blossom across multiple sectors.

The ability of mitigation and adaptation technologies to provide both private and public goods have historically inhibited private investment in these technologies, and thus passed the economic opportunities to the public sector. However, the prosperity of companies such as M-*Kopa* (which provides solar home systems to rural communities),[99] Ignitia (which delivers accurate weather forecasts to farmers)[100] and the commissioning of the first privately owned geothermal plant in Ethiopia,[101] have demonstrated the profitability of private investment in projects at diverse scales, for both mitigation and adaptation technologies.

Solar photovoltaic (PV) and wind technologies are apposite in the context of SSA for diverse environmental, social, and political reasons. The ability of these technologies to reduce the emissions of GHGs by replacing energy generation from the combustion of fossil fuels enables them to achieve desired environmental outcomes, from direct air pollution reductions to ameliorated climate change effects. Socially, the use of solar-PV and wind technologies to replace traditional power stations significantly decreases the water requirements for electricity generation, serving to mitigate water shortages and power outages in times of drought.[102] In rural Africa many households rely on diesel, which costs approximately US$1 per kWh, however, decentralised solar-PV systems can currently produce power for approximately US$0.20 per kWh.[103] Thus, this technology is known to decrease the economic burden of energy provision for rural families.

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[98] Joseph Amankwah-Amoah, 'Solar Energy in Sub-Saharan Africa: The Challenges and Opportunities of Technological Leapfrogging' (2015) 57 Thunderbird International Business Review 15.
[99] Peter Stalker (ed), *Technologies for Adaptation to Climate Change* (UNFCCC 2006).
[100] Anne Olhoff, Skylar Bee and Daniel Puig, 'The Adaptation Finance Gap Update - with Insights from the INDCs' <https://orbit.dtu.dk/en/publications/the-adaptation-finance-gap-update-with-insights-from-the-indcs> accessed 29 April 2021.
[101] Zhenyu Li and others, 'Towards Sustainability in Water-Energy Nexus: Ocean Energy for Seawater Desalination' (2018) 82 Renewable and Sustainable Energy Reviews 3833.
[102] Thomas Feeley and others, 'Water: A Critical Resource in the Thermoelectric Power Industry' (2008) 33 Energy 1.
[103] Amankwah-Amoah (n 98).

This is significant as energy enables improvements in a myriad of sectors including health, education and agriculture, and acts to decrease overall vulnerability to climate change.[104] Politically, the ability of solar PV and wind to help countries progress towards their specific electrification and general development targets is reflected in their enormous theoretical potentials (660 petawatt-hour (PWh) for solar, 460PWh for wind).[105] Furthermore, a transition towards utilising diverse renewable energy technologies (RETs) in energy supply enhances a country's energy security by diversifying the current portfolio of power supply and decreasing any reliance on imported fuels.[106]

Currently solar-PV is envisaged as one of the most promising renewable technologies available due to its exceptional cost decreases and efficiency improvements over time.[107] In the context of SSA it is viewed as under-exploited with 'great opportunities for growth.'[108] These growth potentials can be seen blossoming in the privatisation, liberalisation and deregulation of energy markets across SSA and in the policies currently in force specifically to promote private investment in solar power – these are anticipated to increase further as governments recognise the political, social and environmental advantages of diversifying into clean energy.[109]

At the small systems level, the commercial viability of a product is dependent upon the business model chosen. While reports on the global demand for renewables have forecast that solar will become the cheapest resource by 2030,[110] solar-PV systems require a large upfront cost for the module and associated components. Consequently, business models such as the pay-as-you-go

[104] Antonio Jiménez and Ken Olson, 'Renewable Energy for Rural Health Clinics' (National Renewable Energy Lab, Golden, CO (US) 1998) NREL/BK-500-25233 <https://www.osti.gov/biblio/786177> accessed 29 April 2021; Karen Rajaona Daka and Jérôme Ballet, 'Children's Education and Home Electrification: A Case Study in Northwestern Madagascar' (2011) 39 Energy Policy 2866; Shahbaz Mushtaq and others, 'Energy and Water Tradeoffs in Enhancing Food Security: A Selective International Assessment' (2009) 37 Energy Policy 3635.
[105] Sebastian Hermann, Asami Miketa and Nicholas Fichaux, 'Estimating the Renewable Energy Potential in Africa: A GIS-Based Approach' (International Renewable Energy Agency 2014) <https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2014/IRENA_Africa_Resource_Potential_Aug2014.pdf>.
[106] Anton Eberhard and others, *Africa's Power Infrastructure* (The World Bank 2011) <https://elibrary.worldbank.org/doi/abs/10.1596/978-0-8213-8455-8> accessed 29 April 2021.
[107] Michael Taylor, Andrei Ilas and Pablo Ralon, *The Power to Change: Solar and Wind Cost Reduction Potential to 2025* (International Renewable Energy Agency 2016) <https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2016/IRENA_Power_to_Change_2016.pdf> accessed 29 April 2021.
[108] Amankwah-Amoah (n 98).
[109] 'Climatescope Emerging Markets Outlook 2020: Energy Transition in the World's Fastest Economies' (Bloomberg New Energy Finance 2020) <https://global-climatescope.org/assets/data/reports/climatescope-2020-report-en.pdf> accessed 23 July 2021.
[110] Stephen Lacey, 'Wind and Solar Will Soon Become the "Least-Cost Option Almost Universally"' (*Greentech Media*) <https://www.greentechmedia.com/articles/read/wind-and-solar-will-soon-become-the-least-cost-option-almost-universally> accessed 2 May 2021.

plan (PAYG), which allow incremental payments over time for a product, have been successful in enabling rural households to overcome the initial high upfront costs for solar-PV systems. This model additionally often requires the ability for payments to be made via mobile phones in small instalments.[111] The use of mobile payment collection through the PAYG model has enabled the company M-Kopa to become so successful.[112]

To enable investment, regulations may need to be imposed to direct some of the value of the public good provided back to the investor to make these technologies competitive with polluting incumbents. Variations of these techniques exist today, such as generous feed-in-tariffs (FITs) for RETs which provide clean electricity directly to the grid, or quantity-based instruments such as renewable energy quotas.[113] Approaches such as these are operational in multiple countries across SSA. However, to be considered legitimate they must also be congruent with existing policies and situated within a political and regulatory environment that is perceived as secure.

United Arab Emirates

The United Arab Emirates (UAE) became an unlikely leader in solar energy development in the middle of this decade when they began breaking pricing records for large-scale solar energy projects. In 2016, both Dubai and Abu Dhabi announced gigawatt-scale photovoltaic plants that would produce electricity for less than 3 c/kWh, lower than all but the cheapest fossil fuel electricity.[114] The claim initially attracted scepticism. However, since that time, many other countries, including the US, have followed the UAE's lead in bringing solar electricity prices to 3¢/kWh and below.[115] Recent studies have demonstrated how the changing economics of solar energy have allowed large-scale photovoltaic projects to remain profitable for their investors even while selling electricity at low prices.[116]

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[111] Amankwah-Amoah (n 98).
[112] M-Kopa Solar, 'Impact Report 2019: Upgrading Lives' <https://m-kopa.com/wp-content/uploads/2020/08/M-KOPA-IMPACT-REPORT-2019.pdf> accessed 30 April 2021.
[113] *Turn Down the Heat: Climate Extremes, Regional Impacts, and the Case for Resilience.* (2013) <http://elibrary.worldbank.org/doi/book/10.1596/978-1-4648-0055-9> accessed 30 April 2021.
[114] 'Cheapest Solar on Record Offered as Abu Dhabi Expands Renewables' *Bloomberg* (19 September 2016) <https://www.bloomberg.com/news/articles/2016-09-19/cheapest-solar-on-record-said-to-be-offered-for-abu-dhabi> accessed 23 July 2021.
[115] 'Press Release: Renewables Increasingly Beat Even Cheapest Coal Competitors on Cost' (*International Renewable Energy Agency*, 2 June 2020) <https://www.irena.org/newsroom/pressreleases/2020/Jun/Renewables-Increasingly-Beat-Even-Cheapest-Coal-Competitors-on-Cost> accessed 23 July 2021.
[116] Harry Apostoleris and others, 'Evaluating the Factors That Led to Low-Priced Solar Electricity Projects in the Middle East' (2018) 3 Nature Energy 1109.

The declining cost of solar hardware, coupled with increased experience in system design and construction, has fundamentally changed the way in which solar project development must be approached. In the past, the high cost of hardware meant that projects could only be viable with heavy government subsidies. Therefore, the first areas of the world to build large amounts of solar generating capacity were those with government support for renewables. Some of these places, such as Spain and California, have strong solar resources which leads to high output from solar generating systems; others, such as Germany and the north-eastern US, would not have developed their solar industries so quickly if not for state subsidies. Now, this situation has changed. Major surveys have shown that the capital costs for building solar power plants are now comparable to those for equivalent low-cost fossil fuel plants, and the main factor that will control how quickly solar energy capacity is built will be how much capital can be raised, mostly from the private sector, to finance the construction of new solar power plants.

In the case of Dubai and Abu Dhabi's projects, various steps were taken to lower construction costs, and a change in the attitude of banks towards solar energy allowed the developers to obtain large loans at low interest rates.[117] Both of these aspects appear to be being replicated in other parts of the world. Solar parks in the southwestern US are being built next to decommissioned coal-fired plants and making use of the old plants' electric transmission lines, which otherwise would represent a major cost for the developer.[118] Meanwhile, an 85% fall in prices between 2010 and 2020 (with a current global average of US$0.057/kWh) and the proliferation of new solar projects suggest a strong financing environment, where investors and lenders have high confidence in solar energy to deliver returns.[119]

One aspect that has helped solar energy become a safe investment is the rise of power purchase agreements (PPAs) for utility-scale solar plants. A PPA is a contract signed between the company that builds the plant (typically a private firm that retains full or partial ownership) and a utility company, specifying a fixed price that the utility company will pay for electricity from the plant. In the UAE, PPAs for solar have typically been signed for 25 years or more. Thus, the

[117] Jordan Bincliffe, 'Debt Terms Revealed as Masdar, EDF Close on Dubai PV' (*IJ Global*, 14 June 2017) <https://ijglobal.com/articles/106791/debt-terms-revealed-as-masdar-edf-close-on-dubai-pv> accessed 30 April 2021.
[118] Dane Rhys and Nichola Groom, 'U.S. Solar Developers See Opportunity in America's Post-Industrial Lands' *Reuters* (23 June 2021) <https://www.reuters.com/business/energy/us-solar-developers-see-opportunity-americas-post-industrial-lands-2021-06-23/> accessed 23 July 2021.
[119] IRENA, 'Renewable Power Generation Costs 2020' (International Renewable Energy Agency 2021) 12.

project has a contractually guaranteed revenue stream for most of its expected lifetime. This provides investors and lenders with some assurance of projects' revenue-generating potential.

These low-cost projects use only photovoltaics to produce electricity for immediate use – they do not include energy storage. The UAE is now moving to the next phase of solar development – combining PV with concentrating solar power (CSP) and thermal energy storage to provide 24-hour solar energy. Dubai's most recent solar project – Phase 4 of the Mohammed bin Rashid Al Maktoum Solar Park -- was ordered in 2017, with construction currently underway. It will total 950MW and has the ambition of providing electricity 24 hours per day by combining PV and CSP technology.[120] The development process has been eased by the availability of large amounts of capital; however, it is worth reiterating that the contribution of government money has taken the form of an investment, not a subsidy. Abu Dhabi's 1.1GW PV park is now operational; Dubai's 800MW PV project is nearing completion and their 950MW PV+CSP plant is under construction. These will be projects to watch in the coming years and will provide critical experience in the operation of large scale, 24-hour/day solar energy generation with low electricity prices. The success – technical and economic – of these projects would likely lead the way to a further acceleration in the construction of large solar power plants.

Solar energy has reached maturity as an industry and offers many economically viable solutions to the problem of decarbonization across different sectors. As such, there are many projects that could be implemented in short order to directly reduce GHG emissions, many of which are associated with opportunities for private investment. Utility-scale solar energy projects are typically built by private project developers, who finance construction with a combination of loans and private equity. Green investment funds that direct investors' money towards renewable energy (mainly solar and wind) projects are also growing.[121]

Public investment in both renewable energy and infrastructure projects that will enable the further penetration of renewables is also increasing. Projects such as district heating and cooling and smart electric vehicle charging networks, such as those described in the preceding snapshots, will require a further expansion of public investment. Many countries (including the Netherlands

[120] '4th Phase of the Mohammed Bin Rashid Al Maktoum Solar Park Will Have the Largest Energy Storage Capacity in the World' (*Dubai Electricity and Water Authority*, 28 November 2020) <https://www.dewa.gov.ae/en/about-us/media-publications/latest-news/2020/11/4th-phase-of-the-mohammed-bin-rashid-al-maktoum-solar-park> accessed 23 July 2021.

[121] IRENA and CPI (2020), Global Landscape of Renewable Energy Finance, 2020, International Renewable Energy Agency, Abu Dhabi.

and Ireland) have begun to issue green bonds to raise funds for these projects.[122] These offer another avenue for targeted investment in decarbonization efforts generally.

Innovative start-ups have developed several of the applications described here, including solutions for building-integrated and agricultural PV, and solar heat collection for industrial use. A third, higher-risk investment approach is to invest directly in companies that are developing new solutions to satisfy unmet needs of the market. The aim of this chapter has been to provide a technological background that will allow the investor to begin the process of identifying promising investments.

A final point that must be made is that the importance and applicability of solar energy is likely to expand, not shrink, as global energy markets expand. Much of the operational experience of solar energy systems until recently has been in the global north. In these areas, challenges such as cloud cover and large seasonal changes in the solar resource are commonplace. These issues are less pronounced in large parts of the global south, where the solar resource is typically stronger and more uniform over the year.

iii. Smart Cities – Japan

Smart cities open up opportunities for global technology companies to market solutions which can support more sustainable urban futures. Global institutions such as the World Bank and World Economic Forum back the idea of digitising urban systems and infrastructures as a viable proposition for securing environmental sustainability and economic growth.[123] The proliferation of smart cities is providing the private sector with an opportunity to work with governments. It is a mutually beneficial partnership, given that this means new business for the private sector and greater expertise and cost-efficiency for the government sector.[124] A combination of the technology and innovation of government, cities and companies to benefit citizens, is offered by a successful public-private partnership. Public-private partnerships can help accelerate the pace

[122] Bram Bos and Kaili Mao, 'Green Bond Bulletin: The Case for Green Sovereigns' (*NN Investment Partners*, 15 March 2021) <https://www.nnip.com/en-INT/professional/insights/articles/green-bond-bulletin-the-case-for-green-sovereigns> accessed 23 July 2021.
[123] Jenni Viitanen and Richard Kingston, 'Smart Cities and Green Growth: Outsourcing Democratic and Environmental Resilience to the Global Technology Sector' (2014) 46 Environment and Planning A: Economy and Space 803.
[124] Andrew Ross, 'The Collaborative City: How the Private Sector Can Advance Smart Cities' (*Information Age*, 2 August 2018) <https://www.information-age.com/collaborative-city-smart-cities-123473907/> accessed 30 April 2021.

of change and implementation of smart cities infrastructure, by working together for the greater good.[125]

Connecting cities with financial opportunities is an essential component of building smart cities, ensuring urban resilience, and achieving the right targets. This requires reallocation of existing budgets and the ability to raise revenues.

Japan is a case-study that highlights public-private partnerships as the primary mechanism used to finance capital-intensive smart cities' infrastructure. To encourage investment in such infrastructure, targeted taxes and incentives can also be used to favour low-carbon energy over fossil-fuel sources or density over urban sprawl. Green infrastructure can be encouraged with the help of land value capture mechanism while leveraging the use of private finance. Debt financing instruments such as green bonds have great potential to drive climate-smart investment by allowing cities to acquire long-term debt at stable prices. Innovative financial and collaborative projects will be a key to preparing and implementing sustainable smart cities as bankable projects, developing domestic financial markets, and mobilizing private financing for local investment. To deliver promising smart cities, it is vital to move from planning to pilots, from pilots to projects and from projects to partnerships.

Increasing environmental concerns and awareness, urbanization and technological advancements have together resulted in an urgent requirement and opportunity to build "smart" cities. 'Smart Cities' initiatives try to improve urban performance by using data, information and information technologies (IT) which open the opportunities for the global technology companies to market solutions which can support more sustainable urban futures, specifically focusing on climate change. The proliferation of smart cities is also providing the private sector with an opportunity to work with governments. It is a mutually beneficial partnership, given that this means new business for private sector and greater expertise and cost-efficiency for government sector. It is worth bearing the Public-Private-Partnership (PPP) concept in mind. It refers to a cooperative arrangement in which a private party and a government or public agency engages in a contract to provide a public asset or service. In the current governance framework, the development and implementation of Smart City projects require considerable investments that can be difficult to fund with traditional public finance. In this context, PPPs appear to be a

[125] Preston Read, 'The Importance of Public-Private Partnerships to Make Smart Cities a Reality' (*Verizon Enterprise*, 23 April 2018) <https://enterprise.verizon.com/resources/articles/the-importance-of-public-private-partnerships-to-make-smart-cities-a-reality/> accessed 30 April 2021.

suitable solution to overcome the shortage of public finance and cuts on public spending. Political will has a great role to play in the promotion of sustainability and development of smart cities, which is why the private sector cannot lead or initiate the development of smart cities. However, the private sector can: (a) advocate for smart cities; (b) actively pursue PPPs in the context of green technology investments for the development of smart cities; and (c) incentivise the development of green technology for smart cities. Japan is one of the top countries which actively promotes PPPs and investment in Greentech from the private sector for the development of smart cities.

II. THE INTERNATIONAL POLITICS AND LEGAL DIMENSIONS OF CLIMATE CHANGE TECHNOLOGY INVESTMENT

There appear to be three key debates at play when it comes to climate change and investment in climate change technology. The first is the broad ideological debate between climate emergency and climate scepticism, which has led to increased public scrutiny on how leaders are planning to tackle this issue.

The second debate surrounds developing countries and their development strategies. Many developed countries today enjoy the opportunity to explore a greener future with minimal detriment to modern lifestyles. To get to that stage however, they have all gone through phases of industrial development and growth which have involved heavy emissions and pollution. Many developing nations now face criticism for the same activities which propelled more developed nations towards their current state, and this right to development at the cost of the environment is at the centre of the second major debate. Ironically, while traditional industrialising development fuels climate change, those developing states will also be affected the most by climate change.

The final debate involves a cluster of smaller debates over specific policies and their impacts. Take, for instance, carbon tax vs cap-and-trade schemes. Criticisms of policies such as carbon credits and emissions trading schemes include the idea that they 'greenwash' pollution, and that they act as 'feel-good' measures as opposed to effective climate policies. Furthermore, many see a reliance on technology as a 'silver bullet' which distracts us from lifestyle and public policy changes such as sustainable diets and investment in public transport infrastructure.

Intertwined in these debates is the history of international climate politics and other phenomena such as the role of the private sector in the development of climate change technology. These considerations, with all their complexities and nuances, demonstrate the difficulty in acting on climate change even at a broad international level. However, a significant portion of action against climate change needs to come in at this level to have substantial impact.

III.I INTERNATIONAL AGREEMENTS UNDER THE UNFCCC

i. The Kyoto Protocol

While the United Nations Framework Convention on Climate Change (UNFCCC) was signed in 1992, the 1997 Kyoto Protocol was the first international treaty which resulted from the UNFCCC's mission, and set tangible goals in fighting climate change.

Arguably the first cohesive global action against climate change, the Kyoto Protocol had the overarching aim of reducing greenhouse gas emissions. In comparison to the Paris Agreement, the Kyoto Protocol had a greater focus on greenhouse gases, whereas the Paris Agreement is much more comprehensive, targeting energy, infrastructure, and agriculture. However, the Kyoto Protocol was a rare moment of vindication for the optimists of the international system, lauded as being a binding international treaty which many developed states signed on to.

At its centre, the Kyoto Protocol specified 'Flexibility Mechanisms': strategies and means by which the 55 Annex I countries could reduce their emissions. This included International Emissions Trading, the Clean Development Mechanism (which allows Annex I states to invest in sustainable development projects in developing states) and Joint Implementation (like the Clean Development Mechanism, except that the project is based in another Annex I country).[126]

The main criticism throughout the entire Kyoto Protocol negotiation process and post-signing is that the targets it set would have a minimal effect on climate change and global temperatures. This was especially relevant in light of the major countries that never ratified the treaty and developing nations not being subject to binding targets. One could point to a variety of reasons why this was the case: a failure of diplomacy, domestic politics, or systematic flaws in the design of the Kyoto Protocol. Ultimately, while the idea of the Kyoto Protocol is still hailed as a triumph of the international system, its results are mostly seen as symbolic at best.[127]

The main caveat of the Kyoto Protocol is that while it could be considered as being an important diplomatic achievement, it woefully lacked the kind of results needed in the face of climate

[126] Wytze van der Gaast, 'The Negotiation Process Leading to the Kyoto Protocol' in Wytze van der Gaast (ed), *International Climate Negotiation Factors: Design, Process, Tactics* (Springer International Publishing 2017) <https://doi.org/10.1007/978-3-319-46798-6_4> accessed 30 April 2021.
[127] Michael Greenstone, 'Surprisingly, a Voluntary Climate Treaty Could Actually Work' *The New York Times* (13 February 2015) <https://www.nytimes.com/2015/02/15/upshot/surprisingly-a-voluntary-climate-treaty-could-actually-work.html> accessed 30 April 2021.

change. A more effective agreement was therefore needed, especially one that engaged important countries like the US and BRICS (Brazil, Russia, India, China, and South Africa) states.[128]

A key element of international climate diplomacy is the Conference of the Parties (COP), an annual meeting of the representatives of the Parties to the UNFCCC. At COPs, progress on the Convention and its respective treaties are measured, and further negotiations are undertaken. The original commitment period of the Kyoto Protocol was from 2005-2012, but COP18 in Qatar produced the Doha Amendment to the Kyoto Protocol. Under this Amendment, a second commitment period of 2013-2020 was established, adding new emission reduction targets.[129]

Prior to the Doha Amendment however, several other non-binding agreements had been put forth. This included the Washington Declaration by the G8+5 which agreed on emissions trading being set up for developed and developing states, and the Copenhagen Accord of COP15 which among other things put forth the establishment of the Green Climate Fund (GCF). The GCF helps to fund climate adaptation and mitigation projects in developing states. In the context of investment in climate change technology, it is an important tool to consider. One of the largest investments the fund has made has been in the form of a loan for a solar power plant in Chile. The fund operates in collaboration with financial institutions and its effectiveness can mean that the risk of investment in climate projects can be lowered, enticing more to invest.

ii. The Paris Agreement

The Paris Agreement arising from COP21 entered into force on November 2016, and is the successor to the Kyoto Protocol. The agreement aimed to be as diplomatically successful as the Kyoto Protocol, while creating tangible impacts against climate change. The argument for its diplomatic success certainly has many points in its favour: it has been signed by 196 parties (one of which is the entire EU) including Brazil, India, and China, includes more comprehensive actions, and marked an exceptional moment of agreement amongst states of the seriousness of

[128] Laura Poppick, 'Twelve Years Ago, the Kyoto Protocol Set the Stage for Global Climate Change Policy' (*Smithsonian Magazine*, 17 February 2017) <https://www.smithsonianmag.com/science-nature/twelve-years-ago-kyoto-protocol-set-stage-global-climate-change-policy-180962229/> accessed 30 April 2021; Amanda Rosen, 'The Wrong Solution at the Right Time: The Failure of the Kyoto Protocol on Climate Change' (2015) 43 Politics & Policy 30; Aiten McPherson, 'Let Them Eat Carbon: The End of the Kyoto Protocol' (2014) 41 Georgia Journal of International & Comparative Law 219; van der Gaast (n 126).

[129] UNFCCC, 'Doha Amendment to the Kyoto Protocol' (2012) UN Doc. FCCC/KP/CMP/2012/13/Add.1, Decision 1/CMP.8 <https://cil.nus.edu.sg/wp-content/uploads/2019/02/2012-doha_amendment_english-original.pdf> accessed 3 May 2021.

climate change. Also, the Paris Agreement also arrived in parallel with the Sustainable Development Goals (SDGs), the natural evolution from the Millennium Development Goals (MDGs).

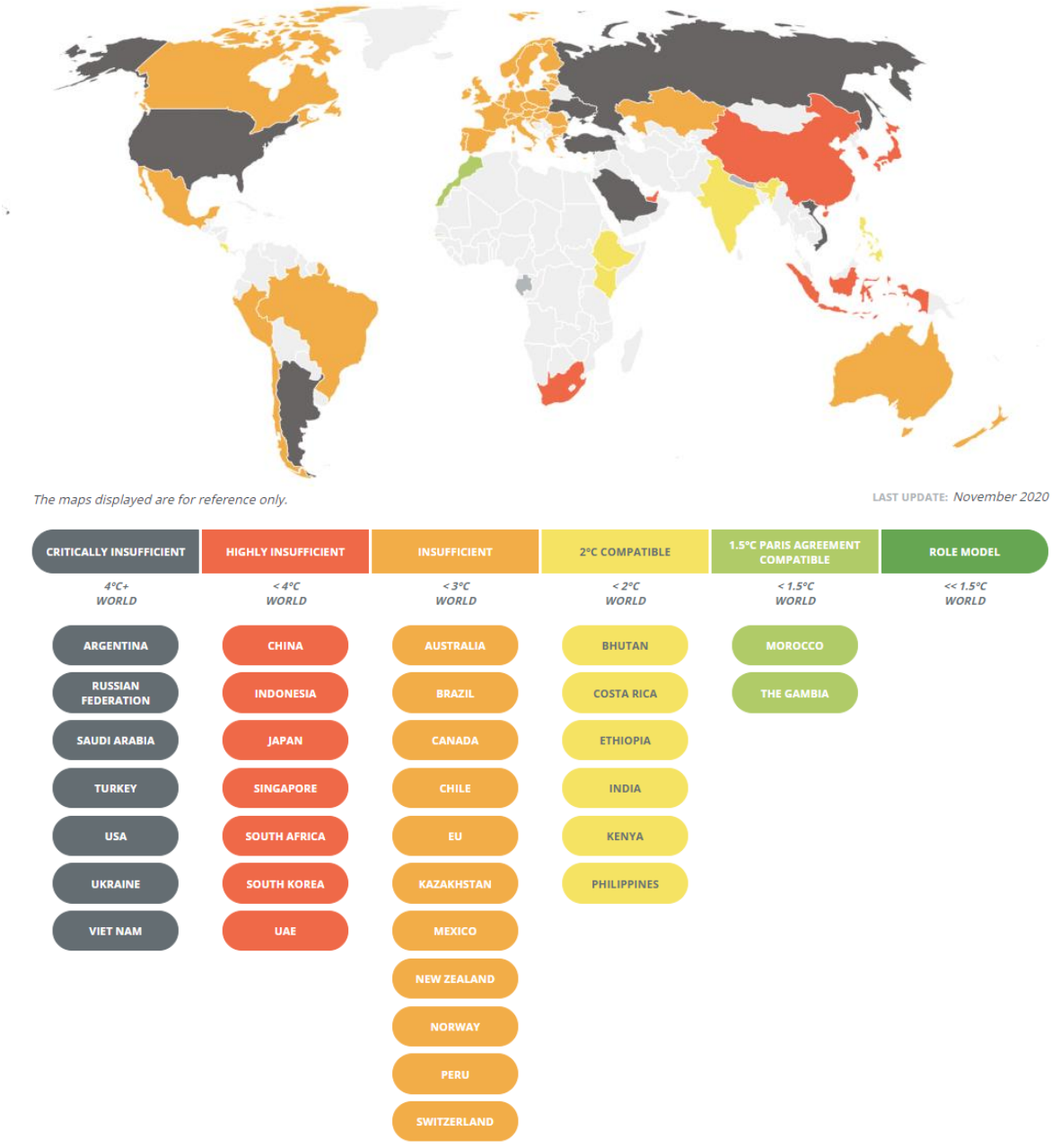

Figure 1: Climate Action Tracker, based on analysis by New Climate Institute, ECOFYS, and Climate Analytics, using UNFCCC frameworks.[130]

[130] 'Countries' (*Climate Action Tracker*) <https://climateactiontracker.org/countries/> accessed 3 May 2021.

Figure 1 from the Climate Action Tracker gives a broad overview of states' progress towards meeting the Paris Agreement, which aims to limit warming to 1.5°C. With the accepted lack of results from the Kyoto Protocol, many small states – especially Small Island Developing States (SIDS) who are at the highest risk of rising sea levels – pushed for this limit of a 1.5°C rise in global temperatures instead of 2°C.[131]

From this figure, it can be clearly seen that Morocco and The Gambia (in West Africa) are the only countries currently on track to meeting the Paris Agreement's requirements, with no country meeting the role model requirement (for going beyond the Paris Agreement). Gambia has been given its rating due to its ambitious goal to unconditionally reduce its emissions by 2.7% by 2030, especially through the adoption of renewable technologies. It also places a strong emphasis on the agriculture and forestry sectors, pledging to restore forests and increase efficiency of farmland among other strategies.[132] Morocco similarly targets agriculture and forestry, though energy appears to be where its focus lies. By driving adoption of renewable energy, it aims to have more than half of its electricity come from renewable energy.[133]

It should also be noted that countries that have been marked as 'Critically Insufficient' include Russia, Turkey, and Saudi Arabia. Other industrially significant and key states such as China, Brazil, and Australia are labelled as 'Insufficient' or 'Highly Insufficient'. Interestingly, India is on the verge of being 1.5°C Paris Agreement Compatible, with the Climate Action Tracker remarking that India's plans to expand its coal power generation are the only policy preventing this. India's rapidly rising investment in renewable energy is noted as being one of the linchpins of India's climate strategy.[134] China, which is often both reported as a heavy industrial polluter, and a world leader in green technology, is also a key nation to note.[135]

International cooperation can also play a vital role, as seen in the coalition of 5 countries – New Zealand, Fiji, Costa Rica, Norway, and Iceland – that were planning to begin negotiations on an

[131] Timothée Ourbak and Alexandre Magnan, 'The Paris Agreement and Climate Change Negotiations: Small Islands, Big Players' (2018) 18 Regional Environmental Change 2201.
[132] 'The Gambia' (*Climate Action Tracker*) <https://climateactiontracker.org/countries/gambia/> accessed 30 April 2021.
[133] 'Morocco' (*Climate Action Tracker*) <https://climateactiontracker.org/countries/morocco/> accessed 30 April 2021.
[134] 'India' (*Climate Action Tracker*) <https://climateactiontracker.org/countries/india/> accessed 30 April 2021.
[135] 'China' (*Climate Action Tracker*) <https://climateactiontracker.org/countries/china/> accessed 30 April 2021.

"Agreement on Climate Change, Trade and Sustainability".[136] The plan would have been to use the countries' relatively small sizes to make rapid headway on a trade agreement that would aim to manifest into a Treaty. The core goals of the agreement involved phasing out subsidies on fossil fuels, developing guidelines on labelling of environmentally friendly goods, and eliminating tariffs on environmental goods including wind turbines and solar panels.[137] The latter goal especially could present a case for similar technologies being more attractive to international markets, spurring greater investment in them.

III.III DEVELOPMENT VS. THE ENVIRONMENT: A TWO-WAY STREET

One of the main challenges that developing states face is their development itself. While developed states have gone through industrialisation in the past, usually involving significant emissions of greenhouse gases, developing states are now criticised for their similar 'dirty' growth. There are several layers to this: the practical aspect of attempting to develop a state and build an industrial sector without excessive pollution is one important ideal. There is also the complex interdependency between developed and developing states. One way this can be easily seen is in the exporting of recyclable material to China – which is often a toxic and environmentally damaging process. More recently, China has implemented new policies, rejecting lower-quality waste. This has resulted in growing landfills as developed states find themselves unable to process these materials in cost-effective ways.[138]

However, this does not take away from the fact that a handful of states contribute towards a significant percentage of emissions. Rather, it highlights the complexity in focussing on individual countries. The divisions are not only between developed and developing states, but the Global North vs Global South and smaller vs larger countries. Among these are also the BRICS countries being states at a more advanced stage of development, and among which large

[136] Ronald Steenblik and Susanne Droege, 'Time to ACCTS? Five Countries Announce New Initiative on Trade and Climate Change' (*International Institute for Sustainable Development*, 25 September 2019) <https://www.iisd.org/articles/time-accts-five-countries-announce-new-initiative-trade-and-climate-change> accessed 30 April 2021.
[137] AFP News, 'New Zealand's Ardern Announces Five-Way Climate Trade Talks' (*Yahoo News*, 26 September 2019) <https://sg.news.yahoo.com/zealands-ardern-announces-five-way-climate-trade-talks-182015266.html> accessed 30 April 2021.
[138] Cheryl Katz, 'Piling Up: How China's Ban on Importing Waste Has Stalled Global Recycling' (*Yale E360*, 7 March 2019) <https://e360.yale.edu/features/piling-up-how-chinas-ban-on-importing-waste-has-stalled-global-recycling> accessed 30 April 2021.

populations look to grow wealthier, bringing with it questions on managing per capita emissions and resource use, as carbon footprints are proportional to prosperity.

Calls for industrialising states to curb emissions are therefore seen as inequitable towards developing states, thereby prompting the idea of Greenhouse Development Rights, which aim to share the effort of climate adaptation and mitigation more fairly.[139] The idea of "sustainable development" for developing states especially is perhaps rightly met with a sense of cynicism – it involves creating extra steps for already disadvantaged states to go through in order to achieve the same things that developed states have. However, India and China have attempted to tackle the problem head on, with significant investment, particularly in the energy sector. China, in particular, is a world leader in renewables: over the last decade, China has added 36% of the world's total renewable generation capacity, with its peak in 2017 when it accounted for approximately 45% of global investment in renewable energy.[140] It continues to hold its place as the biggest producer of wind turbines and solar panels, as well as batteries.[141]

As net importers of fossil fuels, investment in domestic energy generation also provides China the strategic benefit of energy independence. This global move away from fossil fuels of course draws eyes towards the Middle East, which for many decades has had oil and gas as the centrepiece of their economic development. The Gulf states are now looking at ways to diversify their economies for a future that is not reliant on fossil fuels. However, the concrete effects of these diversification strategies draw some cynicism, with analysts suggesting that significant public policy and economic policy changes need to be made domestically before these states can truly see a future beyond oil.[142]

While energy remains a highly important and strategic sector, infrastructure is just as relevant. A report by The Development Bank of Singapore Limited (DBS) and the UN Environment Programme suggests that in ASEAN, the biggest opportunity for investment is in infrastructure

[139] 'Greenhouse Development Rights – Climate Equity Reference Project' (*Greenhouse Development Rights*) <http://gdrights.org/> accessed 30 April 2021.
[140] Samantha Gross, 'The Global Energy Trade's New Center of Gravity' (*Brookings*, 14 September 2020) <https://www.brookings.edu/articles/the-global-energy-trades-new-center-of-gravity/> accessed 23 July 2021.
[141] Charlie Campbell, 'China Is Bankrolling Green Energy Projects Around the World' *Time* (1 November 2019) <https://time.com/5714267/china-green-energy/> accessed 23 July 2021.
[142] Hayder Tuama, 'Economic Diversification and Oil Revenuesin the Arab Gulf Countries - The Case of Saudi Arabia' (2018) 6 Journal of Economics and Development Studies <http://jedsnet.com/vol-6-no-4-december-2018-abstract-15-jeds> accessed 30 April 2021; Martin Hvidt, 'Economic Diversification in GCC Countries: Past Record and Future Trends' (London School of Economics and Political Science 2013) 27 <http://eprints.lse.ac.uk/55252/1/Hvidt%20final%20paper%2020.11.17_v0.2.pdf> accessed 30 April 2021.

centred around energy distribution, water, telecommunications, and climate mitigation and adaptation.[143] The creation of the Asian Infrastructure Investment Bank (AIIB) in 2015 heralded the central role that infrastructure plays in rapidly developing economies, and the comprehensive opportunities that infrastructure development in the 21st century brings – to build resilient systems incorporating the knowledge and experiences of urban planning from around the world.

III.IV POLICIES: THE PRICE OF EMISSIONS

The pricing of carbon remains one of the most hotly contested technical debates in the field of emissions reduction mechanisms, with a carbon tax and cap-and-trade systems on either side. In recent years, some economists and policy analysts have opined that a hybrid system which incorporates some aspects of one mechanism into the other provides the best chance for significant progress on the matter.[144] Indeed, it appears that a mixed policy provides the greatest emissions reduction for countries like China.[145]

Both carbon taxes and cap-and-trade schemes are means by which a price can be placed on carbon, and thereby a way to measure and integrate emissions into national and international economic activity. While a carbon tax simply taxes emissions, a cap-and-trade system sets a limit on emissions and allows trading of permits or carbon credits where possible, which means that firms wanting to emit more than their allocation must buy credits to do so from other firms which have credits to spare.[146]

Complexity arises not only in how such systems are implemented, but also how the money collected is spent. For example, carbon taxes generate significantly more revenue globally than emissions trading systems, but a significantly lower amount of those revenues are spent on 'green initiatives' compared to emissions trading systems.[147] However, the state of local energy markets also factors into the success of either system – depending on whether the market is a monopoly

[143] Chui Fong Lee and Prajwal Baral, 'Green Finance Opportunities in ASEAN' (UNEP Inquiry, DBS 2017).
[144] Brian F Snyder, 'Tax and Trade: A Hybrid Climate Policy Instrument to Control Carbon Prices and Emissions' (2015) 15 Climate Policy 743.
[145] Wei Li and Zhijie Jia, 'Carbon Tax, Emission Trading, or the Mixed Policy: Which Is the Most Effective Strategy for Climate Change Mitigation in China?' (2017) 22 Mitigation and Adaptation Strategies for Global Change 973.
[146] James Boyce, 'Carbon Pricing: Effectiveness and Equity' (2018) 150 Ecological Economics 52.
[147] Jeremy Carl and David Fedor, 'Tracking Global Carbon Revenues: A Survey of Carbon Taxes versus Cap-and-Trade in the Real World' (2016) 96 Energy Policy 50.

or collusive – and therefore empirical evidence and context also ought to be taken into account.[148] Regardless, policies on pricing carbon are one of the most important and established ways in which climate change can be tackled.

i. Domestic and Regional Politics

Domestic politics and non-state actors again play an important role in how effective such policies are. In regional institutions, the European Union (EU) is arguably the only effective player. The design of the system allows for policies and legislation to be enacted across the region, under which member states are all bound. Its climate strategies include legislation under a "climate and energy package" with targets for the year 2020, a "climate and energy framework" for the 2021 – 2030 period, and a long-term strategy aiming for a "climate-neutral Europe by 2050".[149] The EU's climate policies have not been without criticism or challenges, but the strength of its institutions and the relative level of cooperation between member states to politically participate in it demonstrates the potential of regional cooperation, especially in the face of an issue like climate change.

The EU is often compared to the Association of Southeast Asian Nations (ASEAN), even though the latter's design and geopolitics are not intended to be like the former. With regard to climate change, a consensus has been reached in ASEAN to "explore the possibility of developing a harmonised approach to measuring, reporting and verifying greenhouse gas emissions as a first step towards further regional collaboration on carbon markets."[150] There is also increasing cooperation between the EU and ASEAN, especially in sustainable development and disaster risk reduction.[151] Additionally, ASEAN has the assistance of key financial institutions like the Asian Development Bank (ADB) and Asian Infrastructure Investment Bank (AIIB), among others, to aid in development. The ADB's Clean Energy Financing Partnership Facility, for example supports projects that focus on, amongst others, energy efficiency, carbon capture,

[148] Fan-Ping Chiu and others, 'The Energy Price Equivalence of Carbon Taxes and Emissions Trading—Theory and Evidence' (2015) 160 Applied Energy 164.
[149] 'Climate Strategies & Targets' (*Climate Action - European Commission*, 23 November 2016) <https://ec.europa.eu/clima/policies/strategies_en> accessed 30 April 2021.
[150] 'ASEAN Countries Join Forces for Climate Action' (*United Nations Climate Change*, 24 October 2017) <https://unfccc.int/news/asean-countries-join-forces-for-climate-action> accessed 30 April 2021.
[151] 'Backgrounder on EU-ASEAN Development Cooperation' (*European External Action Service, European Commission*, 8 August 2019) <https://eeas.europa.eu/headquarters/headquarters-homepage/66301/backgrounder-eu-asean-development-cooperation_en> accessed 30 April 2021.

utilisation and storage, and sustainable transport. It also supports projects that engage the private sector to invest in clean energy and as of 2019, the total contributions received by the facility amounted to US$295.5 million.[152]

If we were to look across to another continent, similarly, the African Union has issued statements concerning the threat that climate change poses to the region. As with ASEAN, cooperation is certainly visible: in 2009, the Committee of African Heads of State on Climate Change (CAHOSCC) was established, to act as a cohesive political platform to speak on climate change on behalf of the continent. Like Southeast Asia, Africa stands as one of the regions that is most threatened by climate change. By some measures, Africa contributes less than 5% to global greenhouse gas emissions, a figure that provides some perspective to the disproportionate impact the continent faces. Africa also has several intra-regional groups, such as the Economic Community of West African States (ECOWAS) and the Intergovernmental Authority on Development (IGAD) which have developed climate policy frameworks for their specific sub-regions.[153]

The Pacific islands make up a significant portion due to factors such as low population, level of development, and distance from other parts of the world, are regularly overlooked in climate politics – despite heavy use of the terms "Asia-Pacific" and "Indo-Pacific". The Pacific Islands Forum in 2008 signed the Niue Declaration on Climate Change,[154] but the region continues to often be at the mercy of developed nations. There is also a growing debate that climate change is a serious national security issue: not simply in terms of food and water, but also in more traditional strategic matters such as armed conflict; concerns have grown that climate change could act as a 'threat multiplier'.[155] Several intergovernmental groups in Africa have also warned

[152] 'ADB Partnership Report 2019: Building Strong Partnerships for Shared Progress' (*Asian Development Bank*) <https://www.adb.org/multimedia/partnership-report2019/modalities/financing-partnership-facilities/clean-energy-financing-partnership-facility/> accessed 23 July 2021.
[153] Florian Krampe, Roberta Scassa and Giovanni Mitrotta, *Responses to Climate-Related Security Risks : Regional Organizations in Asia and Africa* (Stockholm International Peace Research Institute 2018) <http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-359450> accessed 30 April 2021; 'Africa's Approach to Climate Change Negotiation' (*Oxford Research Group*, 16 April 2019) <https://www.oxfordresearchgroup.org.uk/blog/africas-approach-to-climate-change-mitigation> accessed 30 April 2021.
[154] 'Niue Declaration on Climate Change' (*Pacific Islands Forum*, 2008) <https://www.forumsec.org/2008/02/21/the-niue-declaration-on-climate-change/> accessed 3 May 2021.
[155] 'Climate Change Recognized as "Threat Multiplier", UN Security Council Debates Its Impact on Peace' (*UN Peacebuilding Commission*, 25 January 2019) <https://www.un.org/peacebuilding/fr/news/climate-change-recognized-%E2%80%98threat-multiplier%E2%80%99-un-security-council-debates-its-impact-peace> accessed 23 July 2021.

of the role climate change that could play with regard to creating or exacerbating conflict in the region.[156]

ii. The Role of the Private Sector

This raises the matter of the varying roles that the public and private sectors play. With multinational corporations and political non-state actors, it can be difficult to map the playing field. However, the private sector can arguably play an important role. Corporate leaders hold the key to vital investment capital that can entice leaders to comply with climate agreements and commitments. Philanthropy is another avenue, most famously exemplified by the Bill and Melinda Gates Foundation. In addition to a significant public health and medical focus, the foundation also invests in the development of various agricultural and sanitation technologies.[157]

When it comes to investment in technologies, the private sector and non-governmental entities have a major advantage over states: a greater appetite for risk. Investment in technology development is a relatively risky venture, but there is a notable gap in climate finance for technologies that assist with climate adaptation and mitigation. A full transition into a clean green world might mean that states need to find ways to leverage capital in the private sector to funnel investment into relevant areas, especially in developing countries. Partnerships and policies that facilitate this would presumably be necessary, but challenges lie in how individual states work with corporations that stretch across borders. However, they represent an opportunity for addressing gaps in engaging with climate challenges. One study suggests that PPPs offer the optimal outcome, especially in cases where uncertainty is high. However, the same study found that when bargaining power was unequal, the results were not ideal, suggesting that one of the pivotal challenges is in getting the balance right.[158]

Beyond the UN-related contexts, the World Economic Forum (WEF) and its annual meeting in Davos, Switzerland, represents a more purpose-built environment for relevant discussion. The meeting brings together political leaders, business leaders, NGOs, and more, for talks on a variety

[156] Krampe, Scassa and Mitrotta (n 153).
[157] 'Agricultural Development' (*Bill & Melinda Gates Foundation*) <https://www.gatesfoundation.org/our-work/programs/global-growth-and-opportunity/agricultural-development> accessed 3 May 2021; 'Water, Sanitation & Hygiene' (*Bill & Melinda Gates Foundation*) <https://www.gatesfoundation.org/our-work/programs/global-growth-and-opportunity/water-sanitation-and-hygiene> accessed 3 May 2021.
[158] Marco Buso and Anne Stenger, 'Public-Private Partnerships as a Policy Response to Climate Change' (2018) 119 Energy Policy 487.

of issues relating to global economics and development. This opportunity has been seized by people who drive global investment acting on climate change, as meetings increasingly focus on the issue. For example, a WEF-facilitated group of CEOs in 2018 openly called for emissions reductions, global carbon pricing mechanisms, and investment in relevant technologies.[159]

Ultimately, there is no silver bullet for this conundrum as direct policy interventions, market-influencing mechanisms, taxes, subsidies, etc. can all have complex outcomes, especially in cases where polluting industries play a significant role in state economies.

iii. Opportunities for Private Sector Stakeholders under the Kyoto Protocol

The main achievement of the Kyoto Protocol and Marrakech Accords is to convey a signal to businesses that the future is going to be low carbon; therefore, emissions of greenhouse gases will not only cost money but will also be restricted. It is worth mentioning that businesses in a State Party to the Kyoto mechanisms are dependent on its eligibility to engage in CDM, JI, and International Emissions Trading. If the Party is suspended from using a mechanism and/or fails to meet the criteria, then private sector stakeholders will experience the same problem. As the United States does not participate in this process, there is much more uncertainty for American businesses.[160]

Under the Kyoto mechanisms, especially CDM, TNCs and businesses based in developed countries and developing countries can meet their reduction targets by funding projects for emissions reduction in developing countries. Transnational corporations (TNCs) and businesses can improve their corporate performance through the utilization of the CDM and contribute to sustainable development. The rhetoric around the Kyoto Protocol and Climate Change talks expands markets for advanced technologies and new business opportunities. Moreover, TNCs and businesses can consider CDM-related business opportunities. For example, they can benefit from certified emission reduction credits (CERs) themselves. Foreign TNCs and businesses can fund projects in the developing countries that they operate in, in order to meet their targets..

[159] Alliance of CEO Climate Leaders, 'An Open Letter from Business to World Leaders: "Be Ambitious, and Together We Can Address Climate Change"' (*World Economic Forum*, 29 November 2018) <https://www.weforum.org/agenda/2018/11/alliance-ceos-open-letter-climate-change-action/> accessed 30 April 2021.

[160] Asbjørn Torvanger, 'An Evaluation of Business Implications of the Kyoto Protocol' (Center for International Climate and Environmental Research 2001) 5.

Therefore, private sector stakeholders in developing countries could implement their programs, reduce their emissions, and invest in R&D and/or new "green" and energy efficient technologies for their operations.[161]

For example, industrial installations in the European Union must limit their GHG emissions under the EU Emission Trading Scheme. In 2008, failure to do so could lead to a fine of €100 per tonne of CO2.[162] Therefore, TNCs and businesses in the EU have two main ways to achieve Kyoto targets. They can either take into account lower-cost CDM production opportunities in developing countries or limit their GHG emissions.

The carbon market plays a huge role in shifting private investment flows. The expansion of the carbon market as well as the international auctions for emissions credits can be beneficial for private sector stakeholders considering the carbon market's benefits.[163]

iv. The Paris Agreement and Private Sector Stakeholders

The Paris Agreement focuses on the role of non-Party stakeholders such as cities, civil society, the private sector, etc. in addressing climate change. The agreement tries to encourage the private sector and other stakeholders to build resilience to the adverse effects of climate change, scale up their support to reduce more emissions, and promote cooperation between various stakeholders.[164] Moreover, Article 4 of the Agreement stresses the role of supervisory designated bodies in incentivising and facilitating participation of public and private entities in the mitigation of GHG emissions. At the same time, the Article 8 recognises the importance of a holistic approach, including enhancing public and private sector participation, in the implementation of NDCs.[165]

[161] 'Press Release: Kyoto Protocol Offers Investment Opportunities in Developing Countries' (*United Nations*, 15 February 2005) <https://www.un.org/press/en/2005/tad2011.doc.htm> accessed 30 April 2021.
[162] ibid.
[163] UNFCCC, 'Investment and Financial Flows to Address Climate Change' (United Nations Framework Convention on Climate Change 2007).
[164] 'Paris Agreement' (*Climate Action - European Commission*, 23 November 2016) <https://ec.europa.eu/clima/policies/international/negotiations/paris_en> accessed 30 April 2021.
[165] UNFCCC, 'Conference of the Parties, Adoption of the Paris Agreement' (2015) U.N. Doc. FCCC/CP/2015/L.9/Rev/1 <https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf> accessed 2 May 2021.

The Paris Agreement recognises the role of the private sector as an important stakeholder in addressing climate change and conveys the signal to make low emission and/or emission-neutral investments. Under the Agreement, governments are committing to accelerate the transition to a clean economy and provide a favourable policy environment for investors and businesses. The businesses could use NDCs for forecasting the regulatory environments that they operate in. As the Agreement binds countries to implementing the policies put in place for reaching their targets, private sector stakeholders can use that to predicting future opportunities. For example, all new buildings in the EU will consume nearly zero energy by 2021 and India will introduce new energy efficiency standards. Moreover, as governments put forward their national climate plans, businesses and investors should become aware of changes if their value chains rely on agriculture, forestry, or land use. The Agreement highlights the importance of results-based payment methods, such as REDD+ (Reducing Emissions from Deforestation and Forest Degradation) for sustainable management of forests.[166]

Furthermore, the Agreement conveys a signal to investors and businesses to unleash innovation in low carbon technologies, reduce energy consumption, and shift investments from high carbon assets, among others.[167] It is worth mentioning that another success in Paris was the creation of the Carbon Pricing Leadership Coalition, which now comprises 34 national and sub-national governments, as well as over 160 businesses and more than 85 civil society organisations.[168]

v. Examining the Relationship Between Investors, Investment and Climate Change

Business operations and supply chains are exposed to the negative impacts of climate change, such as extreme weather events, droughts and floods, temperature variations, disease vectors, and sea-level rise, and climate risks.[169] Extreme weather conditions could lead to a 45% loss in global investment portfolios.[170]

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[166] David Wei and others, 'The Paris Agreement: What It Means for Business' (We Mean Business 2016) <https://www.bsr.org/reports/BSR_WeMeanBusiness_Business_Climate_Paris_Agreement_Implications.pdf> accessed 30 April 2021.
[167] ibid.
[168] 'Partners' (*Carbon Pricing Leadership Coalition*) <https://www.carbonpricingleadership.org/partners> accessed 3 May 2021.
[169] Wei and others (n 166).
[170] Christian Grossman, 'We Have an Agreement in Paris: So, What's next for the Private Sector?' (*International Finance Corporation*, 9 February 2016) <https://www.ifc.org/wps/wcm/connect/NEWS_EXT_CONTENT/IFC_External_Corporate_Site/News+and+Events/News/we-have-agreement-paris-so-what-s-next-private-sector> accessed 30 April 2021.

There are both internal and external drivers for investors and companies to get involved. If private sector stakeholders are concerned with reducing costs, stimulating innovation, managing risks, increasing the quality of services/products, and increasing market share, it would be beneficial for them to invest in green technology and contribute to combating climate change. Moreover, there are external drivers such as consumers' demands for "greener" products, government regulations, and the competitive advantage of being the first or one of the first stakeholders to set a trend.

It is worth mentioning that if commitments for limiting global warming are fulfilled, the energy transition will have vast financial implications. Investment opportunities that arising from the energy transition will outweigh climate-related risks in the long run.[171] The cost of climate action is falling while the cost of not taking any action is increasing. According to Wei et al.,[172] businesses that have taken climate action have benefited from an average internal rate of return of 27% on their low carbon investments. Technology experts and economists expect that deep decarbonization alongside with the use of advanced technologies would lower the costs of GHG mitigation options.[173] According to Johnson, the report from Climate Strategies highlights that businesses can profit from international agreements on climate change and the EU's trading scheme.[174] Therefore, investors started to shift their investments to climate-friendly ones.[175]

As climate change has become an increasingly pressing issue and the number of international agreements on climate change are increasing, national governments and international organizations are eager to create favourable conditions for private sector stakeholders. For instance, governments enable private sector stakeholders to manage risks, shift towards low carbon technologies, and make strategic investment decisions through carbon pricing. Businesses that engage with carbon pricing policies and have established an internal carbon price have seen positive results on their climate and financial strategies, and to enhance their competitiveness.[176]

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[171] EYGM, 'Climate Change: The Investment Perspective' (Ernst & Young Global 2016).
[172] Wei and others (n 166).
[173] Jane Leggett, 'Potential Implications of U.S. Withdrawal from the Paris Agreement on Climate Change' (Congressional Research Service 2019) IF 10668.
[174] Toni Johnson, 'The Debate over Greenhouse Gas Cap-and-Trade' (*Council on Foreign Relations*, 3 November 2011) <https://www.cfr.org/backgrounder/debate-over-greenhouse-gas-cap-and-trade> accessed 30 April 2021.
[175] Grossman (n 170).
[176] Executive Briefing: What is the Impact of Carbon Pricing on Competitiveness? (Carbon Pricing Leadership Coalition, June 2016) <https://thedocs.worldbank.org/en/doc/759561467228928508-0020022016/original/CPLCCompetitivenessprint2.pdf> accessed 30 June 2021.

Businesses and investors should also be aware that carbon pricing policies can shape their markets. The Paris Agreement also tries to link and integrate carbon markets and modern frameworks that will lead to increased GHG reduction options for businesses, reduced competitive distortions, enhanced carbon price stability, and strengthened political collaboration.[177] Private sector stakeholders should understand that carbon pricing is a cost-effective way to meet their corporate climate targets. Microsoft has used carbon pricing and applied the revenues from its business units to investing in carbon offsetting measures.[178]

In June 2021, the World Bank Group announced its new Climate Action Plan, which aims to deliver "record levels of climate finance to developing countries, reduce emissions, strengthen adaptation, and align financial flows with the goals of the Paris Agreement".[179] This includes a commitment to increase delivery to an average of 35% of total financing for climate-related investments over the duration of the Plan. Under the first Climate Change Action, the World Bank delivered over US$83 billion in climate finance over a five-year period, with US$21.4 billion delivered in 2020 alone.[180]

III.V. ENGAGING INVESTORS – SOME WAYS FORWARD

i. Corporate Social Responsibility (CSR)/Created Shared Value (CSV)

Integrating external engagement into strategies and operations is an essential determinant of competitiveness and success.[182] Therefore, corporate actors play an increasingly heightened role in shaping community and individual experiences. Socially responsible investing efforts encompass environmental, economic, and social responsibilities.[183]

[177] Wei and others (n 166).
[178] ibid.
[179] 'World Bank Group Increases Support for Climate Action in Developing Countries' (*World Bank*, 22 June 2021) <https://www.worldbank.org/en/news/press-release/2021/06/22/world-bank-group-increases-support-for-climate-action-in-developing-countries> accessed 23 July 2021.
[180] Ibid.
[182] John Browne and Robin Nuttall, 'Beyond Corporate Social Responsibility: Integrated External Engagement' (*McKinsey & Company*, 1 March 2013) <https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/beyond-corporate-social-responsibility-integrated-external-engagement#> accessed 30 April 2021.
[183] Myria Allen and Christopher Craig, 'Rethinking Corporate Social Responsibility in the Age of Climate Change: A Communication Perspective' (2016) 1 International Journal of Corporate Social Responsibility 1.

Corporate sustainability communication (CSC) became popular because of the public relations efforts of organizations' environmental communication programs and corporate social reports produced when organizations in oil, chemical, and other industries faced environmental scandals.[184] Thus, companies started to redefine their CSR and CSV policies to prioritise the environment, which is beneficial for their PR efforts, the planet, and public awareness.[185]

If 'Responsible Corporate Adaptation' is done properly, then the process can bring benefits to companies such as avoiding costs, expanding market shares, accessing new financing streams, etc. as the ability to prosper cannot be detached from community well-being.[186]

ii. Impact Investing

Impact investments are essential in addressing climate change, since doing so requires massive flows of capital. Impact investing seeks to create alternative models for financing and promoting innovation to meet environmental and social objectives. Investment firms are shifting assets to more responsible investment approaches, which means that more money is invested in sustainable business practices and less in environmentally destructive initiatives. In a nutshell, impact investments seek an environmental and/or social impact alongside financial returns by focusing on companies that, for instance, produce renewable energy, manage forests in a sustainable way, and develop green technologies.[187]

iii. Public-Private Partnerships (PPPs)

According to the World Bank, a "PPP is a long-term contract between a private party and a government entity, for providing a public asset or service, in which the private party bears

[184] ibid.
[185] Enrique Dans, 'Corporate Social Responsibility Is Turning Green, And That's A Good Thing' (*Forbes*, 14 September 2018) <https://www.forbes.com/sites/enriquedans/2018/09/14/corporate-social-responsibility-is-turning-green-and-thats-a-good-thing/> accessed 30 April 2021.
[186] 'COP21: An Unstoppable Momentum' (*United Nations Global Compact*, 12 December 2015) <https://www.unglobalcompact.org/take-action/action/cop21-business-action> accessed 30 April 2021.
[187] Amit Bouri, 'Capital for Climate: The Role of Finance in Saving Our Earth' (*International Investment*, 7 May 2019) <https://www.internationalinvestment.net/opinion/4002094/capital-climate-role-finance-saving-earth> accessed 30 April 2021.

significant risk and management responsibility, and remuneration is linked to performance."[188] PPPs are considered a cost-efficient option to enhance innovation and/or clean investments.[189]

Combining private market participation, public financing, and regulation into PPPs is essential for mobilising the private sector to achieve sustainable development. PPPs could take forms such as market price corrections, global fund mechanisms, private provision on public contracts, and technology consortia, among others.[190] PPPs could incentivise both the public and private sectors to overcome the public sector's budgetary gaps.

iv. Blended Finance

Blended finance, which refers to a model for financing sustainable development projects that utilises a combination of initial capital from a philanthropic or government entity and subsequent commercial investment, can also assist in bridging the investment gap for fulfilling the Paris Agreement and 2030 Agenda. This has the potential to attract commercial capital for projects that are beneficial to society while providing financial returns to investors.[191]

III.VI. THE LEGAL UNDERPINNINGS OF CLIMATE CHANGE

A key obstacle within climate change politics is the concept of differentiation as embodied in the principle of common but differentiated responsibilities – which acknowledges the different capabilities and differing responsibilities of individual countries in addressing climate change – with states unable to agree as to whom should take the lead in dealing with climate change. At the outset, the UNFCCC articulated obligations for its parties based on their level of development, with developed countries obliged to take the lead in global efforts by limiting their emissions. However, the asymmetry in obligations would come to the fore as developing

[188] 'What Are Public Private Partnerships?' (*The World Bank*, 4 December 2020) <https://ppp.worldbank.org/public-private-partnership/overview/what-are-public-private-partnerships> accessed 30 April 2021.
[189] Buso and Stenger (n 158).
[190] Guido Schmidt-Traub and Jeffrey Sachs, 'Financing Sustainable Development: Implementing the SDGs through Effective Investment Strategies and Partnerships' (Working Paper, Sustainable Development Solution Network 2015) <https://www.semanticscholar.org/paper/Financing-Sustainable-Development%3A-Implementing-the-Schmidt-Traub-Sachs/ca9af2d591bdc06d855abbdfa874a39964f8bdd2> accessed 30 April 2021.
[191] OECD, 'OECD DAC Blended Finance Principles' (Organisation for Economic Co-operation and Development 2018) <https://www.oecd.org/dac/financing-sustainable-development/development-finance-topics/OECD-Blended-Finance-Principles.pdf> accessed 30 April 2021.

countries such as India and China began to industrialise rapidly. Developed countries thus insisted that any reference to common but differentiated responsibilities be qualified with a statement that the principle is to be interpreted in the light of contemporary economic realities.[192] On the other side of the table, developing countries refused to take on a greater burden in tackling climate change on the basis that the historical responsibility for emissions was deemed to lie with industrialised countries whose development had been achieved in part through reliance on fossil fuels.[193]

Several factors in the period between the Kyoto Protocol and COP 21 facilitated the development of the Paris Agreement. Notably, the narrative around climate change had begun to shift, with states, corporations and individuals beginning to view it as an opportunity as opposed to a burden. Tackling climate change was seen as a means to further technological innovation and boost economic growth.[194] This change in narrative precipitated an increased flexibility in state attitudes towards climate negotiations, with states such as the United States under Barack Obama and China taking a more facilitative role as seen in a bilateral climate agreement made in 2015.[195] Importantly, the focus on common but differentiated responsibility was downplayed in the Paris Agreement with the qualifier 'in light of different national circumstances'. This qualifier in the preambular recital of the Paris Agreement was critical in the widespread support of the Paris Agreement, as the careful language created an expectation that the agreement would reflect the principle of common but differentiated responsibility but stopped short of prescribing it into the implementation of the agreement.[196]

Additionally, a shift in capital was one of the biggest impetuses behind the shift in politics. In the lead up to the Paris Agreement, over 400 investors representing more than US$24 trillion in assets made commitments to increase low carbon and climate resilient investments.[197] In addition, developing countries' investment in renewable energy, excluding large hydropower

[192] Daniel Bodansky, Jutta Brunnée and Lavanya Rajamani, *International Climate Change Law* (Oxford University Press 2017) 221.
[193] Daniel Klein and others (eds), *The Paris Agreement on Climate Change: Analysis and Commentary* (First, Oxford University Press 2017) 19.
[194] ibid 22.
[195] 'U.S.-China Joint Announcement on Climate Change' (*The White House (President Barack Obama)*, 11 November 2014) <https://obamawhitehouse.archives.gov/the-press-office/2014/11/11/us-china-joint-announcement-climate-change> accessed 30 April 2021.
[196] Bodansky, Brunnée and Rajamani (n 192) 222.
[197] 'Global Trends in Renewable Energy Investment 2016' (*Bloomberg NEF*, 24 March 2016) <https://about.bnef.com/blog/global-trends-in-renewable-energy-investment-2016/> accessed 30 April 2021.

projects, surpassed that made by developed countries.[198] This market signal together with the growing strength of the non-state actor climate movement gave governments a mandate to take effective steps in combating climate change.

The recognition of the urgency of climate action is reflected in the resiliency of the Paris Agreement. The Paris Agreement was put to the test in 2017 when the USA announced its decision to withdraw from the agreement.[199] This spurred other states to step up and reaffirm their commitment to tackling climate change; with the EU and China promising to strengthen the deal in light of the USA's withdrawal.[200]

Going further, sub-national actors such as cities, regions and federal states also have a key role to play in climate action. For example, in the USA, despite the federal government's withdrawal from the Paris Agreement, many individual states have expressed their continued commitment to the obligations and aims of the Agreement. This is most evident in the emergence of the United States' Climate Alliance and the Climate Mayors. The US Climate Alliance is a bipartisan coalition of states committed to the goal of reducing greenhouse gas emissions consistent with the goals of the Paris Agreement, and was formed in response to the decision to withdraw from the Agreement.[201]

The Climate Mayors, also known as the Mayors National Climate Action Agenda, is an association of United States mayors formed before the Paris Agreement, but founded with the aim of reducing greenhouse gas emissions. The Climate Mayors consist of 392 US Mayors representing 69 million Americans. Following the federal government's decision to withdraw from the Agreement, the Climate Mayors issued a statement committing to adopt, honour and uphold the 1.5°C - 2°C goal within the Paris Agreement.[202]

The Paris Agreement is a key milestone in forming a middle ground between developed and developing countries and draws the road map for limiting the increase of global

[198] Klein and others (n 193) 24.
[199] 'UN Officially Notified of US Intention to Withdraw from Paris Climate Pact' (*UN News*, 4 August 2017) <https://news.un.org/en/story/2017/08/562872-un-officially-notified-us-intention-withdraw-paris-climate-pact> accessed 30 April 2021.
[200] Daniel Boffey and Arthur Nelsen, 'China and EU Strengthen Promise to Paris Deal with US Poised to Step Away' (*The Guardian*, 1 June 2017) <http://www.theguardian.com/environment/2017/may/31/china-eu-climate-lead-paris-agreement> accessed 30 April 2021.
[201] 'States United for Climate Action' (*U.S. Climate Alliance*) <http://www.usclimatealliance.org> accessed 30 April 2021.
[202] '468 US Climate Mayors Commit to Adopt, Honor and Uphold Paris Climate Agreement Goals' (*Climate Mayors*, 1 June 2017) <https://climatemayors.org/actions-paris-climate-agreement/> accessed 30 April 2021.

temperatures. While its effectiveness has yet to be shown, it is undeniably a significant step forward.

i. The Legal Implications of the Paris Agreement

The Paris Agreement consists of a mix of hard, soft, and non-obligations. It is thus necessary for parties to the agreement as well as various stakeholders to understand the legal normativity of its various components.[203] Broadly speaking, the core obligations as to mitigation and adaptation as set out in Article 4 and Article 7 of the agreement do not impose hard obligations as to what state parties have to achieve within the two respective fields.[204] Rather, the Paris Agreement imposes obligations of conduct as to transparency and reporting.

The focus on transparency and reporting forms the basis of the agreement's hybrid structure that comprises a combination of 'top-down' and 'bottom-up' elements; the former consisting of managerial, transparency and norm-building elements, and the latter consisting of the global stocktake and the setting of non-binding long-term goals.[205]

This combination of 'top-down' and 'bottom-up' elements is best characterised through the Nationally Determined Contributions (NDCs) component of the Paris Agreement. NDCs are national climate action plans dealing with issues such as mitigation and adaptation that are submitted to the secretariat by individual party states.[206] There is no formal obligation as to the content of the individual NDC, the individual contributions are not negotiated, and compliance with them is not binding.[207] The Paris Agreement only imposes obligations of conduct to 'prepare, communicate and maintain' successive NDCs.[208] Accordingly, the NDCs that have been submitted have been formulated in a wide variety of ways. Some are quantitative, and others are qualitative; some are conditional while others are unconditional.[209] Article 4 merely

[203] Lavanya Rajamani, 'The 2015 Paris Agreement: Interplay Between Hard, Soft and Non-Obligations' (2016) 28 Journal of Environmental Law 337, 337.
[204] UNFCCC, 'Conference of the Parties, Adoption of the Paris Agreement' (n 165) art 4 and art 7.
[205] Meinhard Doelle, 'The Paris Climate Agreement – Assessment of Strengths and Weaknesses' in Daniel Klein and others (eds), *The Paris Agreement on Climate Change: Analysis and Commentary* (First, Oxford University Press 2017) 387.
[206] UNFCCC, 'Conference of the Parties, Adoption of the Paris Agreement' (n 165) art 4.
[207] Jürgen Friedrich, 'Global Stocktake (Article 14)' in Daniel Klein and others (eds), *The Paris Agreement on Climate Change: Analysis and Commentary* (First, Oxford University Press 2017) 319.
[208] UNFCCC, 'Conference of the Parties, Adoption of the Paris Agreement' (n 165) art 4.
[209] 'Interim NDC Registry' (*UNFCCC*) <https://www4.unfccc.int/sites/ndcstaging/Pages/Home.aspx> accessed 30 April 2021.

establishes a good faith expectation that parties attempt to achieve their contributions but stops short of actually requiring them to do so.[210]

Whilst the Paris Agreement might not require parties to achieve their NDCs, under Article 13.7(b), parties are required to regularly provide updates on the progress made in "implementing and achieving" its NDC. This reporting requirement further buttresses the consensual and cooperative framework of the Paris Agreement, and gives parties a clearer sense of what is required in order to meet the goals of the agreement.

The Paris Agreement has not established any binding legal obligations on state parties to achieve the 1.5/2°C goal set out in Article 2 nor any specific quantitative requirements as to mitigation and adaptation. Rather, the Paris Agreement relies on a cooperative framework based on transparent reporting, nationally determined commitments, political momentum, and a common long-term goal. The importance of cooperation, being firmly underscored in the elucidation of the Paris implementation framework as set out in the Paris 'Rulebook', is discussed below.

ii. Facilitating Compliance with the Paris Agreement – the Paris 'Rulebook'

Following the adoption of the Paris Agreement in 2015, the next step was to reach an agreement as to the implementation of the agreement. This would be set out at COP 24 in Katowice, Poland through the adoption of the Paris 'Rulebook', a set of guidelines that sets out the essential procedures and mechanisms necessary to make the Paris Agreement operational.[211] The Paris Rulebook reaffirms the importance placed on transparency and accountability by the Paris Agreement, with transparent reporting being the crux of its implementation.

To facilitate the implementation of the Paris Agreement, as well as compliance with its relevant provisions, the parties to the agreement established an elected committee charged with this specific task. The role of the committee is, however, non-punitive and non-adversarial. Its mandate to initiate a 'consideration of issues' is restricted to issues related to reporting and communication.[212] This focus on transparency and reporting is further underlined by the actions available to the committee which consists of measures such as the making of recommendations

[210] Rajamani (n 203) 354.
[211] 'The Katowice Climate Package: Making The Paris Agreement Work For All' (*United Nations Climate Change*) <https://unfccc.int/process-and-meetings/the-paris-agreement/katowice-climate-package#eq-9> accessed 30 April 2021.
[212] UNFCCC, 'Conference of the Parties, Adoption of the Paris Agreement' (n 165) art 3.

or provision of assistance.[213] The facilitative nature of the compliance mechanism thus leads back to the basis of the Paris Agreement as an international agreement founded on political pressure and international cooperation as opposed to one based on hard binding legal obligations.

iii. The Rise of Climate Change Litigation

Following the ratification of the Paris Agreement, there has been a sharp increase in climate change litigation cases around the world.[214] Courts have increasingly become a forum through which individuals and social movements have sought to challenge existing policies and change social norms and values.[215] Notably, the rise of climate change litigation reframes questions regarding the binding nature of international agreements as inquiries into whether certain activities that cause dangerous climate change (as defined in the agreement) violate the rights of individuals.[216] Moreover, the rise of climate change litigation has not been confined to the public sphere alone – there has also been an increase in private climate litigation with cases being brought against businesses and corporations in a bid to hold them accountable to communities for associated climate change damages.[217] This section will look at several examples of climate change litigation against both state and private actors and expound upon the implications of this trend on the legal backdrop of climate change and its impact on stakeholders.

Litigation against State Actors

The Paris Agreement provides litigants with a crucial legal basis with which they can push governments and corporations to close the gap between current policy, and policy required to achieve effective mitigation and adaptation.[218] Litigants are now able to argue that a government's statements about rights and objectives must be supported by concrete measures.[219] This was best exemplified in the landmark case of *Urgenda Foundation v The State of the Netherlands,* which would go on to inspire a new wave of cases. In *Urgenda,* the Dutch Court ruled that the Dutch

[213] ibid art 4.
[214] 'Climate Change Litigation' (*Climate Change Litigation Databases - Sabin Center for Climate Change Law*) <http://climatecasechart.com/climate-change-litigation/> accessed 2 May 2021.
[215] Benjamin Franta, 'Litigation in the Fossil Fuel Divestment Movement' (2017) 39 Law & Policy 393.
[216] ibid.
[217] Geetanjali Ganguly, Joana Setzer and Veerle Heyvaert, 'If at First You Don't Succeed: Suing Corporations for Climate Change' (2018) 38 Oxford Journal of Legal Studies 841.
[218] UNEP, *The Status of Climate Change Litigation : A Global Review* (United Nations Environment Programme and Sabin Center for Climate Change Law 2017) <https://wedocs.unep.org/xmlui/handle/20.500.11822/20767> accessed 30 April 2021.
[219] ibid.

State was under a duty of care to prevent 'hazardous climate change' as defined in the Paris Agreement, and that this duty of care derived from the state's discretionary power in determining climate policy.[220] Accordingly, the court ruled that the Dutch emissions reduction target in its INDC to the Paris Agreement was below the standard deemed necessary by climate science and international policy, ordering the Dutch government to adopt more stringent greenhouse gas emissions reduction measures.[221] The Dutch Court effectively transformed the state's soft laws into domestic hard law obligations.

A further example would be *Ashgar Leghari v Federation of Pakistan* where the Lahore High Court ruled that the Pakistani government had violated the fundamental rights of citizens for failing to implement its National Climate Change Policy and the accompanying Framework of Climate Change Policy.[222] *Ashgar Leghari* is especially important as it reflects the growing receptivity of courts to the reframing of climate change lawsuits within the context of human rights. With the effects of climate change being felt more directly and substantially, the connection between climate change and rights protection will grow more significant, instigating further litigation across the world.[223]

More recently, in the ongoing case of *Juliana v United States,* litigants used a combination of public trust arguments and human rights to argue that the federal government had violated their substantive rights to life, liberty and property through climate change.[224] Although the merits of the case have yet to be ruled on, an opinion and order issued on 10 November 2016 rejected the motion of the US government to dismiss the action. This preliminary decision confirmed that the litigants have a justiciable case and standing to pursue their case. It was further considered that there was a new developing fundamental right – 'the right to a climate system capable of sustaining human life'.[225]

Significantly, the reframing of climate change as a human rights issue, as in the cases of *Ashgar Leghari* and *Juliana,* is a marked shift in discourse, with the large bulk of climate change lawsuits

[220] *Urgenda Foundation v The State of the Netherlands* [2015] District Court of the Hague C/09/456689 / HA ZA 13-1396 (English Translation) [4.36-438, 4.43, 4.65].
[221] ibid 4.31.
[222] *Leghari v Federation of Pakistan and others* [2015] Lahore High Court (Pakistan) W.P. No. 25501/2015, 3 [3, 6–8].
[223] Jacqueline Peel and Hari M Osofsky, 'A Rights Turn in Climate Change Litigation?' (2018) 7 Transnational Environmental Law 37, 40.
[224] *Juliana v United States* [2016] United States District Court, D Oregon, Eugene Division 6:15-cv-01517-TC, 46 ELR 20175.
[225] ibid 32.

having traditionally been brought on the basis of statutory law causes of action against decision-making processes.[226] Even if cases such as *Juliana* are unsuccessful in court, they would still have important ripple effects in shaping public dialogue, business attitudes, and government action.[227]

Litigation Against Private Actors

This trend is not restricted to state actors as indicated in two recent cases brought in Germany and Poland where litigation was brought against private parties based on climate change and its associated damages.

In the German case of *Lliuya v RWE AG,* a Peruvian farmer filed claims for a declaratory judgment and damages in a German court against RWE, Germany's largest electricity producer.[228] The suit alleges that RWE, having knowingly contributed to climate change by emitting substantial volumes of greenhouse gases, bears some measure of responsibility for the melting of mountain glaciers near Lliuya's town of Huaraz. This has increased the threat of flooding due to the volumetric increase in size of a nearby glacial lake. The suit is seeking reimbursement for a portion of the costs incurred to establish the necessary flood protections. Lliuya acknowledges that RWE is only partially responsible for global emissions that contribute to climate change, and thus only partially responsible for the lake's growth. Therefore, Lliuya only made a claim for 0.47% of the total cost – the same percentage as Lliuya's estimate of RWE's annual contribution to global greenhouse gas emissions.[229]

The case was dismissed by the lower courts but recognised as admissible by the appeals court.[230] While the facts of the case are still to be adjudicated, the court's recognition that a private company could potentially be held liable for damages arising from climate change is unprecedented and could potentially inspire similar actions with litigators across different jurisdictions often drawing inspiration from each other.[231]

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[226] ibid 39.
[227] Peel and Osofsky (n 223) 67.
[228] *Lliuya v RWE AG* Essen Regional Court 2 O 285/15.
[229] *Lliuya v RWE AG - Order to parties to submit evidence (unofficial English translation)* [2017] Essen Regional Court 2 O 285/15, 1–5 U 15/17.
[230] ibid.
[231] Peel and Osofsky (n 223) 61.

Another growing area of climate change litigation is that of shareholder activism, with shareholders and investors becoming more involved in climate action.[232] It is now the case that shareholders and investors are trying to take large-scale systemic risks, such as climate change, into their risk management decision-making process.[233] This is especially so in light of recent reports addressing the potential 'carbon bubble' caused by fossil fuel assets that will be significantly overvalued following the transition to cleaner forms of energy, thereby resulting in stranded energy assets. If the 'carbon bubble' were to burst, it is estimated that 40-60% of shared market value could be wiped out, affecting companies and investors worldwide.[234]

An example was the Polish case *ClientEarth v Enea SA,* where ClientEarth, a minority shareholder in the Polish energy company, Enea, filed a challenge against the company's decision to pursue the construction of a new coal power plant.[235] The Court action alleged a breach of fiduciary duty on the basis of entering the project despite the significant financial risks arising from rising carbon prices, increased competition from cheaper renewables, and the impact of EU energy reforms on state subsidies for coal power.[236] In August 2019, the District Court in Poznań held that the company resolution which had authorised the construction of the coal power plan was legally invalid. In light of this landmark ruling, companies and their directors can bear a legal responsibility for managing climate-related risks and can be held potentially liable for undertaking actions that fail to do so.[237]

Although the two aforementioned cases are still pending in courts, their impact goes beyond the actual legal decision. Litigation risks interact very closely with other forms of climate business risk such as insurance risks, reputational risks, and the risk of a disruption to usual business activities. The reputation of a corporation may be undermined by a perception that it is failing

[232] Jacqueline Peel and Hari Osofsky, *Climate Change Litigation: Regulatory Pathways to Cleaner Energy* (Cambridge University Press 2015) 181 <https://www.cambridge.org/core/books/climate-change-litigation/DB1A948D69FE080EBFFB938EE2D58545> accessed 30 April 2021.
[233] ibid 210.
[234] ibid; James Leaton and others, 'Unburnable Carbon 2013: Wasted Capital and Stranded Assets' (Carbon Tracker & The Grantham Research Institute, LSE 2013) <http://carbontracker.live.kiln.digital/Unburnable-Carbon-2-Web-Version.pdf> accessed 30 April 2021.
[235] Alice Garton, Marcin Stoczkiewicz and Peter Barnett, 'ClientEarth v. Enea: Legal Briefing From Plaintiffs' <http://climatecasechart.com/climate-change-litigation/wp-content/uploads/sites/16/non-us-case-documents/2018/20180920_Not-Available_na-1.pdf> accessed 30 April 2021.
[236] ibid.
[237] 'Polish Court Rules Enea's Decision to Construct Power Plant Is Invalid' (*Business & Human Rights Resource Centre*, 1 August 2019) <https://www.business-humanrights.org/en/latest-news/polish-court-rules-eneas-decision-to-construct-power-plant-is-invalid/> accessed 23 July 2021.

to meet its obligations, legal or otherwise, in relation to climate change.[238] Furthermore, the threat of litigation and its accompanying reputational damage may provide an added incentive for corporate actors, even those not specifically targeted by the litigation in question, to adopt more climate-friendly practices.[239]

Soft Law with Hard Consequences

The overarching international agreement governing climate change, the Paris Agreement, does not impose any hard, binding obligations on state parties to make any specific efforts to mitigate greenhouse gas emissions nor to facilitate adaptation to a changing world. Nevertheless, the advent of the Paris Agreement has given individuals and communities an internationally accepted basis from which they can hold governments and corporations to account.[240] This can be seen in the surge of climate change litigation, against both public and private parties, that all cite the Paris Agreement and its preceding IPCC report in establishing the obligations of the defendants.[241] The threat of environmental litigation, in addition to making binding obligations as in the case of *Urgenda*, has become a Sword of Damocles urging corporations to shift towards a greener agenda in a bid to avoid the business risks that accompany such litigation.

Going forward, as the impact of climate change is more saliently felt and public awareness of pathways to enforcement grows, climate change litigation will continue to play a significant role in the shaping of climate policy worldwide. Furthermore, the pattern of climate change litigation pursuing a diverse range of legal theories, from rights-based arguments to shareholder activism, is likely to continue as litigants consider new ways to prompt further climate action by governments.[242]

iv. The Human Rights Element

Beyond litigation risk, a further implication of the rise in climate change litigation, particularly rights-based litigation, on corporations and investors is the increasing recognition of the nexus between climate change and human rights as mentioned in the aforementioned cases of *Ashgar*

[238] Peel and Osofsky (n 232) 184.
[239] ibid.
[240] UNEP (n 218) 8.
[241] ibid.
[242] Peel and Osofsky (n 232) 329.

Leghari and *Juliana*. The UN Human Rights Council issued a resolution in 2008 noting that 'climate change poses an immediate and far-reaching threat to people and communities around the world and has implications for the full enjoyment of human rights'.[243] This would be further supported by a study released in January 2009 by the Office of the UN High Commissioner for Human Rights on the relationship between Climate Change and Human Rights, which recognized the significant linkages between climate change and the realization of basic human rights such as the rights to life, health, food, water, and adequate housing.[244] Although the Paris Agreement failed to make any mention of human rights in any of its operative provisions, the momentum towards formal recognition of the human rights implications of climate change is growing.[245] Issues that had previously been raised only by activists and advisory committees are now entering the courtrooms and human rights tribunals of the world.

The Commission on Human Rights of the Philippines concluded the world's first national inquiry into the human rights impacts of climate change on 13 December 2018. In a series of public hearings held in Manila, New York, and London, the commission sought to ascertain whether the human rights of the Filipino people had been and are being adversely impacted by climate change, with the top 47 fossil fuel producers of the world having contributed to this phenomenon.[246] In 2019, the Commission found that the 47 major fossil fuel and carbon-polluting companies could be found legally and morally responsible for violating the rights of its citizens and causing harm linked to climate change.[247]

The role that investors can play in tackling climate change and the upholding of human rights is best seen in the growing clout of the fossil fuel divestment movement, a movement that has been described as the fastest-growing disinvestment movement in history.[248] Despite the lack of formal legal conclusions, there is a growing consensus implicating investments in industries that

[243] Peel and Osofsky (n 223) 42.
[244] OCHCR, 'Report of the Office of the United Nations High Commissioner for Human Rights on the Relationship between Climate Change and Human Rights' (United Nations Human Rights Council 2009) UN Doc. A/HRC/10/61 <https://www.ohchr.org/Documents/Press/AnalyticalStudy.pdf> accessed 30 April 2021.
[245] Bodansky, Brunnée and Rajamani (n 192) 227; Peel and Osofsky (n 223) 45.
[246] 'Press Release: CHR Concluded Landmark Inquiry on the Effects of Climate Change to Human Rights; Expects to Set the Precedent in Seeking Climate Justice' (*Republic of the Philippines Commission on Human Rights*, 13 December 2018) <http://chr.gov.ph/wp-content/uploads/2018/12/CHR_concluded_landmark_inquiry_on.pdf> accessed 30 April 2021.
[247] 'Press Release: Commission on Human Rights Declares Fossil Fuel Companies Can Be Held Responsible for Climate-Related Human Rights Harms' (*Greenpeace International*, 10 December 2019) <https://www.greenpeace.org/international/press-release/27881/commission-on-human-rights-declares-fossil-fuel-companies-can-be-held-responsible-for-climate-related-human-rights-harms> accessed 23 July 2021.
[248] Franta (n 215) 393.

significantly contribute to climate change in the violation of human rights. In a 2017 survey of institutional investors, it was found that about one-quarter had made significant changes to their portfolios to divest from fossil fuels.[249]

Drawing from the human rights discourse and the various litigation cases brought against states and private parties, the relationship between climate change, human rights, and the rights of future generations is evident. In this vein, investments into industries and technologies that work towards the mitigation of carbon emissions and the adaptation to a post-climate change world are investments that serve to affirm the rights of vulnerable communities and ensure the continued enjoyment of fundamental rights by future generations.

III.VII INVESTMENT THAT WORKS FOR EVERYONE – THE JUST TRANSITION

The economic transformation required to respond to climate change stands out because of the urgency of making progress and the disruptive changes that would arise through the necessary rapid technological change.[250] A deployment of new low-carbon technologies without time to fully consider their impact would lead to the disenfranchisement of workers and communities.[251] The importance of recognizing the socio-economic costs of decarbonisation policies are acknowledged in the preamble to the Paris Agreement, where parties to the agreement take into account the 'imperatives of a just transition of the workforce and the creation of decent work and quality jobs'.[252]

i. The Importance of the Just Transition

The Just Transition has been described as a set of principles, processes and practices that places an emphasis on a regenerative economy – this entails approaching production and consumption

[249] Karen DeMasters, 'Knowledge Needed To Divest Of Fossil Fuels' (*Financial Advisor*, 26 May 2017) <https://www.fa-mag.com/news/knowledge-needed-to-divest-of-fossil-fuels-32943.html> accessed 30 April 2021.
[250] Nick Robins, Vanda Brunsting and David Wood, 'Climate Change and the Just Transition: A Guide for Investor Action' (Grantham Research Institute on Climate Change and the Environment 2018) 10 <https://www.lse.ac.uk/granthaminstitute/wp-content/uploads/2018/12/Climate-change-and-the-just-transition_Guide-for-investor-action.pdf> accessed 30 April 2021.
[251] ibid 6.
[252] UNFCCC, 'Conference of the Parties, Adoption of the Paris Agreement' (n 165) 21.

cycles in a holistic and waste-free manner.[253] It presents an opportunity to pursue a more equitable global economy, recognises the trade-offs between the competing needs that exist within the global economic framework and seeks to address these in an equitable manner.[254]

Further to the importance of justice and equity concerns within the context of global decarbonisation and climate change, a Just Transition is critical for the sustained progression to a green economy. The potential and perceived socio-economic costs of decarbonisation could significantly hinder support for these policies from individuals and communities who are adversely affected.[255] Without strong policies to support displaced communities, these communities would resist rapid decarbonisation, thereby potentially derailing the entire process.

The Global Context

The impact of decarbonisation on jobs and communities is especially conspicuous in the context of the global shift away from coal, where it has been argued that the transition was poorly managed with no proper reskilling or development of alternative economic opportunities.[256] This was the case in The Valleys in the United Kingdom, where coal mining was the once core of local industry.[257] The region is now faced with entrenched high unemployment, poverty, and net worker outmigration.[258] This is the result of a coal transition that lacked an overarching policy framework and was exacerbated by insufficient efforts to reskill workers and create new jobs.[259]

On the other side of the Atlantic, the Appalachian Mountain region faces similar issues. Appalachia runs north to south through thirteen eastern states of the US. Many areas of Appalachia were heavily dependent on low-wage coal mining, following earlier declines in local

[253] 'Just Transition' (*Climate Justice Alliance*) <https://climatejusticealliance.org/just-transition/> accessed 1 May 2021.
[254] Peter Newell and Dustin Mulvaney, 'The Political Economy of the "Just Transition"' (2013) 179 The Geographical Journal 132; UNFCCC, 'Just Transition of the Workforce, and the Creation of Decent Work Quality Jobs' (United Nations Framework Convention on Climate Change 2016) FCCC/TP/2016/7 21 <https://unfccc.int/sites/default/files/resource/Just%20transition.pdf> accessed 1 May 2021.
[255] Noel Healy and John Barry, 'Politicizing Energy Justice and Energy System Transitions: Fossil Fuel Divestment and a "Just Transition"' (2017) 108 Energy Policy 451, 451.
[256] Ajay Gambhir, Fergus Green and Peter Pearson, 'Towards a Just and Equitable Low-Carbon Energy Transition' (Imperical College London 2018) Grantham Institute Briefing Paper No.26 7 <https://www.imperial.ac.uk/media/imperial-college/grantham-institute/public/publications/briefing-papers/26.-Towards-a-just-and-equitable-low-carbon-energy-transition.pdf> accessed 1 May 2021.
[257] Peter Sheldon, Raja Junankar and Anthony De Roas Pontello, 'The Ruhr or Appalachia? Deciding the Future of Australia's Coal Power Workers and Communities' (Industrial Relations Research Centre 2018) 42.
[258] ibid.
[259] ibid.

manufacturing.[260] Due to the vastness of the region and its fragmentation across various state and local governments, the closure of multiple mine sites was not followed by a unified regional transition strategy. Where policy efforts to mine closures were made to mitigate the negative effects of the transition, these were often reactive and short-term in scope, whilst efforts at economic diversification were largely top-down and employer-focused.[261] Ultimately, this led to displaced workers in Appalachia being far less likely to find alternative jobs when compared to other US workers, with research concluding that the policy measures were mostly ineffective for job creation.[262]

In addition to a Just Transition for communities reliant on carbon-intensive sectors, it has to be recognised that low-carbon technologies too can be a source of injustice.[263] An example wherein already vulnerable communities were disadvantaged and dispossessed by the low-carbon transition is the development of the Gujarat Solar Park in India. Gujarat Solar Park-1 was the first to be constructed under the Gujarat Solar Power Policy. Two already disadvantaged communities were severely disaffected by the land acquisition process for this project. The Rabari pastoral community who had previously grazed their herds was dispossessed of its livelihood.[264] Subsistence farmers in the region also ended up selling their land below market rate, thereby leaving them inadequately compensated and similarly disaffected.[265]

Large-scale projects such as the one in India unavoidably require the conversion of large areas of land into non-agricultural use. The means of acquisition of the requisite land is a contentious issue in the transition to a low-carbon economy, especially in developing countries where rights to rural land can be ambiguous, with a lack of legal records or tenure documents serving to facilitate the acquisition of the land by the government.[266]

Ultimately, a failure to implement just and legitimate procedures in land acquisition would violate the rights and livelihoods of marginal and disadvantaged communities. This would incite

[260] ibid 44.
[261] ibid.
[262] Sheldon, Junankar and Pontello (n 257) 45.
[263] Gambhir, Green and Pearson (n 256) 7.
[264] Komali Yenneti, Rosie Day and Oleg Golubchikov, 'Spatial Justice and the Land Politics of Renewables: Dispossessing Vulnerable Communities through Solar Energy Mega-Projects' (2016) 76 Geoforum 90, 91, 97–98.
[265] ibid 98.
[266] ibid 94.

resentment, conflicts and inevitably delay projects.[267] Companies that fail to engage with such communities could face operational, consumer, and regulatory repercussions.[268]

Implementing a Just Transition

The transition to a sustainable low-carbon economy presents major opportunities and challenges for countries and stakeholders. The transition, if properly managed with the full engagement of governments, workers, and employers' organizations, can become a strong driver of job creation, job upgrading, social justice and poverty eradication.[269] As key stakeholders within the global economy, institutional investors are well positioned to call for and effect the necessary changes for a transition to an equitable and sustainable economy. There are now calls for investors and companies to look beyond pure profits and take these broader considerations into account in corporate decision-making. Some of the more notable examples of this were the letters written by BlackRock CEO Larry Fink, to CEOs in 2018 and 2021, where he called for companies to take the lead and demonstrate their commitment to the communities in which they operate.[270]

To achieve this transition, this paper puts forward two key proposals. First, there has to be a strong and comprehensive government policy seeking economic diversification. To this end, institutional investors can lobby and work with governments to enact such a framework, as is being done through the 2021 Global Investor Statement to Governments on Climate Change, which is being prepared by a consortium of investor organisations across the world in advance of COP26.[271] Second, companies involved in the transition should utilise a more thorough and transparent reporting framework. This can be achieved through a combination of government regulation and institutional pressure from investors holding shares in these companies.

Looking at the first proposal involving government policy, a positive example of a Just Transition achieved through effective government policy is the transition in the West German Ruhr, which developed from a steel and coal-based economy to a knowledge-based economy in the 1990s.

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[267] ibid 98.
[268] Robins, Brunsting and Wood (n 250) 12.
[269] UNFCCC, 'Just Transition of the Workforce, and the Creation of Decent Work Quality Jobs' (n 254) 21.
[270] 'Larry Fink's Letter to CEOs: A Sense of Purpose' (*BlackRock*, 2018) <https://www.blackrock.com/corporate/investor-relations/2018-larry-fink-ceo-letter> accessed 1 May 2021; 'Larry Fink's Letter to CEOs' (*BlackRock*, 2021) <https://www.blackrock.com/corporate/investor-relations/larry-fink-ceo-letter> accessed 1 May 2021.
[271] 'Policy Advocacy' (*The Investor Agenda*) <https://theinvestoragenda.org/focus-areas/policy-advocacy/> accessed 1 May 2021.

An essential component of the successful transition was a comprehensive policy framework which comprised of the active management of economic diversification by the federal and regional governments, paired with the participation of workers and communities in the entire restructuring process.[272] Additionally, the implementation of widespread retraining programmes to retrain displaced coal industry workers to participate in this newly diversified economy was key to avoiding the social fallout that would have otherwise occurred.[273]

There is no set formula appropriate for every local transition given the multifarious nature of economic changes. The International Labour Organisation (ILO), in its Guidelines for a Just Transition, affirms the position that policies and programmes need to be designed in line with countries' specific conditions and their respective local circumstances.[274] Nevertheless, drawing from the case studies discussed earlier in this paper and the principles and policy points set out in the ILO Guidelines, two broad principles for government action can be extracted.[275]

First, it is essential that there is a long-term overarching framework that brings cohesive leadership and coordination throughout the transition process. All studies of successful carbon transitions demonstrate a considerable role for active government involvement in steering regions towards new and alternative industries.[276] That said, it has been argued that the best approach would utilise both top-down and bottom-up policy development processes.[277] This is essential to avoid a mismatch between top-down expectations and the reality on the ground, as was the case in Appalachia.

Second, as no single actor can deliver the Just Transition alone, there has to be a strong social consensus on the goals and pathways of the transition. This can only be achieved through continued efforts at consultation through maintaining a tripartite social dialogue between the government, businesses, and worker unions.[278] In a study analysing 6 cases of mining closures

[272] Béla Galgóczi, 'The Long and Winding Road from Black to Green: Decades of Structural Change in the Ruhr Region' (2014) 6 International Journal of Labour Research 217, 238–239.
[273] Clark Miller, Alastair Iles and Christopher Jones, 'The Social Dimensions of Energy Transitions' (2013) 22 Science as Culture 135.
[274] ILO, 'Guidelines for a Just Transition towards Environmentally Sustainable Economies and Societies for All' 6 <https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---emp_ent/documents/publication/wcms_432859.pdf> accessed 1 May 2021; Martin Vezér and others, 'How Investors Integrate ESG: A Typology of Approaches' (Investor Responsibility Research Center Institute 2017) 58.
[275] ILO (n 274) 6.
[276] Gambhir, Green and Pearson (n 256) 11.
[277] Vezér and others (n 274) 67.
[278] ibid 54; UNFCCC, 'Just Transition of the Workforce, and the Creation of Decent Work Quality Jobs' (n 254) 49.

across the USA and the EU, Caldecott et al highlighted the importance of such a tripartite dialogue together with long-term policy commitments and a proactive approach to managing uncertainty in the face of unforeseen circumstances.[279] Furthermore, in its guidelines for a Just Transition, the ILO would reiterate this point in its calls for governments to actively promote and engage in a social dialogue to discuss the best means to implement national social, economic, and environmental goals.[280]

Ultimately, if more resources are invested into tailoring a transition that takes into account the interests of domestic communities, workers, and businesses of a specific region, it is far more likely that a sustainable and Just Transition can be achieved at a significantly reduced overall financial cost.[281]

Looking beyond government policy, corporations as well as their investors can effect a Just Transition by utilising or encouraging the use of a more thorough reporting framework – a framework that incorporates climate disclosure as well as social aspects such as the protection of human rights and the provision of decent jobs.

A climate disclosure framework already exists in the Task Force on Climate-related Financial Disclosure (TCFD) framework, which establishes recommendations for the disclosure of clear and comparable information about the risks and opportunities presented by climate change.[282] This seeks to develop voluntary, consistent climate-related financial disclosures that would help stakeholders understand relevant material risks.[283] The TCFD provides "global recommendations on climate-related financial disclosures, including four widely adoptable principles that are applicable to organisations across sectors and jurisdictions.".[284] The TCFD has been publicly endorsed by the Global Investor Coalition, and as of 2020, has already been endorsed by over 1,500 organizations globally, including over 1,340 companies with a combined market capitalisation of US$12.6 trillion and US$150 trillion assets under management by

[279] Ben Caldecott, Oliver Sartor and Thomas Spencer, 'Lessons from Previous "Coal Transitions" High-Level Summary for Decision-Makers' (Institute for Sustainable Development and International Relations (IDDRI), Climate Strategies 2017) 24 <https://apo.org.au/node/97371> accessed 1 May 2021.
[280] ILO (n 274) 8.
[281] Vezér and others (n 274) 58.
[282] TCFD, 'Recommendations of the Task Force on Climate-Related Financial Disclosures' (Task Force on Climate-Related Financial Disclosures 2017) <https://assets.bbhub.io/company/sites/60/2020/10/FINAL-2017-TCFD-Report-11052018.pdf>.
[283] ibid 2.
[284] 'Briefing Paper on the 2018 Global Investor Statement to Governments on Climate Change' <https://globalinvestorcoalition.org/wp-content/uploads/2018/07/180529_GISGCC_briefing_paper_FINAL.pdf> accessed 1 May 2021.

financial institutions.[285] By facilitating greater transparency in the context of climate risk, the framework would ensure fully informed corporate and investment decision-making.

In addition to climate-related risks, a reporting framework has to include the social implications of the transition. This can be achieved by extending the TCFD framework using accepted approaches such as the UN Guiding Principles Reporting Framework,[286] which covers human rights issues; the Workplace Disclosure Initiative,[287] which deals with how companies manage workers in their operations and supply chains; and the Global Reporting Initiative,[288] which provides sustainability reporting standards that cover economic, environmental, and social impact. Comprehensive and transparent reporting on the social implications of corporate actions has a two-fold impact. First, it would influence corporate behaviour by bringing Environmental Social and Corporate Governance (ESG) goals to the fore, which could lead to a shift towards a more just and equitable agenda. Second, it would empower workers, affected communities, and NGOs to have their voices heard and be a part of the corporate decision-making process.

Economic disruption caused by the transition to a low-carbon economy is unavoidable. Nevertheless, it is the position of this paper that the worst impacts of the transition can be softened and even alleviated. A strong government policy that provides an overarching framework whilst keeping a close ear to the ground can guide affected regions through these tumultuous times. Furthermore, corporate cooperation through a transparent reporting framework would also empower and inform stakeholders, thereby further facilitating a just and equitable transition to a cleaner and greener economy.

[285] 'Task Force on Climate-Related Financial Disclosures: 2020 Status Report' (Task Force on Climate-Related Financial Disclosures 2020) <https://assets.bbhub.io/company/sites/60/2020/09/2020-TCFD_Status-Report.pdf> accessed 23 July 2021.
[286] 'UN Guiding Principles Reporting Framework' <https://www.ungpreporting.org/wp-content/uploads/UNGPReportingFramework_2017.pdf> accessed 1 May 2021.
[287] 'Workforce Disclosure Initiative 2020 Survey Guidance Document' (Workforce Disclosure Initiative 2020) <https://shareaction.org/wp-content/uploads/2020/09/WDI-2020-survey-guidance.pdf> accessed 1 May 2021.
[288] 'About GRI' (*Global Reporting Initiative*) <https://www.globalreporting.org/about-gri/> accessed 1 May 2021.

IV. RECOMMENDATIONS – WHAT LIES AHEAD?

The inevitable consequences of climate change have left mankind with no more than a decade to overturn centuries of destructive development. While it may seem like a Herculean task to overcome deeply embedded partisan bureaucracy that often defines government today, it is not impossible.

One of the peak developments and key institutions of the 21st century – the financial market – has the potential to define our fates. Investment markets hold significant power in our economies, and they should be regarded as one of the prime tools to help the world overcome the impending climate disaster. Also, technology is also arguably one of the key features that defines modern society in this century. Investment into climate change technologies could potentially be the most important key to unlocking the puzzle that we are facing today. Research by major corporations already suggests that the economic benefits of investment will outweigh the costs of inaction towards anthropological climate change.[289] From the current economic perspective, research for climate change investment has already yielded positive results, with total global climate change investment output expected to increase under a lower emissions scenario, while investments in climate change mitigation technologies and solutions are anticipated to generate attractive and growing yields.[290]

Investment in climate change technologies is also a proven methodology that outpaces conventional technology development and market productivity. According to the International Renewable Energy Agency (IRENA), the cost of wind turbines fell by 37-56% and that of solar photovoltaics by approximately 80% by 2018. As a result, renewable energy is now the cheapest source of power generation in many parts of the world.[291]

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[289] EYGM (n 171).

[290] 'The Cost of Inaction: Recognising the Value at Risk from Climate Change' (The Economist Intelligence Unit 2015) <https://eiuperspectives.economist.com/sites/default/files/The%20cost%20of%20inaction.pdf> accessed 3 May 2021; Jason Channell and others, 'Energy Darwinism II: Why a Low Carbon Future Doesn't Have to Cost the Earth' (Citigroup 2015) <https://ir.citi.com/E8%2B83ZXr1vd%2Fqyim0DizLrUxw2FvuAQ2jOlmkGzr4ffw4YJCK8s0q2W58AkV%2FypGoKD74zHfji8%3D> accessed 3 May 2021.

[291] IRENA, 'Corporate Sourcing of Renewables: Market and Industry Trends' (International Renewable Energy Agency 2018) <https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/May/IRENA_Corporate_sourcing_2018.pdf>.

IV.I UNDERSTANDING SITUATIONAL LIMITATIONS

Before delving into the recommendations, it is necessary to understand the key differences between countries, as well as the identification of differentiated policies for differentiated circumstances to suit each nation's unique characteristics and potential transition.

As the Asian Development Bank (ADB) has coined it, planning for climate change requires a move away from a 'predict-then-act' approach towards a 'no-regret' approach. The latter calls for an understanding of the drivers of vulnerability and investments in resilience that would be justifiable under a wide range of climate scenarios or even in the absence of climate change. The 'no-regret' approach also does not depend on detailed climate projections, but on solid action to effectively reduce emissions in time.[292]

The difference between developing and developed nations should also be a key deciding factor for the consideration of policies. However, it would also be naïve to only define our target audience within just the two aforementioned categories, as it would be in every nation's best interest to carefully consider their unique socio-economic situations as well as weigh the industrial capacity of their own country with the policies available to them.

The driving theme that would define our policy recommendations is to highlight the importance of education. Education is a foundation for growth in industries and has been used throughout history to develop generations of citizens that would be able to propel society forward. It would be important to not only define education as one that is obtained from public and private institutions, but as one that will be inclusive to the greater population that has graduated from the system. For example, socially inclusive education through public communications, campaigns, and marketing can be leveraged effectively, to ensure that public human capital can be more receptive towards supporting investments in climate change technologies, thus in turn encouraging growth and propelling investment for it.

[292] ADB, *Climate Change and Rural Communities in the Greater Mekong Subregion: A Framework for Assessing Vulnerability and Adaptation Options* (Asian Development Bank 2014) <https://www.adb.org/publications/climate-change-and-rural-communities-greater-mekong-subregion-framework-assessing> accessed 1 May 2021.

IV.II POLICY RECOMMENDATIONS

i. Education

Education on climate change should be considered a strong factor advocating for the increase of investments in CCTOs. Public acceptance and awareness (gained through education) is a necessary tool for potential stakeholders to dive into investments. As we observed in the growing appetite for renewable energy technology, global investments in renewable energy increased five-fold over the 15 years 2004-2019.[293] This coincides with the latest results in a decade-long string of surveys on "Climate Change in the American Mind," run by researchers at Yale and George Mason University, which measured a big rise in acceptance of climate change. For the second consecutive time since it began in 2008, more than 60 percent of respondents said that global warming is caused mostly by humans.[294] This reflects a relationship between awareness and action, where the increase in investments arguably naturally coincided with increased global awareness.

Global Swiss financial institution UBS also reported that better education often leads to higher adoption for sustainable investments. Sustainable investors were influenced by multiple sources, including professional advisors, family, friends, and media. 90% of sustainable investors cite an advisor's impact on their decision to invest sustainably.[295]

Nuclear energy, a potentially invaluable technology that would greatly reduce carbon emissions from industries, remains stuck in the bitter end of public perception.[296] However, with education, people are becoming increasingly supportive of nuclear energy when they feel better informed. The Eurobarometer polls from a combined report from the Nuclear Energy Agency and OECD showed that while Europeans believe they are not familiar with nuclear safety issues, respondents with higher levels of education are more likely to think that the advantages of nuclear outweigh

[293] Beate Antovich, 'Renewable Energy Investments Increased Five-Fold Globally Over Past 15 Years' (*International Institute for Sustainable Development Knowledge Hub*, 7 February 2019) <https://sdg.iisd.org/news/investment-in-renewable-energy-is-clean-but-in-transmission-and-distribution-technologies-not-necessarily/> accessed 1 May 2021.
[294] Anthony Leiserowitz and others, 'Climate Change in the American Mind: April 2020' (Yale Program on Climate Change Communication 2020) 4 <https://climatecommunication.yale.edu/wp-content/uploads/2020/05/climate-change-american-mind-april-2020b.pdf> accessed 1 May 2021.
[295] UBS, 'Return on Values' (*UBS Wealth Management*) <https://www.ubs.com/global/en/wealth-management/our-approach/investor-watch/2018/return-on-values.html> accessed 1 May 2021.
[296] Jesse H Ausubel, 'Renewable and Nuclear Heresies' (2007) 1 International Journal of Nuclear Governance, Economy and Ecology 229.

the risks (38% in the highest educational group vs. 27% in the lowest).[297] In the data gathered in this report, respondents also showed that perceived levels of knowledge in, and personal experience of, nuclear energy has a significant impact on views about nuclear energy.

Since the advent of human capital theory in economic thought, estimating the returns of investment in education has been a very popular subject among researchers.[298] Investment in human capital through education can result in greater public awareness towards the inevitable societal changes wrought by climate change technologies. This could increase a natural appetite for more technological improvements, thus increasing demand and profitability for it. For example, as we study Singapore's policy in prioritising education and leveraging human capital as a growth catalyst in the 1990s, we would be able to observe how economic development in a significantly smaller state in Southeast Asia developed tremendously with increased value and quality of human capital that has become a trademark of Singapore's miraculous growth.[299]

Societal pressure also plays an important role towards pushing companies to change to climate friendly structures and technologies. For example, the recent plastic straw revolution showed us the point of contact that influenced true sweeping changes in the F&B industry, leading to a wave of sustainability initiatives that has spread into major institutes and industries. The role of communications for the road ahead will arguably be more important than it has ever been in the last century. Marshall McLuhan most prominently emphasised the impact of media technology on society in 1964 with his statement that "the medium is the message", which refers to the power of media to change people's feelings and perceptions through an extension of their own understanding.[300]

In our global interconnected world today, it would be naïve to deny the plausible effects of communications towards education and influencing greater society. The prominence of social media movements in the past decade has spawned enough examples for policies to leverage and

[297] OECD, 'Public Attitudes to Nuclear Power' (OECD Publishing 2010) 27 <https://www.oecd-nea.org/jcms/pl_14534/public-attitudes-to-nuclear-power#:~:text=Public%20attitudes%20to%20nuclear%20power%20are%20critical%20in%20shaping%20nuclear,its%20benefits%20outweigh%20its%20risks.>.
[298] Harry Patrinos, George Psacharopoulos and Aysit Tansel, 'Returns to Investment in Education: The Case of Turkey' (World Bank 2019) Policy Research Working Paper 8789.
[299] Aahad Osman-Gani, 'Human Capital Development in Singapore: An Analysis of National Policy Perspectives' (2004) 6 Advances in Developing Human Resources 276.
[300] Marshall McLuhan, 'The Medium Is the Message', *Understanding Media: The Extensions of Man* (McGraw-Hill 1964) 1–18.

pressure corporations into adopting climate change technologies. Renewable Energy 100 (RE100) is one of the major international corporate commitments available to multinational corporations to signify their foray into climate change technological investments. This is a global corporate initiative that brings influential businesses together to commit to 100% renewable electricity consumption. Over 300 MNCs have already pledged to achieve 100% renewable energy use by across a range of target schedules.[301]

Such a change would have been unfathomable a decade ago. However, rising urgency as well as increased media coverage of the impending climate disaster acts as an educational bridge that fills the gap and allows individuals to understand and react to the severity of the situation. However, we still have a long way to go. Micro-consumerist behaviours account for change but would barely scratch the surface of the greater issue we are facing in our rising carbon emissions. Regardless, such developments represent hope and possibility towards such an approach for education to inevitably increase investment in, and attention to climate change technologies.

While considering communications as one of the key tools for progressive and inclusive education with regard to the benefits of climate change technologies, it would also be beneficial for investors to look towards socio-environmental campaigns with governments and engage with public relations firms to fully maximise the efficiency of public climate change education that can work well in tandem with increasing investments in climate change technologies.

Bipartisan education should be considered a vital component in ensuring the longevity of most of our policy recommendations. With support and pressure from society, corporations will be more motivated to commit towards climate change technologies, and governments can be more courageous in introducing such transitions to the economy. Survival psychology – which focuses on the mental or cognitive aspects of who survives in disasters or times of crisis – in the masses will be a factor towards the growth of climate change technologies; however, before it can be triggered, people must be educated enough to understand the true consequences and feel the necessity of being open towards a new way of life. Investors should step forward now and consider a two-pronged approach, by investing in both education and sunrise industries that will prepare the population for what is to come.

[301] 'RE100 Members' (*Renewable Energy 100*) <https://www.there100.org/re100-members> accessed 3 May 2021.

The future of climate change technological investments will be dependent on the awareness and courage of corporations and governments. Businesses in sunrise sectors must be able to build efficient risk management structures that will be able to encourage investors to step in, while government policies will be key in guiding these climate change technological sectors to sustainable growth.

ii. Circular Economy

Circular economies are built upon an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems and business models.[302] By transitioning modern economies from the linear destructive model of industrialisation to a circular structure, we will be able to naturally increase the appetite for investment in climate change technologies that are essential to fit into the new running model.

iii. Rural Initiatives with Public Private Partnerships (PPPs)

Rural communities can be engaged as stakeholders for investment in climate change technologies.[303] This would also have great potential levelling effects for these communities in terms of development, when we provide them with green technologies to increase their standard of living sustainably, moving them away from the industrial revolution model of growth.

For example, we have observed successful renewable energy technologies in their stages of infancy that have leveraged upon rural communities to reduce their carbon footprint by offering an environmentally sustainable alternative. The introduction of pilot projects for solar diesel

[302] Jamie Butterworth and others, 'Towards the Circular Economy: Accelerating the Scale-up across Global Supply Chains' (World Economic Forum 2014) <http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf> accessed 2 May 2021.

[303] Purnamita Dasgupta and others, 'Rural Areas' in Christopher Field and others (eds), *Climate Change 2014: Impacts, Adaptation, and Vulnerability: Working Group II Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge University Press 2014) 613–657.

hybrids in Nepal, Pakistan, and Sri Lanka has shown promising results in keeping up with developing communities and their needs while allowing the technology and stakeholders to gather valuable experience to tailor efficient development.[304] Such an implementation strategy and policy also allows technology to be tested in harsher conditions at its early stages, as well as benefit developing communities. Such technological drift would also help communities build towards a circular economic model sooner, instead of being forced to rely on fossil fuels and unsustainable industrial methodology for development. As seen in the case of Bangladesh, they are expected to expand solar power-based irrigation systems in rural areas to replace existing diesel and electric water pumps, which is an example of transitioning into actual implementation after testing adaptations of the green technology with such communities.[305]

In this regard, community participation is key to the vulnerability assessment process by allowing members of the community to co-create possible solutions and decide suitable adaptation options. It also helps foster a greater sense of ownership in terms of implementation of the selected adaptation strategies.[306] This is able to improve the cohesion of investment into the technology that will be mutually beneficial for all parties. To improve adaptation planning for communities, there is a need to better understand their climate vulnerability through an appropriate assessment methodology. Assessment outcomes can then be used to support the mainstreaming of climate change adaptation initiatives in community development planning to increase community resilience both now and under a future climate.[307]

Private capital can also make a major contribution to investment, with an estimated US$100 trillion in global assets managed by pension, sovereign wealth funds, insurance companies, and other institutional investors.[308] This could aid governments in developing countries who may not be able to afford to test a wide range of necessary climate change technologies in their rural areas – a mutually beneficial partnership in which after successful development, the relevant

[304] ADB, *Improving Lives of Rural Communities Through Developing Small Hybrid Renewable Energy Systems* (Asian Development Bank 2017) <https://www.adb.org/documents/improving-lives-rural-communities-hybrid-renewable-energy> accessed 2 May 2021.
[305] 'Solar-Powered Pumps Reduce Irrigation Costs in Bangladesh' (*World Bank*, 8 September 2015) <https://www.worldbank.org/en/results/2015/09/08/solar-powered-pumps-reduce-irrigation-costs-bangladesh> accessed 23 July 2021.
[306] ADB (n 292) x.
[307] ADB (n 292).
[308] Rabah Arezki and others, 'From Global Savings Glut to Financing Infrastructure: The Advent of Investment Platforms' (International Monetary Fund 2016) IMF Working Paper WP/16/18 <https://elibrary.imf.org/view/journals/001/2016/018/001.2016.issue-018-en.xml> accessed 2 May 2021.

technologies could be adapted to developed countries and their resources, while increasing green industrial growth.

Further policies such as controlled investments with scientific advisory and streamlining adaptation processes in urban areas would also encourage the growth of PPPs for climate change technological opportunities as private capital would be enticed to invest with more reliable regulations guiding the development phase of these technologies. We can observe government guidelines with providers in China's renewable energy market that allowed the industry to boom in the past 5 years. Data released by the National Energy Administration (NEA) in January 2021 showed that China added 71.76 gigawatts (GW) of wind power capacity in 2020, nearly triple of 2019's levels. New solar capacity also increased to 48.2 GW, significantly higher than an earlier industry estimate of 40 GW. According to the NEA data, China had 281.5 GW of wind generation capacity and 253.4 GW of solar generation capacity by end-2020. It also continued to build thermal power capacity with 56.37 GW generated, the highest level since 2015.[309] State Grid Corp, the China Southern Power Grid, and the Inner Mongolia Power (Group), continuously improved their system adjustment capabilities, optimised operations, and allowed the utilization rate of renewable energy to grow significantly with the guidance from the state. This reflects how state ownership and private partnerships are able to maximise technological growth that will ultimately attract more investments with successful results.

State ownership in PPPs can also be a risk incentive towards private investment in climate change technological opportunities. State ownership reduces the exposure risk that stakeholders would face in a financial portfolio. Furthermore, reducing liability through state ownership would incentivise private investment capital who are undergoing positive transitional adjustments to their corporate structures. Also, reputational risks within large multinational corporations can be mitigated with the state taking more responsibility in guiding the portfolio through regulation and legislation.

Reducing risk profiles and having higher credit ratings can also attract private investment. Sovereign and national risks play an important role in predicting the number of PPPs reaching financial close and the size of private investments. In their empirical analysis using Euromoney's

[309] Muyu Xu and David Stanway, 'China Doubles New Renewable Capacity in 2020; Still Builds Thermal Plants' *Reuters* (21 January 2021) <https://www.reuters.com/business/sustainable-business/china-doubles-new-renewable-capacity-2020-still-builds-thermal-plants-2021-01-21/> accessed 23 July 2021.

measure of country risk, Araya, Schwartz, and Andrés found that private sector participation in infrastructure projects is sensitive to country risk; that is, risk ratings are a generally reliable predictor of PPP investments in developing countries.[311]

Leaders can enact policies that support the attainment of the Paris Agreement's goals to provide and accelerate private sector action with greater certainty to governments' commitment in tackling climate change. This will encourage and improve investors' ability to assess climate-related risks and opportunities, to measure and disclose portfolio exposure to the low carbon transition and physical climate impacts, and to further invest in opportunities to support climate change technologies. By incorporating Paris-aligned climate scenarios into all relevant policy frameworks and energy transition pathways, government ownership and commitment will only fuel private capital's appetite towards climate change opportunities.

iv. Special Economic/Environmental Zones (SEZs)

SEZs are a geographically delineated area subject to differentiated regulation and administration from the host country where it resides, for the purpose of attracting foreign direct investment in economic activity that could not otherwise be achieved.[312] This has been a traditionally successful model that can be most prominently observed in Shenzhen, China. In the case of the Shenzhen SEZ, the state was aided with foreign investment initiatives and tax benefits for businesses to expand and grow. In the years that followed, Shenzhen expanded at an alarming pace. Its GDP per capita grew a jaw-dropping 24,569 percent between 1978 and 2014, and by 2016, its population stood at nearly 12 million, growing from a fishing village of 30,000.[313]

Using this concept, it would be possible for nations to develop "Special Environmental Zones" to create testbeds for climate change technologies and invite investment to allow them to bloom in controlled conditions without global interference. This will encourage growth in investment

[311] Gonzalo Araya, Jordan Schwartz and Luis Andres, 'The Effects of Country Risk and Conflict on Infrastructure PPPs' (World Bank 2013) Policy Research Working Paper 6569 <http://elibrary.worldbank.org/doi/book/10.1596/1813-9450-6569> accessed 2 May 2021.
[312] 'Special Economic Zones as a Tool for Economic Development' (Oliver Wyman 2018) <https://www.oliverwyman.com/content/dam/oliver-wyman/ME/banners/Special%20Economic%20Zonesdigitalrev.pdf>.
[313] Frank Holmes, 'China's New Special Economic Zone Evokes Memories Of Shenzhen' (*Forbes*) <https://www.forbes.com/sites/greatspeculations/2017/04/21/chinas-new-special-economic-zone-evokes-memories-of-shenzhen/> accessed 2 May 2021.

for climate change technologies, where corporates are incentivised to finance projects with maximised efficiency in the SEZ from birth to public implementation stages.

Regionally, we can leverage on intergovernmental associations like the EU and ASEAN to collaborate and grow SEZs that would form an interconnected region to accelerate regional technological developments. Naturally, such investment portfolios will have increased attractiveness with support from the government. Regionally connected SEZs will also have the potential to diffuse information for greater growth throughout the regions. China's selection of SEZ clusters in Shenzhen, Zhuhai and Shantou were all in the same Guangdong province and had a geographical advantage which promoted inter-city business expansion. Education in SEZs were also a major factor for the rise of the Chinese economy. In this example, many zones have a well-equipped skills training centre, which works closely with technical and vocational schools, colleges, and universities to provide relevant skills training and technology support for the firms in the zones.[314]

Nations can begin by setting economic policies to fund technological start-ups with implementation and testbeds in their most vulnerable states to be appointed as SEZs. This would maximise and enable start-ups to increase efficiency of development as well as secure resources and feedback from communities that can benefit from such technologies that are now available and tailored to them. This creates a unique microcosm for potential new climate change tech to grow with support and structure. Policies for SEZs also promote economic caution as the Chinese practiced in their first set-up. As Zeng noted in the analysis of the beginning of China's SEZs, not knowing what to expect from the reforms, Chinese authorities decided not to open the entire economy all at once but just certain segments: in Deng Xiaoping's words, "crossing the river by touching the stones".[315]

Therefore, besides the planned objectives of an SEZ — such as attracting investment into climate change technologies, promoting exports and development, and generating specialised employment and spill-overs to the local economy — one important mission should be to test new

[314] Zhihua Zeng, 'Global Experiences with Special Economic Zones: Focus on China and Africa' (World Bank 2015) Policy Research Working Paper 7240 <http://elibrary.worldbank.org/doi/book/10.1596/1813-9450-7240> accessed 2 May 2021.
[315] Douglas Zeng, 'China's Special Economic Zones and Industrial Clusters: Success and Challenges' (Lincoln Institute of Land Policy 2012) <https://www.lincolninst.edu/sites/default/files/pubfiles/2261_1600_Zeng_WP13DZ1.pdf>.

policies and new institutions for a climate change tech centred market economy, or the new circular economy model. The very purpose and nature of SEZs means that the definition of success implies redundancy of that zone's original proposition. Planning for such sustainable success requires identifying the target evolutionary path of an SEZ, designing for that at inception, with constant adaptation to internal and external economic dynamics.[316] In an ever-changing world, any SEZ strategy must be designed with enough in-built agility to avoid becoming static or redundant in a very short space of time – responding to competition to remain relevant without delay or cost. The introduction of regional cooperation would help alleviate the competition between zones and unlike the economic zones, environmental zones would focus on refining technology and contribute towards cost-efficient widespread implementation. This will be crucial for SEZs to remain a powerful and viable tool for environmental economic development.

We can also observe Singapore's introduced measures to catalyse the private sector to pursue new growth opportunities in sustainability industries and innovation, such as by setting aside S$900 million under the Research, Innovation and Enterprise 2020 urban solutions plan. Such public investment will be key in encouraging entrepreneurship within the planned region, where small medium enterprises will have greater financial incentives to maximise efficiency and development of their technologies with financial backing. Governments can lead on from such initiatives regionally through cooperation with intergovernmental organisations, to help progressively maximise talent and sector growth within neighbouring countries. International cooperation for such economic plans can ultimately also increase capital growth and reduce information barriers between potential investors and businesses from another region. MNCs can also capitalise by engaging in corporate partnerships with such plans, allowing industry experts to be part of the growth process as mentors to learn and improve their current technological foundation with innovation from a specialised and motivated market.

v. Integration into Present and Future Technological Systems

In order to bridge the gap between past and future technological systems, governments must be able to plan ahead to acclimatise and adapt upcoming climate change technologies towards their current systems. This would ensure that foundations are prepared for the inevitable, and societies will be able to adopt changes with the least discomfort. This ties in with the education of the

[316] 'Special Economic Zones as a Tool for Economic Development' (n 312).

population, in terms of retraining of disenfranchised workers to reduce the human capital skill gap between sunrise and sunset industries. It would also be necessary to consider a nation's geographical advantages in producing and implementing climate change technologies. For example, consider China's approach in solar panel expansion within its northern territories which are more exposed to sunlight each day, thus increasing technological efficiency.[317]

Careful utilisation of geographical advantages towards climate change technologies where applicable would be ideal for its development in its early stages. This would also mean that investment in climate change technologies should be guided by specialised academia to maximise efficiency and reduce risk for stakeholders. For example, renewable energy currently available is widely distributed geographically. Hydropower generally are more centralised options constrained by geographic location while other renewable energy sources are defined by variables with limited predictability. Such characteristics can constrain ease of integration and invoke additional costs when reaching higher market shares.

vi. Institutional Changes with Education

The rapid rise of the Environmental, Social and Governance (ESG) values has marked a situation where investors are showing more caution and demands in the market. It also reveals a higher emphasis on requirements where they expect bigger positive impact and better performances.

In the 2018 UBS Investor Watch, a survey of more than 5,300 investors in 10 markets on sustainable investing revealed that, while some investors understood the basic concept, confusion about sustainable investing terms, its various approaches and even its impact, is widespread. For example, investors make little distinction among the three major sustainable investment approaches: exclusion, integration, and impact investing.[318]

Positive outlooks by sustainable investors also reveal an easier road ahead for more potential investments for climate change technologies. 82% believe the returns of sustainable investments

[317] AF Sherwani, JA Usmani, and Varun, 'Life Cycle Assessment of Solar PV Based Electricity Generation Systems: A Review' (2010) 14 Renewable and Sustainable Energy Reviews 540.
[318] UBS (n 295).

will match or surpass those of traditional investments. Investors view sustainable companies as responsible, well-managed and forward-thinking, and thus as good investments for the future.[319]

However, despite the positive outlook, not nearly as many investors apply their values to their investing. Currently, only 39% hold sustainable investments in their portfolios, defined as at least 1% of their investable assets. 58% of investors also expect sustainable investing to become the standard approach to investing in 10 years. Part of this disconnect can be accounted to confusion about sustainable investing that is likely preventing widespread adoption. 72% of investors find the language of sustainable investing perplexing—and less than half are very familiar with the term itself.[320] Moreover, investors make little distinction among the major approaches to sustainable investing. This has revealed that while the intention for investments in sustainability and climate change technologies may be growing, there is an educational and knowledge gap that is yet to be filled.

Like other financial institutions, banks are limited in their ability to make quantitative judgements about climate-related data. However, that does not prevent them from developing a lending strategy that combines their views on the technological transition with other strategic considerations, such as growth targets or geographic priorities. Banks can partner with collective organizations, such as the 2° Investing Initiative, which explore new tools for assessing climate-related investments. The 2° Investing Initiative is a global think tank for developing climate and long-term risk policy options in the financial markets. Financial institutions can leverage specializations with such organizations to ensure that they are taking note of specific risks to assets or borrowers from local changes, such as energy efficiency regulations.[321] They can also benefit from sustainable investing through such partnerships, where risk assessment for financial portfolios and climate financial policies and frameworks can be developed together with subject matter experts. At the regional scale, such collaborations can also help smoothen the transition of climate solutions into investment and financial choices on the ground.

[319] ibid.
[320] ibid.
[321] 'About Us' (*2 Degrees Investing Initiative*) <https://2degrees-investing.org/about-us/> accessed 3 May 2021.

vii. Improving the Investment Climate

Structural simplification

It is essential for governments to take the lead in partnering with the private sector so as to take a leap of faith towards sunrise industries. When governments create long-term economic plans to encourage foreign investment for climate change technologies, it would be necessary to co-plan with potential private investors, understanding and adapting to the private sector's concerns and requirements that would ultimately benefit stakeholders in the long run. This can reduce structural barriers to entry between investors and businesses, while allowing the government to improve their policy structures to evolving needs between the various industries. In many cases, business and technological firms may be unfamiliar with the quality or technical standards required by larger foreign firms and thus have difficulty entering supply chain agreements and investment with them. Innovative, targeted, and cost-efficient ways can be used to engage the private sector and break down information barriers between business, government, and investors.

Training is a valuable way to encourage linkages and reduce an investor's barriers to entry. Programs should be carefully designed with input from both investors and stakeholders and built around regular dialogue to ensure that problems are identified and solved.[322]

For example, we can observe the German solution for rapid and efficient mobilization of wind turbines and solar cells in its industries. The nature of the policies employed and the political process which led to the adoption of these instruments was accelerated through four steps: institutional change in the form of research and design policies, formation of markets in the form of protected niches, entry of firms and establishment of an advocacy coalition. The value of this was not just in the rate at which the new technology was diffused or simplified, but in the opportunities for experimentation, learning and formation of a future renewable industry.[323]

[322] OECD, *Policy Framework for Investment* (2015 Edition, OECD Publishing 2015) 44–45 <https://www.oecd-ilibrary.org/finance-and-investment/policy-framework-for-investment-2015-edition_9789264208667-en> accessed 2 May 2021.

[323] Staffan Jacobsson and Volkmar Lauber, 'The Politics and Policy of Energy System Transformation--Explaining the German Diffusion of Renewable Energy Technology' (2006) 34 Energy Policy 256.

Centralised Investment Platform

Taking the lead from the example of Singapore's Economic Development Board (EDB), governments can create centralised investment platforms for climate change technologies to spur businesses forward. The EDB serves as the "one-stop agency" for companies seeking to invest in Singapore, formulates and implements economic strategies for the country, and selects potential investors in alignment with its economic strategy. This centralized institution is unique in the role as it involves the private sector in strategy and policymaking. The connection between them and the government also signals to potential investors the importance of investment attraction to the country, and drives inter-agency cooperation, which leads to faster response time and more efficient use of resources.[324] This ultimately reduces the barriers of entry for investors should policies be required to aid the growth for Special Environmental Zones in new regions.

IV.III CONCLUSION

Former US President Barack Obama has said that we are the first generation to feel the effects of climate change and the last generation that can do something about it. By investing in climate change technologies to propel economies to transition and reduce carbon emissions as soon as possible, we will not just be able to provide greater opportunities for all of society, but also another chance for humanity.

[324] David Moloney and Sandra Octaviani, 'Investment Attraction: Learning from "Best Practice" Jurisdictions' (Lawrence National Centre for Policy and Management 2016) <https://www.ivey.uwo.ca/cmsmedia/2758461/investment-attraction-learning-from-best-practice-jurisdictions.pdf>.

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