The Green Metaverse as a Central Bank net-zero delivery mechanism

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EXECUTIVE SUMMARY

This essay explores the role and function of Central Banks in delivering *net-zero climate neutrality in conjunction with global sustainability* (collectively referred to here as "green finance").

A system thinking approach is applied to reviewing the Central Bank challenge in delivering a green finance solution, with special reference to sustainability and achieving net-zero, in terms of policy development advice to governments and regulatory and advisory guidance to the financial industry.

The following key questions and objectives are explored:

- What are the primary challenges posed to central banks and what could be a recommended strategy going forward?
- Understanding green finance and the definition of "green concepts";
- Progress made in delivering on the 2015 Paris Agreement;
- Progress made in delivering the UN Global Goals, also known as the Sustainable Development Goals or SDGs?;
- Understanding the "net-zero equation" and the required solution;
- Explaining the net-zero equation, solving it and delivering upon it;
- The composition of an affordable and deliverable net-zero transition strategy.

In order to support delivery of a suitable green strategy, which is taking full cognizance of the issues listed above (and to be further discussed in this essay), a generic decision support system is introduced in which the Metaverse is used as ***an advanced virtual collaboration environment.*** This environment, referred to in this essay as the *Green Metaverse Impact Investment Platform* (GMViiP), incorporates a process of generating ***green concepts*** (sustainability and net-zero) using well-tested frameworks, with resulting investment models delivered across a range of application areas.

The underlying material to the proposed solution, referred to as ***Green Concepts***, had been developed over a twenty year plus period, through focused consulting in sustainability and climate neutrality finance in sub-Sahara Africa and the United Kingdom. Application extended over a range of areas including water, renewable energy, health, agriculture, biodiversity, waste, infrastructure, buildings and forestry[1].

Advances in technology have enabled continuous updating of sustainability finance tools and techniques, enabling the current opportunity of considering future growth in the metaverse.

[1] The twenty-year journey is described in the book – "Blackgoo to Blockchain – Sustainability Finance in Practice - A Personal Journey", with a free download available at www.scniic.com

1 CENTRAL BANKS – GREEN FINANCE CHALLENGE

Nick Robins, Simon Dikau and Ulrich Volz in their March 2021 Policy Report – *"Net-zero central banking: A new phase in greening the financial system*" offer a number of key messages and summary recommendations:[2]

Reaching net-zero greenhouse gas emissions is a critical goal of climate policy.

Across the world, growing numbers of governments are introducing targets and plans to achieve net-zero around the middle of this century. Alongside this, leading banks and investors are committing to align their portfolios with net-zero by 2050. As guardians of the financial system, central banks and supervisors also need to introduce explicit strategies to support the transition to net-zero as the next stage in confronting the risks of climate change.

The rationale for central banks and supervisors is two-fold:

First, achieving a net-zero economy is the best way of minimising the risks of climate change to the stability of the financial system and the macro-economy; and

Second, central banks and supervisors need to ensure that their activities are coherent with net-zero government policy. The first signs of financial authorities starting to align their operations with net-zero are beginning to emerge; a systematic approach is now required.

IMPLEMENTING NET ZERO CENTRAL BANKING

Robins et al suggests seven action areas for the implementation of net-zero central banking, providing the first reference framework to be applied in the generation of ***green concepts*** on the SCNiiC Metaverse Platform.

1.Strategy and Policy coordination

- Develop a net-zero strategy, with a roadmap of actions including long-term expectations and near-term actions
- Promote liaison and coordination between central banks, supervisors and policymakers on net-zero

Central banks and supervisors need to develop a net-zero roadmap including long-term expectations and near-term actions. This would include the promotion of liaison and coordination between central banks, supervisors and policymakers on net-zero.

[2] Nick Robins is Professor in Practice, Sustainable Finance at the Grantham Research Institute on Climate Change and the Environment. Ulrich Volz is Director of the Centre for Sustainable Finance and Reader in Economics at SOAS, University of London Change and the Environment. Simon Dikau is a Research Officer at the Grantham Research Institute on Climate Change and the Environment. Ulrich Volz is Director of the Centre for Sustainable Finance and Reader in Economics at SOAS, University of London.

In many regards, financial institutions need clear signals from central banks and supervisors concerning expectations on net-zero pathways, including transition scenarios, alignment targets and timeframes. In addition, central banks and supervisors will need to play a key role in shaping the tools, methodologies, data systems and taxonomies required for net-zero. Providing independent advice to governments on what the financial system needs to do to facilitate the transition will be a vitally important role for central banks and supervisors, in terms of real economy policies
(e.g. carbon pricing), but also in terms of financial system reforms to achieve an effective intermediation of net-zero investment. Retrofitting Europe's building stock is a case in point.

2. Prudential regulation:

Prudential supervisors should make net-zero a core element of supervisory practice at micro and macro levels, aligning supervisory expectations and prudential instruments with net-zero. This could involve requiring all regulated financial institutions to submit net-zero transition plans, as well as addressing climate risks in regulatory ratios. Disclosure frameworks such as that of the Task Force on Climate-related Financial Disclosures (TCFD) will also need to include net-zero.

One way of implementing a net-zero approach through supervisory policy would be to require all regulated financial institutions (banks, insurance firms, pension funds, asset managers) to submit net zero transition plans [3] (Caldecott, 2020; Robins, 2020).

Transition plans can serve as an important risk management tool and should be required by supervisors from financial institutions as evidence of the ability to manage the risks from a net-zero transition. Transition plans are important for micro prudential supervision as they help to establish a strategic approach to climate risk management.

Authorities would then act to manage the financially-related risks of these exposures and signal the need for action by misaligned firms, for example through the use of adjustments to capital requirements and risk buffers. In effect, supervisors would be focusing on the risk of *not* achieving net-zero and the consequences that this will have for both micro- and macro financial stability. Ultimately, a net-zero approach would require prudential policy to put a higher risk weight on assets that are not compatible with net-zero for prudential reasons.

Strengthening disclosure standards

In terms of disclosure requirements, which provide the basis for numerous prudential measures, the recommendations of the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) are the most widely accepted framework. The TCFD's most recent guidance on scenario analysis [4]and its consultation on forward-looking metrics [5]acknowledge the relevance of net-zero due to growing demand from investors. However, to make the TCFD an adequate disclosure framework for net-zero prudential policy and for helping manage systemic climate risk in the financial system, net-zero needs to be made a core component of all four pillars of the TCFD recommendations.

[3] (Caldecott, 2020; Robins, 2020). With the TCFD in its fifth year, it's time to make 'net zero' mandatory for financial institutions. *Responsible Investor*, 29 July. https://www.responsible-investor.com/articles/with-the-tcfd-in-its-fifth-yearit-s-time-to-make-net-zero-mandatory-for-financial-institutions

[4] Task Force on Climate-related Financial Disclosures - *Guidance on Scenario Analysis for Non-Financial Companies.* TCFD. https://assets.bbhub.io/company/sites/60/2020/09/2020-TCFD_Guidance-Scenario-Analysis-Guidance.pdf

[5] Task Force on Climate-related Financial Disclosures [TCFD] (2020b) *Forward-Looking Financial Sector Metrics -Consultation*. TCFD.

The nature of climate risks and the difficulty of modelling the financial stability implications is making it difficult but not impossible for central banks and supervisors to move from acknowledgment to concrete policy action[6]

Policy needs to build on comprehensive disclosure frameworks to enable the identification of risks and on forward-looking, scenario-based methodologies for risk analysis, such as stress-tests.

3. Scenarios

Forward-looking scenarios need to become more consistent with a net-zero pathway to limiting warming to 1.5°C. Central banks and supervisors need to signal clearly that they are not indifferent to the outcome (e.g. whether net-zero is achieved or not) and complement long term scenarios with short-term outlooks.

The climate scenarios recently developed by the [7]mark a major step forward for climate risk analysis. These now need to become more consistent with a net-zero pathway to limiting temperature rise to 1.5°C.

Building on the current NGFS climate scenarios, scenarios could be deployed to highlight the implications of alternative routes to net-zero, which are more or less disruptive for the financial system (e.g. early or late action).

4. Monetary policy

Central banks need to consistently integrate climate change into monetary frameworks and models to adequately account for the impacts of climate change on macroeconomic outcomes. In addition, central bank instruments and policy portfolios need to become operationally aligned with net-zero.

Net-zero alignment for monetary policy means: first, taking the net-zero transition into account within monetary frameworks and models to ensure effective price and financial stability targeting; and second, making sure that central bank instruments and policy portfolios become operationally aligned.

Central banks are increasingly prepared to take account of climate-related risks in monetary policy [8]. Climate change can influence key macroeconomic variables, including output, consumption, investment, productivity, employment, wages, international trade, exchange rates, inflation and inflation expectations[9]. One observer has suggested that the net-zero transition is set to have potentially profound implications for prices, with indications that the expansion of renewable energy could have a significant deflationary effect [10]

According to De Nederlandsche Bank governor Klaas Knot, “central banks can also help to correct the carbon bias in capital markets” and can “explore how […] they can redesign their monetary policy

[6] Finance Watch (2020) *Breaking the climate-finance doom loop*. Finance Watch, Brussels. https://www.financewatch.org/publication/breaking-the-climate-finance-doom-loop/

[7] Network for Greening the Financial System [NGFS] (2020a) *NGFS Climate Scenarios for central banks and supervisors.* NGFS, Paris. https://www.ngfs.net/en/ngfs-climate-scenarios-central-banks-and-supervisors

[8] Network for Greening the Financial System [NGFS] (2020b) *Survey on monetary policy operations and climate change: key lessons for further analyses*. NGFS, Paris. https://www.ngfs.net/en/survey-monetary-policyoperations-and-climate-change-key-lessons-further-analyses

[9] (NGFS, 2020c) Network for Greening the Financial System [NGFS] (2020c) *Climate change and monetary policy. Initial takeaways.* https://www.ngfs.net/en/climate-change-and-monetary-policy-initial-takeaways

[10] Lewis M (2020) Renewables bring deflation to the energy sector. *Financial Times*, 16 December.

instruments to prevent such biases from occurring, and instead contribute to unlocking more green investments"[11].

Banque de France Governor Francois Villeroy de Galhau has set out the need for "decarbonizing the ECB's balance sheet in a pragmatic, gradual and targeted manner for all corporate assets, whether they are held on the central bank's balance sheet or taken as collateral", and the need to define decarbonisation methods and targets[12]. A number of proposals have been made to bring monetary operations into line with net-zero including, in the EU context, the design of green 'targeted longer-term refinancing operations' (TLTROs)[13] the greening of corporate bond purchases [14]and the greening of collateral frameworks[15]. These proposals are increasingly recognised by European central bankers.

To support the reallocation of capital that is needed, access to monetary operations could be made contingent on companies committing to a credible net-zero transition plan.

5. Portfolio management

Sustainable and responsible investment practices for central banks' portfolios should include a net-zero target and central banks should each publish a transition plan to achieve this.

The recent NGFS progress report on the implementation of sustainable and responsible investment practices in central banks' portfolio management shows that considerable progress has been made by some central banks in aligning their own portfolios, followed by the policy portfolios held for foreign exchange intervention and/or financial returns, and pension portfolios (NGFS, 2020d)[16].

The Banque de France also established a Responsible Investment Committee in 2020, which regularly reviews the responsible investment strategy in light of emerging issues, such as fossil fuel exclusions, biodiversity and broader social aspects[17].

6 Just transition

Central banks should explore the implications of net-zero for jobs and livelihoods to mitigate potential downside sectoral and regional consequences.

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[11] Knot K (2021) *Getting the Green Deal done: how to mobilize sustainable finance*. Keynote address by Mr Klaas Knot, President of the Netherlands Bank (DNB), at an open event organized by Bruegel, 11 February 2021. De Nederlandsche Bank, Amsterdam.

[12] Villeroy de Galhau F (2021a) *The role of central banks in the greening of the economy*. Speech by Mr François Villeroy de Galhau, Governor of the Bank of France, at the 5th edition of the Rencontres on 'Climate Change and Sustainable Finance', organised jointly with Option Finance. Paris, 11 February 2021. Banque de France, Paris.

[13] (Senni, 2021; van 't Klooster and van Tilburg, 2020) *The Case for Climate Objectives in Central Banks' Targeted Refinancing Operations.* Council on Economic Policies, Zürich. https://www.cepweb.org/the-case-for-climate-objectives-in-central-bankstargeted-refinancing-operations/

[14] Dafermos Y, Gabor D, Nikolaidi M, Pawloff A, van Lerven F (2020) *Decarbonising is Easy. Beyond Market Neutrality in the ECB's Corporate QE.* New Economics Foundation, London. https://neweconomics.org/2020/10/decarbonising-is-easy

[15] (Monnin, 2020; Oustry et al., 2020) *Shifting Gears: Integrating Climate Risks in Monetary Policy Operations* (No. 2020/01), Policy Brief. Council on Economic Policies, Zürich. https://www.cepweb.org/shifting-gears-integrating-climate-risks-inmonetary-
policy-operations/

[16] (NGFS, 2020d) Network for Greening the Financial System *Progress report on the implementation of sustainable and responsible investment practices in central banks' portfolio management.*
https://www.ngfs.net/en/progress-report-implementation-sustainable-and-responsible-investmentpractices-central-banks

[17] Network for Greening the Financial System [NGFS] (2019) *A call for action. Climate change as a source of financial risk. First comprehensive report*. NGFS, Paris. https://www.mainstreamingclimate.org/publication/ngfs-a-callfor-action-climate-change-as-a-source-of-financial-risk/

Central banks also have a role to understand the socioeconomic implications of achieving net-zero and the role that the financial system could play to ensure that the process is inclusive in terms of employment and regional development.

Moreover, central banks and supervisors can play an important role in facilitating a just transition by supporting inclusive green finance[18].[19]

7. International cooperation

Net-zero needs to be incorporated into key international financial and regulatory frameworks and processes. There is also potential for partnerships with multilateral development banks in developing and emerging economies.
Net-zero is a global imperative, and monetary and financial authorities in all parts of the world will need to develop their own strategies for net-zero that combine a stability focus along with policy coherence, calibrated to national legal and institutional frameworks.

CONCLUSIONS

There is a dual rationale for action:

First, recognising that achieving a net-zero economy is the best way of minimising the risks of climate change to stability of the financial system and the macroeconomy; and

Second, making sure that central banks and supervisory activities are coherent with net-zero government policy.

Monetary and financial authorities will need to play a pivotal role in shaping the tools, methodologies, data systems and taxonomies required for net-zero. Crucially, they also need to align their own policies and operations with net-zero.

[18] (Volz, Knaack et al., 2020) Volz U, Ahmed SJ (2020) *Macrofinancial risks in climate vulnerable developing countries and the role of the IMF –Towards a joint V20-IMF Action Agenda*. SOAS Centre for Sustainable Finance, Global Center on Adaptation,and Munich Climate Insurance Initiative. London, Rotterdam and Bonn. https://www.v-20.org/resources/macrofinancial-risks-in-climate-vulnerable-developing-countries-and-the-role-of-the-imftowards-a-joint-v20-imf-action-agenda

[19] Volz U, Beirne J, Ambrosio Preudhomme N, Fenton A, Mazzacurati E, Renzhi N, Stampe J (2020) *Climate changeand sovereign risk*. SOAS University of London, Asian Development Bank Institute, World Wide Fund for Nature Singapore, and Four Twenty Seven, London, Tokyo, Singapore, and Berkeley, CA. https://eprints.soas.ac.uk/33524/1/Climate%20Change%20and%20Sovereign%20Risk_final.pdf

2 GREEN FINANCE AND GREEN CONCEPTS

Green finance is any structured financial activity – a product or service – that's been created to ensure a better environmental outcome. It includes an array of loans, debt mechanisms and investments that are used to encourage the development of green projects or minimize the impact on the climate of more regular projects. Or a combination of both.

For the banking sector, green finance is defined as financial products and services, under the consideration of environmental factors throughout the lending decision making, ex-post monitoring and risk management processes, provided to promote environmentally responsible investments and stimulate low-carbon technologies, projects, industries and businesses[20]

Green financing is to increase the level of financial flows (from banking, micro-credit, insurance and investment) from the public, private and not-for-profit sectors to sustainable development priorities. A key part of this is to better manage environmental and social risks, take up opportunities that bring both a decent rate of return and environmental benefit and deliver greater accountability[21].

The main areas for the current work on green financing are:

- Supporting public sector in creating an enabling environment
- Promoting public-private partnerships on financing mechanisms such as green bonds
- Capacity building of community enterprises on micro-credit and participation of decentralised autonomous organisations (DAOs).

For the United Nations, green financing plays an important role in delivering several of its Sustainable Development Goals. Its Environment team is focused on working with public and private sector organisations in an attempt to align to the sustainable development agenda.

Some of the activities UN Environment is involved in, include helping countries re-engineer their regulatory frameworks and helping steer public sector planning in a more environmentally friendly direction.

Typical projects that fall under the green finance umbrella include:

- Renewable energy and energy efficiency;
- Biodiversity conservation;
- Pollution prevention and control;

[20] Pricewaterhouse Coopers Consultants (PWC) (2013): Exploring Green Finance Incentives in China, PWC

[21] Refer UN Environment Program website: https://www.unep.org/regions/asia-and-pacific/regional-initiatives/supporting-resource-efficiency/green-financing

- Circular economy initiatives;
- Sustainable use of natural resources and land.

The UK launched the Green Finance Strategy on 2 July 2019.[22]

The Strategy is an ambitious package, bringing together work from across the government, regulators and the private sector. It has 3 core elements:

- greening finance: ensuring current and future financial risks and opportunities from climate and environmental factors are integrated into mainstream financial decision making, and that markets for green financial products are robust in nature
- financing green: accelerating finance to support the delivery of the UK's carbon targets and clean growth, resilience and environmental ambitions, as well as international objectives
- capturing the opportunity: ensuring UK financial services capture the domestic and international commercial opportunities arising from the 'greening of finance', such as climate related data and analytics, and from 'financing green', such as new green financial products and services.

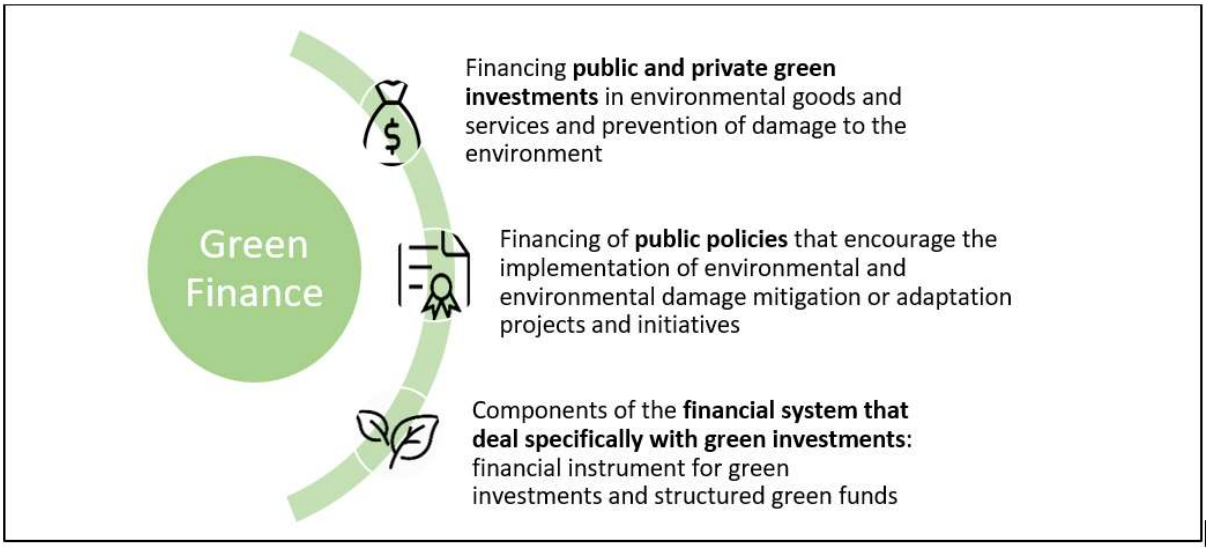
According to green finance platform[23] is one that creates, values and transacts financial assets in ways that shape real wealth to serve the long-term needs of an inclusive, environmentally sustainable economy. Green finance then refers to any financial instruments whose proceeds are used for sustainable development projects and initiatives, environmental products and policies under the single goal of promoting a green economic transformation toward low-carbon, sustainable and inclusive pathways.

Two main goals of green finance are to internalize environmental externalities and to reduce risk perceptions. Promoting green finance on a large and economically viable scale helps ensure that green investments are prioritized over business-as-usual investments that perpetuate unsustainable growth patterns. Green finance encourages transparency and long-term thinking of investments flowing into environmental objectives and includes all sustainable development criteria identified by the UN Sustainable Development Goals (SDGs).

Green finance covers a wide range of financial products and services, which can be divided into investment, banking and insurance products. The predominant financial instruments in green finance are debt and equity. To meet the growing demand, new financial instruments, such as green bonds and carbon market instruments, have been established, along with new financial institutions, such as green banks and green funds. Renewable energy investments, sustainable infrastructure finance and green bonds continue to be areas of most interest within green financing activities.

[22] https://www.gov.uk/guidance/green-finance

[23] https://www.greenfinanceplatform.org/page/explore-green-finance



Reference: Lindenberg, Nannette, Definition of Green Finance (April 15, 2014). DIE mimeo, 2014. Available at SSRN: https://ssrn.com/abstract=2446496

The systemic risk posed by the climate crisis to financial services requires decisive action and a rapid pivot towards the opportunities presented by the zero-carbon economy. Box-ticking, sloganeering, greenwashing and relying on the heroic efforts of individuals won't achieve the scale of the transformation required. Cross-sector collaboration and the focused application of the creativity, innovation and skills of the financial services industry to finance the global transition will."[24]

[24] Dr Rhian-Mari Thomas OBE CEO GREEN FINANCE INSTITUTE

3 GREEN FINANCE – PROGRESS STATUS

It is now generally agreed that climate change is a global emergency that goes beyond national borders. It is an issue that requires international cooperation and coordinated solutions at all levels.

In this section we review the current status of three important elements of the global green finance ecosystem:

- Progress made in the delivering on the 2015 Paris Agreement;
- Delivering of Sustainable Development Goals (SDGs);
- Net-Zero transition finance

The 2015 Paris Agreement

To tackle climate change and its negative impacts, world leaders at the ***UN Climate Change Conference (COP21)*** in Paris reached a breakthrough on 12 December 2015: the historic ***Paris Agreement***.

The Agreement sets long-term goals to guide all nations:

- substantially reduce global greenhouse gas emissions to limit the global temperature increase in this century to 2 degrees Celsius while pursuing efforts to limit the increase even further to 1.5 degrees;
- review countries' commitments every five years;
- provide financing to developing countries to mitigate climate change, strengthen resilience and enhance abilities to adapt to climate impacts.

The Agreement is a legally binding international treaty. It entered into force on 4 November 2016. Today, 193 Parties (192 countries plus the European Union) have joined the Paris Agreement.

The Agreement includes commitments from all countries to reduce their emissions and work together to adapt to the impacts of climate change, and calls on countries to strengthen their commitments over time. The Agreement provides a pathway for developed nations to assist developing nations in their climate mitigation and adaptation efforts while creating a framework for the transparent monitoring and reporting of countries' climate goals.

The Paris Agreement provides a durable framework guiding the global effort for decades to come. It marks the beginning of a shift towards a net-zero emissions world. Implementation of the Agreement is also essential for the achievement of the Sustainable Development Goals.

The Paris Agreement has survived the US withdrawal and normalised net zero, but emissions are still rising and vulnerable people are suffering from climate disasters.

Here are five things the Paris Agreement has achieved — and five things still to work for[25].

1) Political resilience

There is no doubt that president Donald Trump withdrawing the US from the Paris Agreement was a body blow.

For his four-year term, the world's second highest emitter would not pull its weight in carbon cuts, giving cover to others to slack off.

But the move did not, as some feared it would, lead to an exodus of like-minded nationalists from the pact. Even Jair Bolsonaro, Brazil's deforester-in-chief, was persuaded to stay in. The US stood alone — but has subsequently re-joined under president Biden.

The structure of voluntary national contributions and a common accountability framework, with an ambition "ratchet" every five years, is working more or less as intended.

2) Normalising 1.5C

One of the biggest surprises of Paris was the inclusion of 1.5C as an aspirational limit on global temperature rise.

Long demanded by the most vulnerable island states as essential to their survival, 1.5C had previously been brushed aside as infeasible by bigger powers. 2C was the moderate, reasonable target.

The Intergovernmental Panel on Climate Change was invited to produce a special report on the science of 1.5C. Published in 2018, it reinforced the difference half a degree would make to millions of lives.

Official recognition of 1.5C did not make it any less of a long shot to get there. But it shifted the onus away from proponents of 1.5C having to defend its feasibility, to proponents of 2C having to defend sacrificing vulnerable communities.

3) Normalising net zero

Net zero emissions is fast becoming a buzzword of the twenty first century, with China, Japan and South Korea joining the EU and UK in setting carbon neutrality goals.

This trend has its roots in the Paris Agreement. It got less attention than the temperature goal at the time, obscured as it was by jargon, but signatories did agree to ultimately go carbon neutral.

The aim is "*to achieve a balance between anthropogenic emissions by sources and removals by sinks … in the second half of the century*".

It translates the global warming limit into a more practical milestone, with implications for investments today.

[25] https://www.climatechangenews.com/2020/12/09/five-years-five-things-paris-agreement-achieved-didnt/

If you are aiming for zero in 30 years, it makes no sense to build a polluting coal plant, oil pipeline or LNG terminal with a typical lifespan of 40 years or more.

4) Clean energy shift

The financing landscape has shifted decisively in favour of clean energy.

Paris sent the signal that clean technology improvements were a worthwhile — and safe — investment, while fossil fuels were increasingly risky. This years' coronavirus crisis reinforced the message.

In spring 2015, former UN climate chief Yvo de Boer said coal plants were still the "logical choice" for developing countries. In 2020, the notoriously conservative International Energy Agency hailed wind and solar power as more resilient than fossil fuels to a Covid-induced demand slump.

Asian financial institutions are starting to follow their western counterparts in blacklisting coal, a stance recently endorsed by China's environment ministry.

Clean energy supermajors are overtaking oil companies in terms of market value. Forecasters are naming earlier dates for peak oil demand, with some in the industry entertaining the idea demand may never return to pre-pandemic levels.

5) Institutional change

The Paris Agreement has no central enforcement mechanism. That does not mean it is unenforceable.

Institutions ranging from financial regulators to city authorities are embedding the deal's targets and principles in their policies, creating new avenues for accountability.

More than 400 public development banks committed to align their activities with the Paris deal and a handful of Asian hold-outs are under increasing pressure to follow suit.

The EU has made compliance with Paris a condition of every free trade agreement struck since 2015 — and Brazil's backsliding on deforestation is a potential barrier to ratification of its deal with the Mercosur bloc.

Lawyers are citing the deal in court cases around the world. And in the UK, they are testing whether it can be used to block the expansion of Heathrow Airport.

However, any sense of optimism about the progress driven by the Paris deal must be tempered by the harsh reality of how far there is to go.

Here is what has yet to change:

1) Rising emissions

Global greenhouse gas emissions have continued to grow, with a billion tonnes of CO2 added to annual figures between 2015 and 2018.

The trend is dominated by emerging economies in Asia, as incumbent energy industries meet a hunger for development by any means.

A plateau in China's emissions from 2014-16 raised hopes of decoupling its economic growth from pollution, but the numbers then resumed their rise.

Advanced economies are not cutting emissions fast or consistently enough to offset growth elsewhere.

A drastic reduction in travel and economic activity across much of the world for several months of 2020, to curb the spread of coronavirus, is only projected to cut global energy-related CO2 emissions by 7% year-on-year.

That pace would need to be sustained in the absence of a deadly pandemic to meet the 1.5C goal.

2) Rising temperatures

As emissions rise, so too do temperatures. 2020 was 1.2C warmer than pre-industrial times and among the three hottest years on record, despite the cooling effect of La Nina.

The word "unprecedented" keeps coming up in weather coverage. Wildfires in the Arctic. Cyclones hitting parts of Africa that are not prepared. Droughts and floods confounding subsistence farmers the world over.

Scientists have got more confident and assertive about attributing these extremes to global heating. In the case of one deadly Japanese heatwave in 2019, modellers found it simply would not have happened without human influence on the climate.

The atmosphere will keep serving up new records for generations. Temperatures will not stabilise until emissions reach net zero, because carbon dioxide builds up in the air.

3) Rising fossil fuel production

The phrase "fossil fuels" does not appear in the Paris Agreement. Nor do the words "coal", "oil" or "[methane] gas".

To meet the Paris goals, the vast majority of hydrocarbons need to stay in the ground — but that was too blunt a reality to concede for countries economically reliant on them.

While the coronavirus crisis has cast considerable uncertainty over the future for coal, oil and gas markets, many governments are doubling down on polluting sectors.

Producers have a perverse incentive to exploit their reserves quickly while they still can — a clearance sale. That carries risks for workers, communities and citizens dependent on oil revenues, as well as for the climate.

With Paris ill-equipped to address this dynamic, some are calling for an OPEC-style deal for a managed decline of fossil fuel production.

4) The vulnerable suffer

Within and between countries, it is poor and marginalised people who are most exposed to the climate crisis.

The Paris Agreement is not all about cutting emissions. It covers adapting to the impacts of climate change and acknowledges that some people will experience loss and damage that cannot be mitigated against or adapted to. It calls on developed countries to support poorer nations with finance, technology and training.

Climate finance flows from rich governments have increased on the face of it, but the majority is delivered as loans, not grants, adding to the debt burden of developing countries. Greening growth in middle income countries eternally takes priority over protecting the poorest from a problem not of their making.

There is no compensation for victims of climate disaster, only talking shops and insurance schemes they must pay the premiums for.

More solidarity is needed to make the deal work for vulnerable communities.

5) International transport gets away

Early drafts of the Paris Agreement explicitly called on the UN bodies responsible for international aviation and shipping to set sectoral emission reduction targets and policies to deliver them. That text did not make the final cut.

The International Civil Aviation Organization (ICAO) and International Maritime Organization went on to negotiate climate deals, but neither are aligned with a 1.5C or 2C global warming limit.

Initial steps to implement those deals further watered down ambition, while ICAO lashed out at climate critics on social media.

In both forums, industry dominates while civil society observers and media operate under tight restrictions. Policymakers belong to the same elite class as frequent flyers, while shipping is out of sight, out of mind.

The two sectors' carbon footprint, currently around 5-6% of global emissions, is set to grow and will increasingly stand out in the absence of stronger action.

Progress made in delivering on the UN Global Goals, also known as the Sustainable Development Goals or SDGs?;[26]

The Sustainable Development Solutions Network (SDSN) published the seventh edition of its annual Sustainable Development Report, which includes the 2022 SDG Index, the 2022 International Spillover Index, and Dashboards. The 508- page report warns that "for the second year in a row, the world is no longer making progress on the SDGs." It shows that the "multiple and simultaneous" crises spanning the areas of health, climate, biodiversity, and geopolitics have hit poor and vulnerable countries hardest, and presents a global plan to finance sustainable development.

The SDSN's 2021 report documented the first reversal in progress since the SDGs were adopted in 2015. This year's report reveals a further decrease in the global average country score on the SDG Index, mainly due to the impacts of the COVID-19 pandemic on SDG 1 (no poverty) and SDG 8 (decent

[26] http://sdg.iisd.org/news/sdg-progress-halted-partnerships-needed-sdsn-report/?utm_medium=email&utm_campaign=SDG%20Update%20-%209%20June%202022&utm_content=SDG%20Update%20-%209%20June%202022+CID_6501638de3223e07abc0c2424ca3b059&utm_source=cm&utm_term=

work and economic growth) and poor performance on SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water), and SDG 15 (life on land).

The report's authors – argue that in addition to "massive humanitarian costs," military conflicts, including the war in Ukraine, affect food security and energy prices and "crowd out space for long-term thinking and investments." "Peace, diplomacy, and international cooperation are fundamental conditions for the world to progress on the SDGs towards 2030 and beyond," they underscore.

Citing decreased development budgets, squeezed by shifts in strategic priorities, especially in Europe, the report outlines a five-point plan to finance the SDGs globally. It recommends that:

- The G20 commit to channelling "far larger flows of financing" to developing countries to support their economic development and help them achieve the SDGs;
- The G20 "greatly increase" the multilateral development banks' (MDBs) lending capacity and annual flows through greater paid-in capital and greater leverage of their balance sheets;
- The G20 bolster SDG finance for the low income countries (LICs) and lower middle income countries (LMICs) through increased official development assistance (ODA), large-scale philanthropy, and refinancing of debts falling due;
- The International Monetary Fund (IMF) and credit rating agencies redesign the assessments of debt sustainability based on developing countries' growth potential and need for "far larger capital accumulation"; and
- Developing countries work with the IMF and MDBs to improve their debt management and creditworthiness by taking measures to prevent future liquidity crises.

The report highlights the SDG Summit 2023 as an opportunity to "define priorities for restoring and accelerating SDG progress by 2030 and beyond," and underlines that "ambitious and sound national targets, strategies, and plans are crucial to turning the SDGs into an action agenda." To support the SDGs, it stresses the need to scale up partnerships and innovations in scientific cooperation and data through increased and prolonged investments in statistical capacities, research and development, and education and skills.

FINANCING THE NET-ZERO TRANSITION

The transition to net zero is not just about mitigating climate change and avoiding risks such as reputational issues or stranded assets. It also presents a huge opportunity for businesses and investors to create and fund innovative technologies and business models, implement efficiencies and take advantage of incentives from governments looking to meet their own targets.

Making the transition to a net zero economy will only be possible with huge financial support and multilateral cooperation. The OECD estimates that we need to invest $6.9 trillion annually in low-carbon, climate-resilient infrastructure – just under $1,000 per year for every person on the planet– and by most estimates, this will only partly solve the problem.

Governments and private-sector firms around the world have committed to achieving net zero with the goal of limiting global warming to 1.5 degrees C. Nearly 200 countries signed the 2021 Glasgow Climate Pact, through which they resolved to "pursue efforts to limit the temperature increase to [1.5 degrees C]."5 At the time of writing, 128 countries, representing 90% of global GDP, have made a net-zero commitment and over 10,000 companies, organizations, or subnational governments have joined the UN Race to Zero, committing to achieve net-zero carbon emissions by 2050, at the latest.

Glasgow Financial Alliance for Net Zero (GFANZ

GFANZ is a global coalition of leading financial institutions committed to accelerating the decarbonization of the economy.

The Glasgow Financial Alliance for Net Zero (GFANZ) was launched in April 2021 by UN Special Envoy for Climate Action and Finance, Mark Carney and the COP26 Presidency, in partnership with the UN-backed Race to Zero campaign launched by UN High-Level Climate Champions Nigel Topping and Gonzalo Muñoz, to unite net-zero financial sector-specific alliances from across the globe into one industry-wide strategic alliance.

Bringing together existing and new net-zero finance initiatives in one sector-wide coalition, GFANZ provides a forum for leading financial institutions to accelerate the transition to a net-zero global economy. Members currently include more than 450 member firms from across the global financial sector, representing more than $130 trillion in assets under management and advice.

As it approaches its one-year anniversary on Earth Day, GFANZ now represents over 450 financial firms, all of which are committed to reaching net zero before 2050. Already, many GFANZ members have released their 2030 interim targets, representing a fair share of the 50% decarbonization required by the end of this decade.

But the window of opportunity for keeping the Paris Agreement's 1.5C goal within reach is rapidly diminishing. As we mark another Earth Day, leaders need to keep the climate crisis at the centre of their deliberations about energy security. In doing so, we might help ensure that finance flows at the pace and scale required to where it is needed most, improving overall economic health and driving long-term sustainable development.

Alignment with Paris Agreement

Since the adoption of the Paris Agreement, financial institutions and other economic actors have taken commitments to 'align' their activities with the goals agreed to by national governments in 2015. A growing body of literature from both the research community and practitioners has emerged on 'alignment' with the Paris Agreement goals – but to date no overarching framework has been proposed to define what it means and implies in practice. This Discussion Paper written by I4CE aims to fill this gap and propose a framework that can be used by all institutions, governments and companies to develop their alignment strategies.[27]

Part of a joint study conducted with the Climate Policy Initiative, this discussion paper proposes a framework that can be used by financial institutions seeking to align strategies and operations with the Paris Agreement.

Building on an analysis of how the Paris Agreement has reframed climate action from a focus on the near-term incremental increase of adaptation and mitigation actions to emphasize the long-term

[27] A Framework for Alignment with the Paris Agreement: Why, What and How for Financial Institutions? A discussion paper by I4CE – Institute for Climate Economics
https://www.i4ce.org/en/publication/framework-alignment-with-paris-agreement-why-what-and-how-for-financial-institutions/

transformation of economies and societies, I4CE's framework for alignment specifies three dimensions for action:

A Comprehensive Scope of Action: institutions should seek to directly or indirectly support low-GHG climate-resilient development across all business areas – and take into account impacts on broader systems and value chains.

***A Long-Term Time Horizon to Guide Impact*:** institutions should prioritize actions that are consistent with both near-term climate objectives and long-term goals and do not lead to lock-in or mal-adaptation.

***An Ambitious Scale of Contribution*:** institutions should seek to contribute to the ambitious goals of the Agreement through activities that:

- **Do No Harm**: all activities should neither hinder nor be counterproductive to the achievement of climate objectives and should be consistent with long-term national sustainable and low-GHG, climate-resilient development pathways;
- **Support Paris-Consistent Climate Co-Benefits**: whenever possible, institutions should prioritize activities with direct or indirect mitigation and adaptation co-benefits that are consistent with the national attainment of the long-term goals of the Paris Agreement;
- **Foster Transformative Outcomes**: whenever possible, institutions should prioritize activities with 'transformative outcomes' that reduce the barriers to and support the large-scale, systemic and structural changes needed for the transition of economic, social and natural systems across and within national economies.

Furthermore, Paris alignment should take into account national contexts and support shared pathways or 'visions' of how long-term climate goals could be met nationally and internationally.

Moving from theory to practice, the paper applies the framework to the case of financial institutions to help understand the implications of aligning with the Paris Agreement and integrating these considerations at the strategic and operational levels.

PUBLIC AND PRIVATE FINANCE

From a report by Dr. Ben Caldecott[28] "Achieving Alignment in Finance", as part of a Thought Leadership Series, sponsored by EiT Climate KIC and the UNEP Finance Initiative[29] , the following extract is taken:

"Governments and government-backed entities will have an important role to play in helping to finance the transition to ACO. The sheer quantity of capital required is one reason. In the energy sector alone, meeting well-below 2°C could require US$1.5 trillion of additional investment per year from now until 2050 (McCollum et al., 2018), up from a total of around US$1.2 trillion of investment in 2019[30] (Buchner et al., 2019). This story is replicated in other sectors and already constrained private sector balance sheets are probably unable to efficiently raise all the capital needed."

[28] Dr Ben Caldecott is the founding Director of the Oxford Sustainable Finance Programme. He is an Associate Professor and Senior Research Fellow at the University of Oxford Smith School of Enterprise and the Environment, a Supernumerary Fellow at Oriel College, Oxford, and a Visiting Scholar at Stanford University. Ben is also the COP26 Strategy Advisor for Finance based out of the UK Cabinet Office

[29] https://www.climate-kic.org/insights/how-can-financial-institutions-move-beyond-climate-risk-management-towards-much-closer-alignment-with-climate-outcomes/

[30] Buchner, B., Clark, A., Falconer, A., Macquarie, R., Meattle, C., & Wetherbee, C. (2019). *Global Landscape of Climate Finance 2019.* Retrieved from https://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2019/

With regards to private finance a further extract is presented:

"While central banks and financial supervisors have shown significant and growing interest in climate-related risks, they have generally shown much less interest in Alignment with Climate Outcomes (ACO). The focus of the Network of Central Banks and Supervisors for Greening the Financial System (NGFS) has primarily been on micro-prudential supervision, and to a lesser extent macro-prudential supervision, followed by monetary policy and financial conduct.
Perhaps the area that has most overlapped with ACO from a NGFS perspective has been growing concern about greenwashing and the mis-selling that could result.

While central banks and supervisors have been more interested in CRM than ACO, there are clearly potential levers they could pull to ensure financial institution and financial system ACO. Sidestepping the question of whether this is within their mandates and assuming they would be given proper instructions from politicians held to account by the public, what could these levers be?
Below is an attempt to outline some of them. It is possibly not now the right time now for central banks or financial supervisors to pull these levers, but there may be a time in the future when this is desirable or even necessary. In the meantime, central banks and supervisors, together with policymakers, should work on these and other related ideas to understand their pros, cons, and delivery challenges. A full assessment of these supervisory options for ACO is beyond the scope here.

Capital charges for ACO – Capital charges for finance provided to incompatible assets could be introduced. This would go beyond aligning capital charges with climate-related risk and would overlay ACO considerations onto the setting of risk weights.

ACO targets for supervised firms – ACO targets for portfolio and loan books could be introduced. Supervisors could ask firms to disclose voluntary targets or they could set mandatory ones. If targets were introduced, they should set out the ultimate destination in terms of the percentage of assets that will be compatible with Paris aligned global warming thresholds for every 5-year period starting in 2020 up to 2050 for a given confidence level. For voluntary target setting, supervisors could require standardised levels of confidence, as well as common metrics and assumptions, to ensure comparability. Supervisors could consider requiring quarterly or even monthly reporting for all supervised firms.

Introduce carbon budgets to ALM and SAA – Risk budgeting is used to guide Asset-Liability Matching and Strategic Asset Allocation. Supervisors could require that carbon budgets be factored into these processes, which would allow institutions to determine the most efficient use of a given carbon budget allocated to their institution. This carbon budget would need to take account of carbon lock-in (see previous sections) and could be introduced voluntarily or compulsorily.

Senior Managers Regime ACO –In a similar way to how the Senior Managers Regime is now used in the UK for climate-related risk management (see Bank of England, 2019), ACO could be added to this framework. This would create clear supervisory oversight and accountability of senior executive management."

In the Conclusions and Recommendations, the following three elements are outlined:

"Three interlocking elements that combined make ACO possible for financial institutions:

• Measuring, tracking and targeting using carbon lock-in approaches for assessing (in)compatibility together with confidence levels for given targets;

• Contributing to alignment through instruments across asset classes actually making a difference to the real economy transition, with financial institutions proactively maximising their impact; and
• Adopting appropriate governance, behaviours, and principles and embedding alignment in overarching strategies and key functions.

Adopting the following recommendations can help ensure financial institutions, wherever they are, and the financial system as a whole, deliver ACO.

Carbon lock-in assessment across all emitting sectors is a robust way of assessing asset, company, or portfolio (in)compatibility and should become a norm.

We should also set and track targets for (in) compatibility in a way that explicitly acknowledges uncertainties. Targets should have confidence levels associated with them and these would quantify how resilient your asset(s) or portfolio(s) are to Paris compatibility if there are changes to asset(s) usage and efficiency, the sector(s) carbon budget, and the global carbon budget.

Financial institutions contribute to alignment through the financial products and services they offer, as well as the investments they make or finance they provide. ACO must also mean demonstrating and measuring these contributions to A (cost of capital), B (liquidity), C (risk management), D (adoption of sustainable practices), and E (spill over effects) much more precisely than hitherto has been the case.

Financial institutions should maximise the contribution they make to the real economy transition by getting as close as possible in practice to the theoretical maximum potential impact their instruments in an asset class can have. Further, financial institutions seeking ACO should maximise the positive real economy impact across all the instruments they have and potentially even seek to optimise their portfolio of instruments to have the most impact on ACO.

Financial institutions should have to systematically review how they can better support ACO and then develop plans to embed alignment in everything they do. This is an ongoing and resource intensive process.

Financial institutions should create board-approved targets and strategies to achieve alignment over time. This should set out the ultimate destination in terms percentage of assets that will be compatible with Paris aligned global warming thresholds for every 5-year period starting in 2020 up to 2050 for a given confidence level.

Boards, senior management teams, portfolio managers and other relevant functions should undertake courses and training, as well as continued professional development, to ensure they have access to the latest skills and knowledge to support ACO.

There should be complete internal and external clarity about the key individuals at a board-level and in senior executive management who are responsible and accountable for implementing, monitoring, and improving ACO over time.

Investors should clearly outline their expectations of investee companies regarding ACO. This should include the expectation that company boards have their own plans, strategies, and targets for ACO, and that these are incorporated into strategic planning and reporting. Financial institutions should promote, and over time require, investee company alignment with the Paris Agreement.

Asset owners should ensure that responsible ownership strategies and practices are built into their passive holdings. This is particularly important as passive funds, unlike active funds, by definition follow the index and have to buy the holdings contained in the index. Active ownership is, therefore, the most powerful tool passive funds have to effect change in investee companies.

Financial institutions should put in place the necessary processes and incentives to implement the above. Financial institutions should also link internal and external manager incentives, including remuneration and renewal of mandates, to progress against ACO.

Achieving ACO will not be possible without every type of public finance adopting the three interlocking elements of alignment set out in this report. Policymakers should urgently review public financing and public financial institutions to ensure public finance is supportive of ACO, in both the quality and quantity of financing available.

Central banks and financial supervisors should explore options for supervising for ACO and develop an understanding of their pros, cons, and delivery challenges. The options should include capital charges for ACO, ACO targets for supervised firms, introducing carbon budgets to ALM and SAA, and integrating ACO into Senior Managers Regimes."

A further contribution on this subject is "Aligning portfolios with climate goals – representing views from McKinsey's Financial Services, Risk & Resilience, and Sustainability Practices."[31]

[31] McKInsey - Aligning portfolios with climate goals – A new approach for financial institution" Sudeep Doshi, Cindy Levy, Dickon Pinner, Carter Powis, and Dan Stephens,

4 ”NET-ZERO EQUATION” AND SOLUTION

McKinsey’s sustainability practice shares an article on why the net-zero equation is not yet solved through commitments and pledges alone. “This can only change if nine interdependent requirements are met with singular resolve, unity, and ingenuity”.[32]

Even as additional and more extensive commitments, including near-term targets, are discussed by key public-, private-, and social-sector entities, the world would need to advance rapidly from what is to be achieved—a net-zero world, within three decades or sooner—to how this can best be done. But moving from commitments to action has not proven easy or straightforward so far. There are five main reasons for this:

First, the required step-up in spend on physical assets (both capital expenditures and consumer spend on durable goods) to reach net zero by 2050 would be substantial. Indeed, we currently estimate this spend to represent an about 60 percent increase relative to today (from an estimated annual $5.7 trillion to $9.2 trillion)[33]. While many of these investments come up with a positive return, financing for this scale of capital needs to be secured. The scale of the challenge is compounded by the speed at which it is required: entire energy- and land-use systems that evolved over a century or two would have to be transformed over the next 30 years.

Second, the transition calls for collective and global action and entails hard choices. This action would need to be taken in a spirit of unity as the burdens of the transition would not be evenly felt, and, for some stakeholders, the costs would be much more difficult to bear than others. Indeed, the effects of climate change and any near-term effects of the climate transition are likely to be regressive and hit the poorest communities and populations the hardest.[34] Without a real effort to address these effects in a spirit of fairness, it appears unlikely that the most affected stakeholders would be either able or willing to do their share to advance the transition. In the words of Frans Timmermans, the European Commissioner for Climate Action: “Without [a] just transition, there will just be no transition.”

Third, stakeholders would need to act now to avoid an unrelenting accumulation and compounding of physical risks in the future, which would require a different time horizon and discount rate than currently guide decisions. The challenge is that there are both perceived and real trade-offs between securing net-zero emissions in the future and capturing growth opportunities today. Indeed, actions to secure the transition are often perceived as costs incurred today, rather than investments in humanity’s collective future.

Fourth, meeting these requirements would involve changing business practices and lifestyles that have been established for decades, if not longer, and that have provided many benefits in the past.

[32] Mekala Krishnan is a partner in McKinsey’s Boston office; Tomas Nauclér is a senior partner in the Stockholm office; Daniel Pacthod, Hamid Samandari, and Humayun Tai are senior partners in the New York office; Dickon Pinner is a senior partner in the San Francisco office; and Sven Smit is a senior partner in the Amsterdam office.

[33] For more, see “Climate risk and response: Physical hazards and socioeconomic impacts,” McKinsey Global Institute, January 16, 2020, on McKinsey.com. See also: Mekala Krishnan and Jonathan Woetzel, “Climate change hits the poor hardest. Here’s how to protect them,” World Economic Forum, October 14, 2020, weforum.org.

[34] See also: Mark Carney, “Breaking the tragedy of the horizon – climate change and financial stability – speech by Mark Carney,” Bank of England, September 29, 2015, bankofengland.co.uk.

Shifting these patterns and overcoming the prevailing inertia—without immediate benefits necessarily accruing differentially to those who make the shifts— has so far proven elusive.

Together, these four factors highlight why the prevailing notion of (enlightened) self-interest alone is unlikely to be sufficient to help achieve net zero.

Finally, the central role of energy in all economic activity and the profound consequences that disruptions to energy markets can entail highlight the criticality of an orderly transition—one where the ramp-down of high-emitting assets is carefully coordinated with the ramp-up of low-emitting ones and which is supported by the appropriate redundancy and resiliency measures. Such a transition, however, is nontrivial, both intrinsically and against the backdrop of other political, economic, and societal issues (see sidebar "What is an orderly transition?"). Indeed, the transition involves the transformation of the most important systems supporting our life and well-being—energy- and land-use systems. Even small disturbances to these systems could affect daily lives, from raising producer and consumer costs to impairing energy access, and could lead to delays and public backlash.

Achieving net zero is, in its essence, solving an equation that balances sources and sinks of emissions by reducing GHG emissions as much as possible while increasing GHG stores to remove any remaining emissions from the atmosphere. This is what we refer to in shorthand as the "net-zero equation." In reality, this is not a single equation but a system of equations, as the emissions equation is *coupled* with a capital and a labour equation; demand for capital and labour in a net-zero economy must match with supply, over time and across regions. These equations
must be solved simultaneously while pursuing economic development and inclusive growth.

This is a nontrivial task both for the reasons noted above and because of a number of technical challenges.

First, the emissions equation is still ***incompletely defined***. The focus has so far been on man-made emissions, but it is becoming increasingly difficult to ignore the natural emissions resulting from biotic feedback loops.

Second, the terms of this equation are a function of time and depend, sometimes nonlinearly, on a host of evolving variables. For example, the emissions associated with a given economic sector or geography depend on existing or yet-to-be-developed technologies that are deployed in them.

Third, the emissions equation is intrinsically ***underspecified*** in mathematical terms. It could theoretically be satisfied with many different combinations of decarbonization and offsetting actions, which would require a greater degree of cross-sector and cross-geography coordination.

Finally, like all real-world systems of equations, these equations are subject to initial and boundary conditions that will, in practice, constrain the solution space. For example, the age and recency of fossil-power assets in a country would influence how easily and quickly they could be ramped down; or the amount of sunshine a certain region receives will constrain its potential to produce solar power.

EXPLAINING THE NET-ZERO EQUATION, SOLVING IT AND DELIVERING UPON IT

Given the complexities involved, a critical step at this juncture is to better understand the fundamental requirements to solve these equations, as well as the interdependencies between these requirements. What we present here is a holistic framework for doing so. ***The framework entails nine key requirements*** . These requirements are not specific to a given sector, and indeed all stakeholders—in the public, private, and social sectors—will need to play a role if they are to be met. They can be seen

as the fundamental chords that would all need to be resolved in concert, if not in unison, for a net-zero transition to materialize.

The nine requirements can be grouped into three categories: —

Physical building blocks,

Encompassing

(1) technological innovation,

(2) ability to create at-scale supply chains and support infrastructure, and

(3) availability of necessary natural resources.

Economic and societal adjustments,

Comprising

(4) effective capital reallocation and financing structures,

(5) management of demand shifts and near-term unit cost increases, and

(6) compensating mechanisms to address socioeconomic impacts. —

Governance, institutions, and commitment

Consisting of

(7) governing standards, tracking and market mechanisms, and effective institutions,

(8) commitment by, and collaboration among, public-, private-, and social-sector leaders globally; and

(9) support from citizens and consumers.

THE COMPOSITION OF AN AFFORDABLE NET-ZERO TRANSITION STRATEGY

In what follows, we address each of these nine requirements in the spirit of the critical, collective quest that must be pursued for the how. While, along the way, we list potential solutions that have been or could be considered, our main focus is on the key questions that would ultimately need to be addressed by the whole world, from individuals to nations and private organizations to public entities. Better questions and answers will come, as they must, if the world is to achieve a more orderly transition to net zero. It is our intent as a firm to contribute to this undertaking by providing analyses of the facts and options available.

Five main conclusions emerge from the examination of these requirements.

First, much of the attention to date has been focused on the first category—physical building blocks—but this needs to be expanded to also encompass the other two categories. In particular, understanding and preparing to address the socioeconomic impacts of the transition appears to be a critical step at this stage. Indeed, there is a very real risk that transition costs and effects would be unbearable to many in the absence of compensating measures; for example, if companies and countries do not manage the shifts in demand or cost impacts to their existing products and services or if communities are left behind as the world transitions to a net-zero economy. There is also a risk that the transition itself is derailed, for example, if sufficient capital is not allocated to low-emissions assets or to responsibly retire high-emissions assets at the pace at which this is needed.

Second, meeting all nine of these requirements is undeniably challenging. Meeting them quickly enough to limit warming to 1.5ºC will be even more so. Achieving net zero will require overcoming traditional orthodoxies and ways of working and developing new ways of working collectively. Constructive actions taken during the pandemic have demonstrated the world's ability to innovate and intervene at scale to support both lives and livelihoods. This challenge will require similar efforts, albeit sustained over multiple years and decades and at a much larger scale.

Third, in the meantime, adaptation and resiliency will be of critical importance. Climate science tells us that, because of inertia in the geophysical system, some amount of additional warming is already locked in over the next decade, regardless of emissions pathway.[35] The world would thus need to fundamentally increase and accelerate efforts toward adaptation, so as to alleviate the more immediate and pernicious impacts of the climate change that has already occurred or is locked in irrespective of any decarbonization action.

Fourth, clear principles will be needed to ensure that the world appropriately balances short-term consequences and long-term benefits: seeking to minimize the capital and operating costs of the transition; actively managing the risk of energy system failures; supporting unequal outcomes across income and demographic groups, countries, and sectors; and driving the transition while sustaining growth and economic development to finance the transition and to enable prosperity and energy access for all.

Fifth, there are no simple silver bullets here. Rewiring the way the world and our economy works is a substantial undertaking and will require all stakeholders to play a role. While specific actions will evolve over time, all stakeholders must begin on their journey now. Indeed, we are starting to see accelerating action in certain sectors. In particular, financial institutions—which play a central role in deploying the capital needed for a net-zero transition—are coming together to set net-zero targets and commitments to climate finance. More broadly, leaders must understand and commit to the transition, including understanding the fundamentals of climate science and the transition and making personal and professional commitments; assess and plan their actions, including through building risk-assessment capabilities and establishing decarbonization plans; reduce and remove emissions in accordance with these plans; conserve and regenerate natural capital to support decarbonization; adapt and build resilience to manage the physical risk that is already locked in; reconfigure and grow, for example, by reallocating capital and ramping down high-carbon businesses responsibly while scaling low-carbon ones; and seek to engage and influence those around them, across their investors, customers, suppliers, peers, and regulators.

PHYSICAL BUIDLING BLOCKS

1. Technological innovation

The present state and rate of climate change is an outcome—or, more precisely, an externality in the language of economics—of humanity's astounding technological progress. Human ingenuity, unleashed over 12,000 years of relative climate stability, has given rise to an unprecedented level of global prosperity. At the same time, this prosperity has come with emissions-intensive forms of production and consumption that cannot be sustained at these levels and rates.[36]

[35] H. Damon Matthews et al., "Focus on cumulative emissions, global carbon budgets, and the implications for climate mitigation targets," Environmental Research Letters, January 2018, Volume 13, Number 1, iopscience.iop.org.

[36] Climate change 2021: The physical science basis, Intergovernmental Panel on Climate Change, August 2021, ipcc.ch.

Yet, just as technological innovation has led us into this crisis, it can also accelerate the recovery. Transforming technologies—across power, mobility, industry, buildings, and agricultural, forestry, and land-use systems—will be essential to reducing global emissions and helping the world achieve net-zero emissions. As one important example, the agricultural sector is in particular need of accelerated innovation to manage its emissions of not only CO2 but also other greenhouse gases such as methane. More generally, low- and zero-carbon technologies would need to be developed, tested, improved, and made cost-effective. Over time, it will be essential to lower unit costs to scale up and achieve broad commercial adoption. And across all technologies, careful planning would be needed to ensure new technologies link with each other and with existing infrastructure (for instance, safely integrating hydrogen into existing gas-pipeline networks or managing grid intermittency with new sources of renewable power).

There are a wide range of views about how technically feasible it is to transition to net zero by 2050. Past McKinsey research suggests that there is a line of sight to the technologies needed to limit warming to 1.5ºC above pre-industrial levels, though continued innovation is still needed[37]

Our work on decarbonization in Europe, for example, found that more than 85 percent of today's emissions in Europe can be abated with already demonstrated technologies, including 28 percent that are mature and 32 percent that are in the early-adoption phase (although, it is important to note that the pathway to deploying these technologies is still uncertain, and would require addressing a host of other requirements, as described in the rest of this article).[38]

Human ingenuity has risen to the needs of the moment in the past, and innovation has the potential to solve the remaining technological challenges ahead of us. However, the remaining challenges should in no way be minimized, as substantial work lies ahead in developing and refining the required technologies and offering solutions that are affordable throughout the globe, subject to evolving constraints on inputs, labour, and capital. It is also important to recognize that—as with the transformative investment booms in railroads, electricity, or the internet—there will be missteps along the way, and, in hindsight, likely misallocation of effort and even of capital. But, given the nature and magnitude of socioeconomic impacts posed by a changing climate, standing still carries significant risk. Viable technologies must be deployed today, and a range of promising technologies must be further developed. Finally, hand-in-hand with the development of mitigation technologies, society would also need to simultaneously prepare for the risk that solutions may not be developed in time to limit warming to 1.5ºC, or even 2ºC, and to develop the technologies needed to manage the physical impacts which may then ensue. In the words of John Holdren, former president of the American Association for the Advancement of Science and an energy and climate expert, "We basically have three choices: mitigation, adaptation, and suffering. We're going to do some of each. The question is what the mix is going to be. The more mitigation we do, the less adaptation will be required and the less suffering there will be.[39]

[37] Kimberly Henderson, Dickon Pinner, Matt Rogers, Bram Smeets, Christer Tryggestad, and Daniela Vargas, "Climate math: What a 1.5-degree pathway would take," McKinsey Quarterly, April 30, 2020 , McKinsey.com. Research from others has had similar findings. Most recently, the World Energy Outlook 2021 from the IEA has found that technological solutions to close the gap with a 1.5C path are available, and that about 40 percent are cost-effective.

[38] Paolo d'Aprile, Hauke Engel, Godart van Gendt, Stefan Helmcke, Solveigh Hieronimus, Tomas Nauclér, Dickon Pinner, Daan Walter, and Maaike Witteveen, How the European Union could achieve net-zero emissions at net-zero cost, December 3, 2020, McKinsey.com

[39] James Kanter and Andrew C. Revkin, "World scientists near consensus on warming," New York Times, January 30, 2007, nytimes.com.

Key questions for stakeholders:

What is the appropriate mix of technologies needed to be deployed to achieve emissions reductions while staying within a "carbon budget," limiting costs, and delivering required standards of performance (for example, ensuring grid stability)?

How does this mix vary across geographies? How will it change over time? —

How market-ready and cost-effective are the technologies needed to get to net zero? What are the greatest gaps that remain to be filled? How would these technologies be best prioritized in terms of their scalability and impact? —

What are the policies, funding structures, demand signals, market mechanisms, and other means necessary to accelerate the maturation of promising early-stage technologies (for example, those that could provide 10x performance improvement), sustain innovation in the later stages of the technology-development journey, and make technologies that are now prohibitively expensive more practicable? —

How can technological uncertainties best be managed? What roles should the public and private sectors play in this regard? Solutions on the table for consideration: —

Accelerate deployment of existing low- and zero-carbon technologies (for example, energy efficiency and renewables in geographies where they remain a small share) by providing incentives and appropriate demand signals. —

Create industry-wide technology roadmaps to reduce uncertainty and align R&D investments, particularly for key technologies such as hydrogen; carbon capture, utilization, and storage; and new forms of electricity storage. —

Facilitate innovation in new technologies by making purposeful, holistically-minded investments in R&D. This requires considering the full basket of technologies needed for net zero, not just those needed to achieve the next milestone (for example, 2025 or 2030). It will require parallel action across the full portfolio of technologies and maintaining perspective of the complete innovation journey— from concept to lab and then to prototype and commercial maturity. —

Foster industrial ecosystems and encourage collaboration across value chains to enable "in the field" innovation and diffusion.

2. Ability to create at-scale supply chains and support infrastructure

To mitigate GHG emissions or remove them quickly, low- or no-carbon technologies would not only need to be created but also need to be widely deployed. Enabling and deploying necessary technologies will, in turn, require scaling up of production and distribution capacity and building out global supply chains. For example, under a 1.5ºC pathway, the number of solar panels installed globally per week would be approximately eight times higher than they are today. The rate of wind-turbine installations would need to be increased by fivefold.[40] Building out supply chains to support that kind of step change requires not only significant capital and the right capabilities but also extensive coordination. While mismatches between the steps that actors take across a supply chain

[40] 4 Kimberly Henderson, Dickon Pinner, Matt Rogers, Bram Smeets, Christer Tryggestad, and Daniela Vargas, "Climate math: What a 1.5-degree pathway would take," McKinsey Quarterly, April 30, 2020, McKinsey.com.

could occur, leading to bottlenecks, shortages, and price increases, effective planning will help limit these mismatches. Additionally, expanded and new infrastructure would have to be built out for low-carbon systems to operate. Consider Europe, where we estimate that the installation rate of public charging stations for electric vehicles would have to increase by a factor of 20 by 2030 to meet the emissions-reduction target for passenger cars. That suggests that capabilities, incentives, and support measures would be needed at an unprecedented pace and scale—even though they cannot be applied on a one-size-fits-all basis. Yet as the recent progress in developing mRNA-based vaccines demonstrates, unprecedented does not mean unachievable. As was the case in response to the pandemic, critical actions along the value chain follow appropriate demand signals, which incentivize producers and help mobilize capital. As discussed above, it is important to accelerate low- and zero-carbon technology deployment today where it is viable. Indeed, deploying and scaling technologies will enable their continued improvement over time, both in terms of performance and costs.

Key questions for stakeholders:

Where are supply-chain and infrastructure bottlenecks most likely to occur, based on existing capacity, the ease of building new capacity, and existing capabilities? —

For each industry or country, how might consequences vary based on the pathway to net zero (for example, mix of technologies deployed)? —

What are the foreseeable consequences of any bottlenecks in terms of shortages or price increases? How severe could these be, and are there particular sectors or geographies most at risk? What forms of preparedness or insurance can be developed in advance to mitigate potential bottlenecks? —

What incentives, demand signals, capability building, and broader measures can help expand production capacity of new technologies at a fast-enough pace? —

As new supply chains are built, what are the implications for trade flows, import dependencies, and national competitiveness? Solutions on the table for consideration: —

Create cross-value chain forecasts and roadmaps that are on the scale of the technology build-up needed, to set consistent targets across industry players and to support multistakeholder coordination and collaboration. —

Encourage and enable collaboration across supply chains and ecosystems to scale production (such as by matching suppliers of new technologies with providers of capital and guaranteed buyers of these technologies).

Stimulate demand from downstream consumers for new low-emissions materials and products in each one of the hard-to-abate sectors (for example, from automotive companies for green steel or from retailers for low-emissions logistics provision) and do so at levels sufficient to create the incentive for at-scale investments and reach cost-reduction tipping points in those sectors by 2030. —

Examine the range and mix of demand signals and financial measures needed to create the appropriate incentives and create certainty about the building-out of supply chains and infrastructure, ideally by taking a test-and learn approach.

3. Availability of necessary natural resources

The deployment of technology and the maintenance and creation of supply chains and support infrastructure—often on a massive scale—will be possible only if sufficient natural resources are available. Three forms will be especially critical. The first is raw materials, both those used in large

quantities today (such as copper and nickel) and those which are currently considered relatively niche (for example, lithium, cobalt, and rare-earth metals). McKinsey analyses show that a net-zero transition would require a substantial increase in the use of some of these raw materials. Resulting constraints, for example, in scaling up production, may lead to temporary shortages and price increases. The second resource is land, which is crucial to building out renewables' capacity. Compared with fossil fuels, renewables require more area per unit of energy output. Replacing a typical gas plant of approximately 1 gigawatt with solar power generating the same amount of electricity, for example, would raise total land use from about 350 acres to approximately 40,000 acres.[41] Even counting the land associated with the entire fossil-power value chain—for example, extraction, transportation, and storage of fossil fuels—total land use would still increase by a factor of five to ten. Land is also crucial for carbon stores and sinks such as forests, peatlands, and mangroves. On the other hand, forest land can contribute to emissions if not well managed, for example, through deforestation or forest fires. This suggests that preserving and regenerating natural capital will need to go hand-in-hand with the technological solutions described above. Importantly, natural, high-quality sinks are largely concentrated in a few geographies, and land often has competing uses, including food production and housing development. Its proper management would therefore require careful planning. Third, water will also be a critical resource. Building an economy that is fuelled in part by hydrogen will require large amounts of water. Water will also be crucial for extracting key minerals. The reliance on water would thus only increase under a net-zero transition, all while water is likely to be in shorter supply, both from increased demand for other uses and, in some geographies, from the reduced precipitation resulting from a changing climate.

Key questions for stakeholders: —

Which natural resources are required for a net-zero transition, and how much would their use increase? How might this vary based on the pathway to net zero (for example, the mix of technologies deployed), under different scenarios, across geographies, and over time? —

Where are there "hard" resource constraints that may limit the scalability of certain technologies? Where are there "soft" constraints that may lead to temporary shortages and price surges? How might this vary across geographies and over time? —

Where might it be feasible to use technological innovation to "engineer out" the use of certain raw materials?

How can worker safety issues and local environmental impacts related to the extraction of key mineral resources best be addressed? —

How can land and water use be managed within and across regions to limit constraints on a net-zero transition while meeting other key needs (such as for population centers and food production)? —

What incentives, demand signals, and broader measures would be needed, both at the national and global levels, to allow for natural resources to be effectively balanced across multiple needs? —

What would be the consequences of new technologies on production locations and commodity trade flows? For example, would green hydrogen facilities and steel mills be better located near iron ore

[41] Assuming a solar-capacity factor of approximately 20 percent, land use of approximately ten acres per megawatt, and a gas-utilization factor of approximately 80 percent, and land use of approximately 0.35 acres per megawatt; based on The footprint of energy: Land use of U.S. electricity production, Strata, June 2017, docs.wind-watch.org.

sources to help produce green steel, rather than the iron ore being shipped, as it is today, to ports where coal is available? —

How could we reimagine or create a new global trade ecosystem to support a net-zero transition so that countries or regions that have abundant solar, wind, or land resources can fruitfully trade with countries or regions where these resources are also needed?

Solutions on the table for consideration: —

Develop a global and granular view of natural resource needs by technology, and identify where key bottlenecks are likely to occur, including over time and across different net-zero pathways. —

Develop a global and granular view of the regions that have key endowments (such as minerals, hydrogen potential, and carbon capture and storage [CCS] potential) and those which lack them. —

Coordinate development plans for additional production capacity for key minerals, create mechanisms for cooperation across countries and companies, and begin scaling up production capacity in "no regret" areas. Explore opportunities for coordination across and within regions to better balance resource availability and need. —

Incorporate potential resource constraints into technology development to help engineer out raw materials which may be difficult or expensive to source. —

Examine the range and mix of incentives and other financial measures that could help scale up resource availability, factoring in lead times that will be needed for planning, permitting, financing, and scaling up production. —

Encourage greater societal buy-in for renewables land use; technical potential may run ahead of social acceptance. —

Build a fact base and accounting system to measure end-to-end impacts from resource use, including on worker safety and broader environmental impacts, to manage a broad set of outcomes, and conceptualize and evaluate trade-offs.

ECONOMIC AND SOCIETAL ADJUSTMENTS

4. Effective capital reallocation and financing structures

An orderly transition to net zero would require significant changes to capital allocation. Forthcoming estimates by McKinsey based on a scenario limiting warming to 1.5ºC and reaching net zero by 2050 from the Network for Greening the Financial System (NGFS) suggest that spending on physical assets across energy- and land-use systems would substantially increase and shift relative to today. In our current estimation, the net-zero 2050 scenario would entail spending on physical assets of $9.2 trillion per year on energy- and land-use systems until 2050. This represents $3.5 trillion more than current annual spending in these areas, all of which would need to be spent in the future on low-emissions assets.

This incremental spend is equivalent to about half of global corporate profits, 7 percent of household spending, represents a quarter of total tax revenue, and is about 20 percent higher than the average annual increase in public debt seen between 2005 and 2020. If we consider the likely evolution of this spend, given population growth, GDP growth, and current momentum toward the net-zero transition, the capital outlay would be smaller but remain significant. Indeed, if the NGFS "current policies" scenario, which accounts for currently legislated policies and cost reductions in key low-emissions

technologies, is taken as a basis, the incremental annual spend in a net-zero scenario would be $0.9 trillion higher (as opposed to the $3.5 trillion number noted above). Managing stranded assets (the early retirement or underutilization of existing property, plant, and equipment) will also be an important part of ensuring effective capital reallocation. Some geographies will be more exposed than others, based on their age of assets. Coal power plants typically have a useful life of 40 to 60 years, yet the age of coal power plants varies across countries—just 13 years old on average in India, for example, compared with 39 years old in the United States. Moreover, an additional approximate 300 gigawatts of coal plant capacity (equivalent to close to 15 percent of the global installed capacity) is currently under construction or approved.[42] At the same time, the massive public outlay over the last two years to blunt the economic and societal impact of COVID-19 gives an indication of the magnitude of the resources that can be mobilized when the danger is clearly recognized.[43] Moreover, the economic adjustments involved in reaching net zero in a planned manner would likely prevent the further build-up of physical risks and the additional costs arising from a more disorderly transition. As stated by the European Central Bank in its recent report, "the short-term costs of the transition pale in comparison to the costs of unfettered climate change in the medium to long term."[44] Indeed in the long run and in the aggregate, the upfront capital expenditures for a net-zero transition would result in overall operating savings for the world economy as a whole through reduced fuel consumption, improved material and energy efficiency, and lower maintenance costs. Many of these investments are already cost-effective and come with a return. However, in the short run, various challenges need to be managed: raising capital and securing financing at this scale, managing technological uncertainty of investments, considering risk–return trade-offs, and driving capital flows to both developed and developing countries. McKinsey analysis suggests that lower income countries, for example, would invest more than others as a share of GDP—about 1.5–2.5 times in Africa and India as in Europe or North America—in large part due to rapid economic growth and the needed expansion of electric-power infrastructure in a net-zero transition. Raising and deploying capital would also be more challenging for specific sectors and geographies.

Key questions for stakeholders: —

What are the biggest capital needs across sectors and geographies? How will these needs vary based on the mix of technologies deployed for the net-zero transition? —

Where is capital already flowing toward needed investments? Where are the biggest gaps? —

Based on the risk–return profiles, pay-off periods, and broader characteristics of capital investments, what is the likely mix of the types of capital that will be required (for example, public equity, public debt, private equity, project finance, and public guarantees)? What are the respective roles that private finance and public finance (for example, sovereign funds and multilateral development banks) would need to play? —

[42] Global Coal Plant Tracker, Global Energy Monitor, July 2021, globalenergymonitor.org

[43] Governments have provided massive fiscal support to protect companies and individuals. Estimates suggest that global fiscal support totaled $13.8 trillion, with $7.8 trillion in incremental spending and forgone revenue and $6.0 trillion in equity injection, loans, and guarantees since March 2020. See: The territorial impact of COVID-19: Managing the crisis and recovery across levels of government, OECD Policy Responses to Coronavirus (COVID-19), Organisation for Economic Co-operation and Development, May 10, 2021, oecd.org.

[44] Spyros Alogoskoufis et al., ECB economy-wide climate stress test, European Central Bank, ECB Occasional Paper Series No 281, September 2021, ecb.europa.eu.

What financial innovations and structures (such as new financial products, carbon markets, or blended finance) could drive capital to the sectors and geographies with the biggest needs and opportunities and drive the brown-to-green transition for high-carbon-intensity companies? Where will the creation of additional, effective compliance markets further help to facilitate the necessary capital allocation? —

How can voluntary carbon markets help facilitate capital reallocation (for example, investments into carbon-removal and avoidance or reduction assets), and how can such markets be scaled? How can the integrity and depth of these markets be ensured? —

What is the value of assets that may be stranded across sectors and geographies? How can the associated risks be proactively managed? —

What financing structures could create incentives for the retirement and decarbonization of carbon-intensive assets instead of merely their divestment? —

What new metrics and analytics are needed to factor into capital planning and to drive capital reallocation (for example, return on carbon, portfolio warming, and stress testing)? Solutions on the table for consideration: —

Increase transparency and improve robust disclosures of emissions and scenario-based assessments of physical and transition risks to inform capital-allocation decisions.

Develop and scale new financial products and structures to help companies wind down legacy assets and scale up new low-emissions assets. Solutions could include special-purpose vehicles that would enable companies to ringfence legacy-emitting assets and retire them in line with a science-based net-zero pathway, financing structures such as long-term purchase agreements from renewables plants (with lower total life-cycle costs) to replace coal generation assets, and new financial instruments (for example, for negative emissions or for nature-based solutions). —

Develop and scale new voluntary carbon markets in the near term (to complement companies' primary imperative to decarbonize their operations) and compliance markets over a longer term. Voluntary carbon markets would include markets both for avoidance credits (for example, to prevent forests from being cut down) and for removal credits (for example, from afforestation or direct air capture). —

Systematically and judiciously use public finance both on a national and global scale to fund key infrastructure investments that provide positive impacts but which may be more difficult to finance through markets (for example, electric vehicle charging stations, hydrogen fuelling stations, and carbon sequestration). —

De-risk private capital aimed at mitigating climate risk through public guarantees or other risk hedges, and support capital flows to sectors and geographies with large financing gaps, for example, refocusing the function of development-finance institutions or multilateral development banks to provide first-loss and currency-risk hedges. —

Establish new, or restructure existing, multilateral or government funds to manage the ramping down of emitting assets and minimize the value at risk from stranded assets.

5. Management of demand shifts and near-term unit-cost increases

Under a net-zero transition, changes in policies, technologies, and consumer and investor preferences would drive demand toward low carbon goods and services and away from high carbon ones. The shift

in energy mix would likely be the most significant, with the potential for a decline in demand for fossil fuels and an increase in demand for low-emissions power, hydrogen, and biofuels. The energy transition would also affect products that use fossil fuels, as would be the case, for example, in a shift toward low-emissions vehicles and a shift toward low-emissions heating and cooking systems. Similarly, demand could fall for products manufactured with carbon-intensive processes as end users switch to substitutes or reduce their consumption. On the other hand, industries that manage carbon through CCS technologies would benefit and grow. And opportunities would arise in a range of supporting sectors: for example, in upstream manufacturing sectors to support the deployment of new technologies, climate finance, and environmental assessment and risk-management services. This suggests that companies and countries will need to consider adjustments to navigate these demand shifts, remain competitive, and capture opportunities. Companies will also have to deal with changes in production costs which could increase in certain sectors, particularly in the near term. In some instances, a cost increase would be due to the high upfront investments that would be needed to build out production capacity, resulting in capital charges (for example, investments in building out additional power-generation capacity and associated transmission and distribution infrastructure). In other cases, the switch to zero-carbon technologies could substantially raise operating costs, such as when carbon capture, utilization, and storage units are added or when more expensive zero carbon feedstock is used in sectors like steel and cement. Often, those costs would diminish over time as technologies climb the learning curve. We observe that this has already happened in the case of onshore wind and solar-power generation and is currently happening for offshore wind and batteries.[45]19 In the long run, technological innovation could help drive down costs in other sectors as well. But today, our analysis suggests that the additional cost of decarbonization remains significant in some hard-to-abate sectors; green-steel production costs, for example, are more than 40 percent higher than conventional production routes, and, even in 2050, they are expected to still be 20 to 30 percent higher. Various interventions may therefore be needed to provide an incentive for the transition in these sectors, particularly in the near term. Actions to encourage decarbonization could include enabling producers to distribute the costs of transition to stakeholders along the value chain (including end consumers); phasing in commitments to buy increasing quantities of green materials; changing product design to reduce costs; improving productivity, for example, through increased energy or capital efficiency; providing or removing subsidies; and implementing regulatory measures such as new performance standards or zero-carbon quotas. Such adjustments will not be easy, particularly for internationally traded goods such as steel, where producers may face competition from regions with less ambitious climate policies or for businesses that serve customers who are less willing or able to pay a “green premium.”

Key questions for stakeholders:

What kind of demand shifts can be anticipated for different products, and how might these vary over time across sectors and geographies?

How could costs rise or fall for different sectors and geographies over the net-zero transition?

How might this vary depending upon the mix of technologies that are deployed? —

How could the shifting of demand and costs affect competitiveness across companies and countries?

[45] See: Alun Gu and Yi Zhou, “Learning curve analysis of wind power and photovoltaics technology in US: Cost reduction and the importance of research, development and demonstration,” Sustainability, April 2019, Volume 11, Number 8, pp. 2310, mdpi.com.

What would be the implication for trade flows?

What new capabilities are needed for companies and countries to navigate these shifts? How can uncertainties on the pace and scale of demand and cost shifts best be managed? —

How can companies, countries, and stakeholder groups—public and private—work together to manage demand shifts and cost changes along the net-zero pathway? What might cause them to be at odds with each other, and how can those pressure points be mitigated?

Solutions on the table for consideration: —

Put in place ongoing capabilities to granularly assess risks and opportunities. Create a granular and scenario-based understanding of demand and cost changes by sector, value chain, and geography.

Map existing capabilities and how they can best be used to capture new growth opportunities. Identify new capabilities needed and how to go about building them. —

Identify new areas of opportunity from a net-zero economy, considering the end-to-end needs of the transition. —

Identify a range of compensating mechanisms in cases where decarbonization actions increase costs, and understand which measures work best under different sets of circumstances and constraints (for example, standards and regulations, trade-enabling carbon content certificates, national and international subsidies, and global general-purpose funds designed to help transition carbon-dependent national economies). —

Identify opportunities to distribute the impact of cost increases along the value chain, and develop industry structures and economic systems to help bear costs and encourage a faster, more orderly transition (such as by charging a green premium). —

Harmonize policies and standards across borders and facilitate global coordination to drive incentives and limit disruptions to global trade (for example, through carbon free trade agreements).

Examine the continued viability of subsidies on existing carbon-intensive industries.

6. Compensating mechanisms to address socioeconomic impacts

Net-zero transitions will impact countries, regions, workforces, and households in different and unequal ways. A combination of falling demand for high-carbon products and rising demand for low-carbon ones would result in the reallocation of labour across companies, sectors, and potentially even geographies. The impacts are likely to be geographically concentrated, and specific communities are likely to be disproportionately affected. Specific communities where employment is anchored on high-carbon industries would also need to consider economic diversification programs, including better understanding communities' existing strengths and capabilities and using these strengths and capabilities to the communities' advantage. Certain countries may also see existing trade flows and government revenue affected. Without robust planning and commitments to equity and environmental justice, impacts would likely tend to be regressive, and the most at-risk communities are likely to carry a disproportionate burden, as transitioning to new employment and building new skills are challenging. In some instances, consumers may face higher upfront capital costs— as is the case, for example, with electric vehicles or retrofitting buildings. While in the long-run, they could benefit from lower operating costs, the upfront spend tends to be more challenging for lower-income households to bear. The transition could also result in energy price increases in the near term, as substantial capital investments are made to build new capacity and supporting infrastructure. This

would also disproportionately hurt low-income households, as well as developing countries that are seeking to provide low-cost energy to large portions of their populations. Unfortunately, climate hazards are themselves also often regressive, worsening the exposure of the most vulnerable. An orderly transition would therefore require appropriate compensating mechanisms to blunt these negative impacts. Such mechanisms would also be critical to facilitating collective will—within and across nations—to embark and persist on the path of net-zero transition. While such mechanisms often fall under the domain of governments, the role of individuals, financial intermediaries, and real-economy companies cannot be underestimated.

Key questions for stakeholders:

What would be the impact of various transition paths on overall economic activity and in terms of jobs lost, gained, or changed by sector, subsector, country, and region? —

What would be the total cost burden on families within each country and region in these scenarios? How does that vary by smaller regions, such as by zip code or by socially determined, disadvantaged groups? How might these burdens vary based on the mix of technologies deployed for the transition? —

How can governments best manage the negative consequences (for example, through programs for workers and subsidies for consumers) while maximizing the positive effects (including supporting job transitions to new and growing sectors)? —

What can the private sector and industry ecosystems do to help blunt the negative impacts and facilitate new opportunities? Solutions on the table for consideration: —

Identify skills that will be in higher or lower demand under different transition scenarios. Map potential job losses, opportunities, and gaps across and within sectors and geographies. —

Establish appropriate reskilling programs for workers who are most at risk, and bring together the capabilities of the public, private, and social sectors to design and deliver holistic solutions (such as by forming coalitions to instruct on reskilling or creating pathways to employment). —

Identify and address potential friction points for those who may wish to receive retraining (for example: Are training programs affordable? Are retraining centers accessible? Is childcare available if retraining is conducted during nonschool hours?). —

Establish social support schemes and compensating measures (nationally and internationally) for affected workers, including income-support measures such as unemployment protection and cash transfers, as well as public employment programs. —

Support economic-adjustment and diversification programs for affected communities (including, for example, programs for unlocking natural endowments such as solar and wind to develop new industries or using targeted finance to develop new economic activity).

GOVERNANCE, INSTITUTIONS AND COMMITMENT

7. Governing standards, tracking and market mechanisms, and effective institutions

Although individual actions by companies and governments can support a wide range of stakeholders during the transition, these actions would not be enough to meet all the needs that could arise. The pace, scale, and systemic nature of the required transition likely means that many of today's institutions may need to be revamped, and new institutions may need to be created to enable best-

practice sharing, drive capital deployment at scale, manage uneven impacts across stakeholders, and spur collective action. These institutions include standard-setting organizations, global platforms for collective action (including partnerships across public and private sectors), local chapters of larger organizations, and civil society institutions. Further institutional needs will also undoubtedly emerge. As with technological innovation, adapting or creating organizations committed to net zero will likely gain momentum as the transition proceeds—and engender resistance. It is the nature of a resilient society to prepare and allow for both. Hand-in-hand with this will be establishing standards and regulations to specify disclosures of physical and transition risks and measurement of emissions (both direct and financed). Such standards allow emissions to be appropriately factored into pricing and investment decisions, consumer choices, and regulatory and global trade regimes. Just as investors, regulators, and managers today rely on common, transparent, and audited financial standards (for example, generally accepted accounting principles [GAAP]), a net-zero economy would likely be a force for transparency and relative uniformity in terms of how organizations account for GHG emissions. Standards related to climate finance—for example, principles to define carbon credits and govern carbon markets—are also crucial.[46] Standards would need to be supported by appropriate tracking mechanisms to ensure progress is being made apace. Improved tracking and traceability of emissions—across Scope 1, 2, and 3 emissions—could also be needed across value chains and countries.[47]21 And governance, too, would undergo significant changes to fully take into account and price the carbon externality. Key questions for stakeholders: — Where might governments and individual private-sector actors need to be supported by other enabling institutions to achieve the net zero transition? What roles can cross-sectoral, cross-country, and nongovernmental or quasigovernmental institutions play? — How can existing institutions (for example, development financial institutions and multilateral development banks) be reconceived to unlock the other requirements for a transition? In what areas may new institutions be needed? How might this change over time? — What will be best addressed by local institutions and by national or global ones? Where might they be working at cross-purposes? — How can local, national, global, and cross sectoral institutions best work together? How can accountability and shared values be facilitated in such collaborative efforts? Where are efforts being duplicated or working at cross purposes? How could these friction points be mitigated or resolved?

How can institutional capabilities best be built and evolved over time? —

What areas of standard setting most critically need to be enhanced?

Solutions on the table for consideration: —

Explore solutions from a wide aperture without being too quick to dismiss solutions that seem too bold in light of current constraints (such as global, multilateral funding to buyout high-carbon assets and invest in low-carbon technologies); test ideas from the perspective of what could have failed to happen in 2030, 2040, and 2050 to secure the net-zero transition, and consider whether the ideas are bold enough to have prevented such failures. —

[46] Taskforce on scaling voluntary carbon markets: Final report, Institute of International Finance, January 2021, iif.com

[47] Though definitions can vary to some extent, for purposes of this article, “Scope 1” emissions are direct greenhouse emissions that occur from sources that are controlled or owned by an organization; “Scope 2” emissions are associated with the purchase of electricity, steam, heat, or cooling. “Scope 3” emissions are the result of activities from assets not owned or controlled by the reporting organization but that the organization indirectly impacts in its value chain; thus “Scope 3” emissions result from emissions across an organization’s value chain that are not within the organization’s scope 1 and 2 boundary. See “Greenhouse gases at EPA,” United States Environmental Protection Agency, last updated August 6, 2021, epa.gov.

Identify how best to build the institutions that might be necessary to ensure collective success, including the new capabilities and resources needed. —

Build new industry collaborations to collectively make commitments, invest in new technologies, build capabilities, and share best practices. —

Enhance and, where needed, establish standard-setting and certifying institutions for common carbon accounting principles across sectors (for example, building on efforts already underway by institutions such as PCAF or the Science Based Targets initiative [SBTi]) and corporate disclosures (for both public and private companies, to ensure appropriate levels of traceability of emissions). —

Improve point-of-source measurement of emissions through digital tracking technologies, for example, through placing sensors at industrial sites and pipelines to measure fugitive emissions or using satellite-imagery data to map global carbon and methane emissions. Digitally and comprehensively measure and track all major GHG emissions across Scope 1, 2, and 3 emissions. — Embed emissions accounting into existing and new market regimes (for example, in carbon prices or across trade-policy agreements). —

Set up governance mechanisms to ensure the quality and integrity of carbon credits to enable the scale-up of well-functioning voluntary carbon markets.

8. **Commitment by, and collaboration among, public-, private-, and social-sector leaders globally**

Each of the first seven requirements would influence how business leaders, policy makers, and regulators manage the low-carbon transition. Influence also runs in two directions: decisions by businesses (including those driven by both boards and CEOs), investors and shareholders, legislators, and regulators can contribute in a significant way to meeting these requirements. Securing an orderly transition will require public-sector leaders who have the commitment and capabilities to develop coherent, reliable, and workable policies. It would also need private-sector leaders to advance their organization's interests by leaning into the transition through shifts in capital allocation and product portfolios and cooperation within and throughout their organizations' ecosystems. Importantly, it would require leaders to act together, with unity, both to put the physical building blocks in place as well as to secure the economic and societal adjustments needed for an orderly transition. Key questions for stakeholders: — How can leadership conviction be built and sustained? — What are leaders currently incentivised to do? How do those incentives align with or work against actions that would advance a net-zero transition? How can leaders be incentivised to make long-term choices and avoid climate short-termism?

Where might leaders be incentivised to act in opposition to one of the other eight requirements? How might the dynamics of the other eight requirements change what leaders do—and what leaders should do? —

What can leaders do to support one another? —

How can leaders define and articulate the case for a transition? How can they bring their key constituencies along (for example, for CEOs, bring their employees, suppliers, investors, and customers)? Where might constituencies push back, and how can their concerns be anticipated and addressed? —

What no-regrets moves could be taken right now? What big moves are likely to engender the greatest challenges? What would need to happen for this resistance to be redressed or the constraints resulting in such resistance to be relaxed? —

How should companies think about both offsetting (neutralizing and compensating emissions outside their value chain) and insetting (neutralizing and compensating emissions inside their value chain)? Solutions on the table for consideration: —

Create real transparency around physical risks. Build awareness, conviction, and momentum among key constituencies—from the board to the C-Suite to the rank and file of the organization—for the net-zero transition and toward collective action. Leaders would need to better understand and communicate the consequences if the transition is slowed or stopped. —

Make climate considerations an essential element of an organization's highest-level decision making, particularly at the CEO and board levels. —

Re-examine strategy, capital allocation, and supply-chain decisions to incorporate the dynamic, system-wide change in which organizations are operating. —

Determine where regulatory intervention is most critical and which policy tools could be most effective (for example, subsidies, incentives, and safety nets). —

Engage with communities, investors, customers, suppliers, and employees on the case for a net zero transition; try to understand, anticipate, and mitigate their constraints.

9. Support from citizens and consumers

Citizen support is likely to be a crucial part of an orderly transition. In the long run, citizens will benefit greatly from an orderly transition, both as accumulating physical risks are avoided, and as new technologies and infrastructure are able to lower costs, and thus help solve a wide array of societal problems (for instance, low-cost energy can help solve water shortages by making desalinization much more affordable). But in the near-term, citizen support may require a greater shift toward recognizing the magnitude of the challenge, support for compensating mechanisms for those who are negatively affected, and civic participation. An informed public that recognizes the imperative for a net-zero transition can spur action on the part of public- and private-sector leaders. Moreover, to achieve a 1.5ºC pathway, consuming behaviours would likely need to change, for example, by switching to electric vehicles, renovating or retrofitting homes, or reducing carbon footprints in other meaningful ways, such as by eating less meat or reducing travel. In many cases, we would expect that a beneficial cycle could be catalysed by greater transparency, which can lead consumers to adjust their preferences, which in turn increases adoption of low-carbon goods and helps decrease their costs through economies of scale and movements of technologies up the learning curve. Ultimately, citizen pull or pushback is likely to be a critical factor for a net-zero transition.

Key questions for stakeholders:

Where is citizen participation most needed, and what changes could be met with the most resistance? How can consumer and citizen demand be channelled as an opportunity? —

What are the prevailing narratives and social dynamics about the net-zero transition in specific communities, sectors, societies, and countries? How can the needs and concerns of communities best be heard and addressed? How can broad support be cultivated and long-term thinking encouraged? —

Which sectors will most require consumers to shift their preferences and behaviours? How best can incentives be provided for these shifts? Solutions on the table for consideration: —

Communicate about the collective impacts from rising physical risks and the need for a net-zero transition in order to build awareness, will, unity, and conviction. Make clear what the true base case is and what the most likely outcomes are—including the possibility of runaway climate change and the attendant consequences that will advance nonlinearly over time. —

Create new forums and platforms for dialogue on climate change and the climate transition (both in the real and virtual world). —

Proactively address emergent "hotspots," such as communities located next to wind turbines, through community engagement. —

Be transparent with consumers to inform their decision making (for example, provide emissions information on product labels). —

Educate consumers on the impact of their choices and focus particularly on high-impact behavioural changes. —

Factor societal support into net-zero pathway planning.

An agenda for leaders

Each of the nine requirements affects, and is in turn affected by, all the others (see "An interdependent world" below). Addressing them, therefore, will take action and collaboration across sectors and actors—from large industrials to local transport operators and from municipalities to the citizen base that supports them.

The challenge will push public- and private-sector leaders to enter the net-zero arena. The risks in failing to transition or failing to transition in time are high. But the transition is also an opportunity. While the specific actions taken by leaders will change over time as the transition progresses and based on the needs of the moment, they encompass seven key areas:

Understand and commit. Leaders will be well served by internalizing the fundamentals of climate science and economics. This will help them as they apply the imperative for the net-zero transition and consider how it will affect their sectors and communities. Armed with this knowledge, leaders can commit to the transition. CEOs, for example, could increasingly take ownership of the broad sustainability agenda, working with their chief sustainability officers and other leaders. Setting a clear agenda to learn and adapt continuously and to continually engage with their top teams and boards will likely become even more essential. Leaders will be called on to articulate a coherent case for change to their organizations and to communicate why upskilling is so important. The transition will need to be managed by the organization's best talent— likely with a 50-year mindset. — Assess and plan.

Next, organizations would need to develop ongoing capabilities to measure their Scope 1, 2, and 3 emissions and put in place approaches to track and trace emissions across supply chains. They would also need to build capabilities—including using new forms of data and analytical tools—to granularly assess their exposure to risks and opportunities, given the pace and scale of the net-zero transition and the likely acceleration of changes in the basis of competition. As the underlying physical, cost and policy assumptions are constantly changing, and to better identify transition risks and opportunities, these assessments would likely need to be conducted regularly, through scenario-based analysis. To be most actionable, they would need to anticipate as far as possible and capture the ongoing shifts in regulations, investor preferences, consumer behaviours, and the competitive landscape. Leadership in this arena would require a willingness to embrace imperfect information, to base decisions on

future projections, to make decisions with agility, and to adopt a continuous test-and learn approach focused on innovation. However, solving for net-zero emissions globally does create a clear direction. Planning for potential changes will allow leaders to prepare themselves and their organizations for what is to come and to define their own role in shaping the transition. They can use these assessments to prioritize and plan their own net-zero strategy: the actions they need to take to adapt, decarbonize, and thrive in a net-zero economy. —

Reduce and remove.

Based on these plans, leaders would then need to implement decarbonization actions. These actions would need to include Scope 1, 2, and 3 emissions and include operational transformations to deploy low-emissions technologies, de-commissioning or repurposing of emitting assets, and partnering with their suppliers to manage emissions in their supply chains. In doing so, leaders would be able to consider opportunities to both reduce their emissions to the greatest extent possible and also to remove any residual emissions which they cannot reduce, for example, through capturing and storing greenhouse gases, negative-emissions solutions, and through the use of offsets. —

Conserve and regenerate.

Conserving and regenerating natural capital such as forests, peatlands, and mangroves will also need to be a key part of managing GHG emissions. Deforestation creates direct emissions (for example, as cut trees are burned) and results in the loss of crucial carbon-sequestration capacity, in some cases even turning carbon absorbing land into carbon-emitting land. Regenerating lost natural capital can also help create additional sequestration potential to help manage emissions. It is vital to acknowledge that natural capital solutions to tackle emissions must be solved jointly with supporting biodiversity, for example, by conserving intact ecosystems and including diverse and endemic species in regeneration efforts. Indeed, addressing these issues together could result in a range of co-benefits, including supporting food security, health outcomes, and broader ecosystem services. —

Adapt and build resilience.

Decarbonization actions would need to go hand-in-hand with adaptation to manage the impacts of the climate change that has already occurred or is already locked in. Adaptation measures will be important both to manage physical risks that are locked in and to better prepare for new challenges that may arise. Potential actions to consider include protecting people and hardening physical assets, diversifying supply chains, building reserve capacity and stock, reducing exposure to at-risk geographies, and availing of insurance. —

Reconfigure and grow.

The demand and cost shifts, as well as socioeconomic consequences likely under a net-zero transition, mean that leaders would need to consider compensating measures to manage negative consequences on the one hand and actively seek growth opportunities on the other. Public-sector leaders would have an important role in managing impacts on vulnerable populations, while simultaneously taking steps to support the economic diversification and labour force adjustments of affected communities. Private sector leaders would need to consider measures to ramp down their high-carbon businesses and grow new low-carbon ones. Throughout, businesses would also need to manage changes to their cost structure and supply chains, for example, through energy-efficiency improvements. For both sets of stakeholders, implementing these strategies might entail clearly identifying existing capabilities that can support new growth areas, reallocating capital and resources dynamically to emerging

sectors, investing in research and development, and supporting the training and preparation of workforces for the future, where needed. —

Engage and influence.

Leaders would also need to engage with and enable all stakeholders (consumers, suppliers, communities, workers, investors, and regulators) along value chains, in communities, and across borders. For example, executives could have to engage with investors and customers to help them understand the actions being undertaken by the organization and the underlying rationale. Public-sector leaders would similarly engage in a dialogue with affected communities. Leaders should identify opportunities to learn, trade ideas, diffuse best practices, and share experiences with peers. One way to do this might be to form or join an innovation ecosystem of peers, investors, and research institutions, to help develop and deploy new technologies. It is understandable and rational to expect that different stakeholders will have different incentives and goals.

There is no set, predefined solution to the net-zero equations. As the above discussion shows, there are dozens of critical questions that need to be addressed and hundreds of solution elements to be considered and combined together. The solution process can, therefore, only be iterative and proceed in parallel with a better understanding of the equations, their constraints, and the means to removing these constraints. It is not hard to imagine that the solution process would be fraught with challenges and setbacks. The sooner and the better the fundamental requirements described above are met, the better the rate of convergence would likely be. And among these, the conviction of private- and public-sector leaders—individually and collectively— and the support of citizens and consumers appear to be critical. While humanity may be facing the most existential challenge in its history, the path is no different than in the previous ones: probing inquiry, followed by collective will and determined action.

An interdependent world

The nine requirements of solving the net-zero equation are interdependent— each requirement affects the others. Investments influence technology development; technology development influences operating costs; operating costs influence citizen and consumer support; citizen and consumer support influences public policy; public policy influences investments; and so on. One must therefore take a system-level view of these requirements. The same systemic view would also apply to the actions taken to curtail emissions, as there will be clear interdependencies. For example, in the mining industry, the impact of climate change has increasingly become top of mind. Aluminum and copper, among other elements, are vital to help build and scale out the physical assets needed for a net-zero transition. At the same time, the extraction and processing of these minerals has a high carbon footprint. Another example is hydroelectric power, prized as a renewable energy. The building of dams, however, requires pouring huge amounts of concrete, and the artificial lakes they create can contribute to CO2 and methane emissions.[48]1 The overall reduction of emissions may thus require an increase in some areas and can be best achieved through an attempt at systemwide optimization.

Or, consider hydrogen, which will be an essential source of energy for a net-zero world. The rapid growth in the use and deployment of hydrogen in a net-zero transition requires both the simultaneous expansion of production capacity and a rapid increase in demand across sectors. Many hydrogen forecasts project substantial reductions in electrolyser capital expenditures, along with rapid expansions in installed capacity. For instance, the McKinsey 1.5ºC scenario projects an increase in

[48] K. Caldeira and N. P. Myhrvold, "Greenhouse gases, climate change and the transition from coal to low-carbon electricity," Environmental Research Letters, February 2012, Volume 7, Number 1, iopscience.iop.org

hydrogen production from electrolysis to 100 million metric tons by 2030 (from less than one million metric tons in 2020), along with a 60 percent reduction in the cost of electrolysis.[49]

That magnitude of cost reduction is required for green hydrogen technology to reach cost parity with competing technologies. But capital may need to be invested to make the reductions feasible, and investment plans in many cases are conditional on government support. Many early movers would likely seek greater incentives to invest in projects that would otherwise lack a compelling, stand-alone business case. Moreover, green hydrogen production consumes a significant amount of electricity, which requires that sufficient amounts of additional renewable power be added while hydrogen production ramps up. It's essential to note that for hydrogen use to lead to additional, instead of substitutional, abatements to electrification, additional renewables would likely come on top of already ambitious rollout targets to bring electrification plans to fruition. Supply of hydrogen would, in turn, only roll out on the assumption that demand centers in industry, transport and buildings will be developed. As more hydrogen-production and -consumption technologies are deployed and become mature, we could expect that demand would be cultivated by incorporating hydrogen in steel reduction, building out fleets of fuel-cell trucks, and deploying hydrogen boilers in buildings. The wider the use, the more likely that local ecosystems of hydrogen will be attractive in more circumstances (such as switching an industrial site to hydrogen, running city buses on hydrogen, and heating neighbourhoods with hydrogen). And more broadly, a virtuous cycle could emerge between demand and supply. The promise of demand can incentivize producers to ramp up supply; increased supply and scale can help lower consumers' costs; supply and scale would further spur demand.

[49] Kimberly Henderson and Christer Tryggestad, "Climate math: What it takes to limit warming to 1.5°C," January 29, 2021, McKinsey.com.

5 CASE STUDY --“GREEN” CONCEPT DELIVERY

System Thinking as a discipline is useful when viewing a challenge/need/problem holistically.

“Green” is relevant when the solution is focused on sustainability and climate neutrality (net zero).

These challenges are comprehensive and could border on being complex.

Therefore, the introduction of suitable methodologies will greatly assist in facilitating problem solving.

It is suggested in this chapter that further facilitation takes place through the overall introduction of digital technology and decision support systems, with special reference to decision making under uncertainty. This is explained through the introduction of a case study in this chapter.

Please note that we use the word *‘‘Initiative”* interchangeably with “*Concept*” when defined as a focused strategy with regards to a challenging problem, using a multi-dimension multi-variable matrix, capable of delivering a strategy and an investment model identifying the required financial instruments.

Our aim is to create a valuable digital asset from the many concept designs (investment models) created over a twenty-year period focused on sustainability finance, approximated in excess of 400.

A further objective, as touched on in the final chapters of this essay, is to visually present Concepts, using the *Advanced Virtual Collaborative Environment* as suggested by the Metaverse. The resulting product and solution could be considered as a form of digital art and issued as a non-fungible token on the blockchain for investor consideration.

CONCEPT DEFINITION

In informal use the word *concept* often just means any idea.

In the context of this essay, **Concepts** are defined as ideas conceived towards solving sustainability and net-zero challenges and presented as investment models.

Concepts are used as formal tools or models in mathematics, computer science, databases and artificial intelligence where they are sometimes called classes, schema or categories.

In the following case study the broad concept of safe and secured net-zero small islands globally, is discussed as the *Small Island Developing States (SIDS) Initiative.* The analysis is used to illustrate an application of the Sustainability CUBE accompanied by a discussion of decision making under uncertainty. The objective of this approach is indicating the way toward an applicable investment model.

CONCEPT CASE STUDY:

ACHIEVING NET-ZERO – THE SMALL ISLAND DEVELOPING STATES (SIDs) INITIATIVE:

An investment decision support framework to address uncertainty.[50]

Small Island Developing States (SIDS) stand at a critical juncture on their paths to sustainable development. Economic growth, human development and vulnerability indicators point to specific challenges facing SIDS, and suggest that new development solutions and approaches are needed to chart the course to prosperity for their people and their environments - OECD

"The next frontier of development for SIDS is the oceans, which will be the key to food, energy and water security, and fuel innovation". Arvin Boolell, Mauritius Foreign Minister

"Small island developing states (SIDS) know too well the costs of the climate crisis in both lives and livelihoods. For us, Irma, Maria, Dorian and Harold are not just names. These hurricanes in the Caribbean and Pacific have wiped out the entire annual GDP of nations hit and, in some cases, left islands totally uninhabitable. Stemming climate change isn't a desire, it is a necessity –

Gaston Browne." Prime Minister of Antigua and Barbuda – Chair of the Alliance of Small Island States – Financial Times 6 September 2021

Introduction

This chapter presents a system approach towards a generic solution for achieving net-zero in the small island development states (SIDS) initiative. The components of the system architecture are described with introduction of the SIDS Net Zero Climate Strategy. In defining a potential investment structure, the ISDC CUBE is introduced, providing a multi-dimension multi-variable methodology. The system architecture also defines the need for a robust decision support framework and a number of tried and tested approaches are reviewed for decision making on climate change strategies under deep uncertainty, as to be expected in future in an initiative such as achieving net-zero in SIDS. *"Initiative"or Concept* has been defined as a focused strategy on a challenging problem, using a spatial multi-dimension multi-criteria multi-variable matrix,[51] capable of delivering a strategy and an investment model identifying the required financial instruments.

[50] Revised extract from forthcoming Springer publication "Uncertainty Deconstructed – Guideline for Decision Support Practitioners – Bruce Garvey, Dowshan Humzah, Storm le Roux

[51] Also consider "Spatial multi-criteria decision analysis for evaluating sustainable development" – Master dissertation, Ohio University – Walter Kropp - 2010

THE CLIMATE CHALLENGE

A sense of urgency is slowly sweeping across the world, with a growing consensus and understanding of the challenges accompanying the widely used concept “climate change”. Although the concept is not always fully understood, the effects however are increasingly observed on a world-wide basis, such as floods, hurricanes and wild-fires, affecting the everyday lives of people, previously unaffected.

Global warming has been a regular topic of discussion, especially since the publication of the Stern report on 30 October 2006,[52] in meetings of world leaders at events such as COP (Conference of the parties) under UN auspices. Developing countries have continuously called for financial assistance for protection against potentially disastrous effects of climate change.

As reviewed in chapter 3, it would be correct to state that world leaders have been slow to respond with political leadership towards taking constructive action on suitable investment structures. We have seen growing action in recent years by activist groups calling on world leaders to wake up.

What has also become clear is that governments alone are not in a position to provide the required funding and that the time has come for the private finance domain to also step up to the plate. This chapter seeks to introduce a financing framework using exploratory scenario principles (in effect a strategy development tool), to mitigate the inherent uncertainties surrounding the broader issue of climate change.

Towards a Climate Neutral Strategy

The race against climate change, whether by mitigation or resilient adaptation, given the accompanying uncertainty, can only effectively be executed by using a suitable climate neutrality strategy. In addition, a suitable time-line has to be decided on whether being 2,5,10, 20 or 50 years.

Addressing the challenge of developing a suitable climate neutral strategy for any party under discussion (whether a policy maker such as government, a corporate or a private individual) one suggested approach is the application of a strategy development tool to a generic case study, as presented here.

The Concept under consideration is the development of a Net Zero climate strategy, delivering a set of objectives, within a 10-year time frame for a typical SIDS (Small Island Developing State), for which the system architecture is as depicted in Diagram 1 below:

- Achieve overall NET-ZERO status (i.e. climate neutrality);
- Develop a set of key objectives, to be managed by the relevant stakeholders;
- Establish a suitable funding structure through which investment funds will be channelled in order to achieve the desired impact investment;
- Obtain applicable technologies in support of the strategic objectives;
- Ensure that the necessary support functions are in place in order to ensure required delivery;

[52] “The Global Deal – Climate Change and the Creation of a New Era of Progress and Prosperity” N. Stern, Pub: The Bodley Head, 2009.

- Define a Decision Support System, as part of the overall structure, in order to achieve adaptation and resilience under deep uncertainty;

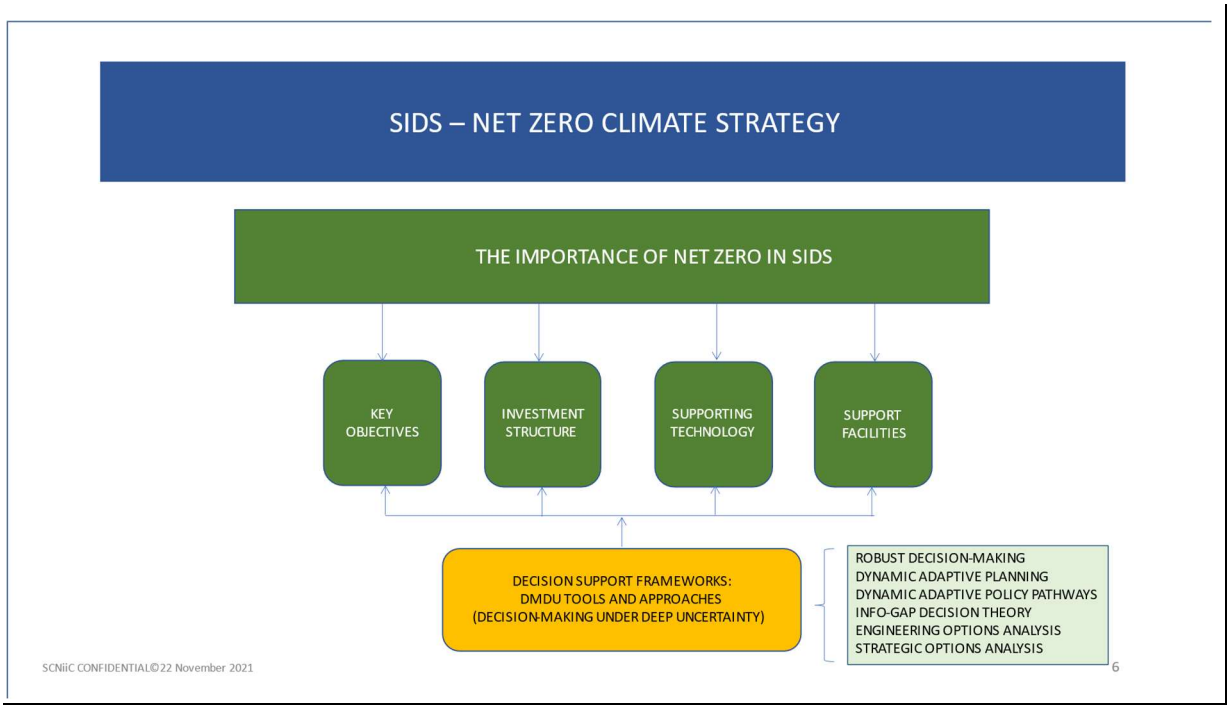


Diagram 1

The Importance of Net-Zero in SIDS

The contemporary challenge posed by climate change is of global concern. The destructive impacts have, and will, touch all nations and populations. Yet, although climate change affects all, it does not affect all equally. Nor are the capacities to respond to the challenges in equal distribution. The small states and territories of the world are some of those most affected and at risk, in particular those under the grouping small island developing states (SIDS). These are a distinct set of small islands and low-lying coastal countries and territories, recognised by the international community as facing specific social, economic and environmental vulnerabilities. Characterised by small populations and geographic isolation, they also contend with resource constraints that affect their ability to effectively protect against such vulnerabilities. With SIDS combined population of around 65 million, contributing less than 1 percent of global greenhouse gas emissions, they have, and will, suffer disproportionately from the damaging impacts of climate change.

What is different for Small States?

Many small states, especially SIDS, have been identified as being particularly vulnerable to climate change. With populations centred largely in coastal zones they are vulnerable to sea-level rises and extreme weather events; these environmental vulnerabilities combine with a particular set of social and economic factors to make small states some of the world's most affected by climate change.

Examples are:

- Most small states are close to sea-level and vulnerable to sea-level rises - some are at risk of going entirely underwater;

- Already the most disaster-prone states, this is made worse with increased intensity of extreme weather from climate change;
- Small and often dispersed populations mean small domestic markets, limiting economies of scale;
- Over dependence on imported fossil fuels and limited progress transitioning to alternative energy;
- Access to and management of uncontaminated freshwater and management of land to control waste and contamination.

Key Objectives (+ Vision and Mission)

Key objectives of the SIDS Concept:

- Decide on an appropriate strategy for the SIDS initiative
- Continue promoting global awareness regarding the continued vulnerability of SIDS with regards to climate change
- Develop a bankable investment plan, delineating and delivering a portfolio of bankable financial solutions leading to the implementation of a suitable action plan
- Plan for resilient adaptation including allowing the possibility of mass migration with dignity.

These objectives are supported by a preliminary Vision statement for the SIDS Initiative thus:

"Deliver a resilient climate change adaptation plan for SIDS globally, ensuring sustainable human well-being, environmental integrity and economic effectiveness for all its people."

The overall mission statement proposed is *"introducing a delivery platform in partnership with suitable interested stakeholders, delivering the stated vision and key objectives."*[53]

The Investment Structure

1.3.1 Investment Opportunities

A sustainability CUBE is used to deliver a portfolio of investment opportunities, jointly constituting an investment model for the initiative. The sustainability Cube consists of a maximum of six core dimensions, with an unlimited number of variables in each dimension.

Taking a systems approach to the focus area, a small island in this case, the objective is to divide the focus area into elements, using relevant frameworks, for creating the required CUBE dimensions. Each

[53] Source : SCNiiC sustainability finance consulting practice, London, UK

element, formed from the cross-over of the frameworks, is then evaluated for its revenue generation capability and investment impact.

Sustainability Cube:

In a typical CUBE, a maximum of six dimensions are distinguished as (1) Input dimension (2) One or more reference dimensions and (3) Output dimension.

In the SIDS CUBE the Input dimension is created using the 17 SDGs (UN Sustainable Development Goals) with special reference to SDG 14 – Life under Water, with ten targets (sub-goals) listed in Box 1 below, and SDG 11 – Sustainable Cities and Communities – in Box 2 below.

Box 1 SDG 14 TARGETS – LIFE UNDER WATER

14.1 PROTECT AND RESTORE ECOSYSTEMS
14.2 REDUCE OCEAN ACIDIFICATION
14.3 REDUCE MARINE POLLUTION
14.4 SUSTAINABLE FISHING
14.5 CONSERVE COASTAL AND MARINE AREAS
14.6 END SUBSIDIES CONTRIBUTING TO OVERFISHING
14.7 INCREASE THE ECONOMIC BENEFITS FROM SUSTAINABLE USE OF MARINE RESOURCES
14.A INCREASE SCIENTIFIC KNOWLEDGE, RESEARCH AND TECHNOLOGY FOR OCEAN HEALTH
14.B SUPPORT SMALL SCALE FISHERS
14.C IMPLEMENT AND ENFORCE INTERNATIONAL SEA LAW

Box 2 SDG 11 TARGETS – SUSTAINABLE CITIES AND COMMUNITIES

11.1 SAFE AND AFFORDABLE HOUSING;
11.2 AFFORDABLE AND SUSTAINABLE TRANSPORT SYSTEMS;
11.3 INCLUSIVE AND SUSTAINABLE URBANIZATION;
11.4 PROTECT THE WORLD'S CULTURAL AND NATURAL HERITAGE;
11.5 REDUCE THE ADVERSE EFFECTS OF NATURAL DISASTERS;
11.6 REDUCE THE ENVIRONMENTAL IMPACT OF CITIES;
11.7 PROVIDE ACCESS TO SAFE AND INCLUSIVE GREEN AND PUBLIC SPACES;
11A STRONG NATIONAL AND REGIONAL DEVELOPMENT PLANNING;
11B IMPLEMENT POLICIES FOR INCLUSION, RESORCE EFFICIENCY AND DISASTER RISK REDUCTION;
11C SUPPORT LEAST DEVELOPED COUNTRIES IN SUSTAINABLE AND RESILIENT BUILDING.

The first SIDS CUBE Reference dimension is created using a Climate Neutrality Framework developed by SCNiiC, consisting of the following ten variables, each of which provides a platform on which to obtain net zero climate neutrality:

Water, energy, health, agriculture, biodiversity, waste, industry, buildings, transport and forestry.

The second SIDS CUBE Reference dimension framework (also referred to as Digital Transformation Platform) is selected from fourteen advanced technologies, each considered for its contribution towards enhancing climate neutrality of the CUBE element under consideration, in no particular order:

Artificial Intelligence, Blockchain, IoT (Internet of Things), Intelligent Sensors, Digital Twinning, Cybersecurity and Cloud Management, Big Data Analytics, Virtual Reality/Augmented Reality, UAVs (Unmanned Aerial Vehicles), Robotics, 5G Networks, 3D-printing, BIM (Building Information Modelling) and GIS (Geographic Information Systems).

In the use of CUBES in strategy development over several years, these advanced technologies have been found to provide a robust reference framework.

From the SIDS CUBE Output Dimension, one or more INVESTMENT MODELS generated, schematically indicated in Figure 15.3 below, and results from the elements created. The evaluation of each such element results in a mini- whitepaper (or prospectus), the combination of which creates an investment portfolio, to be presented to the applicable investment structure.

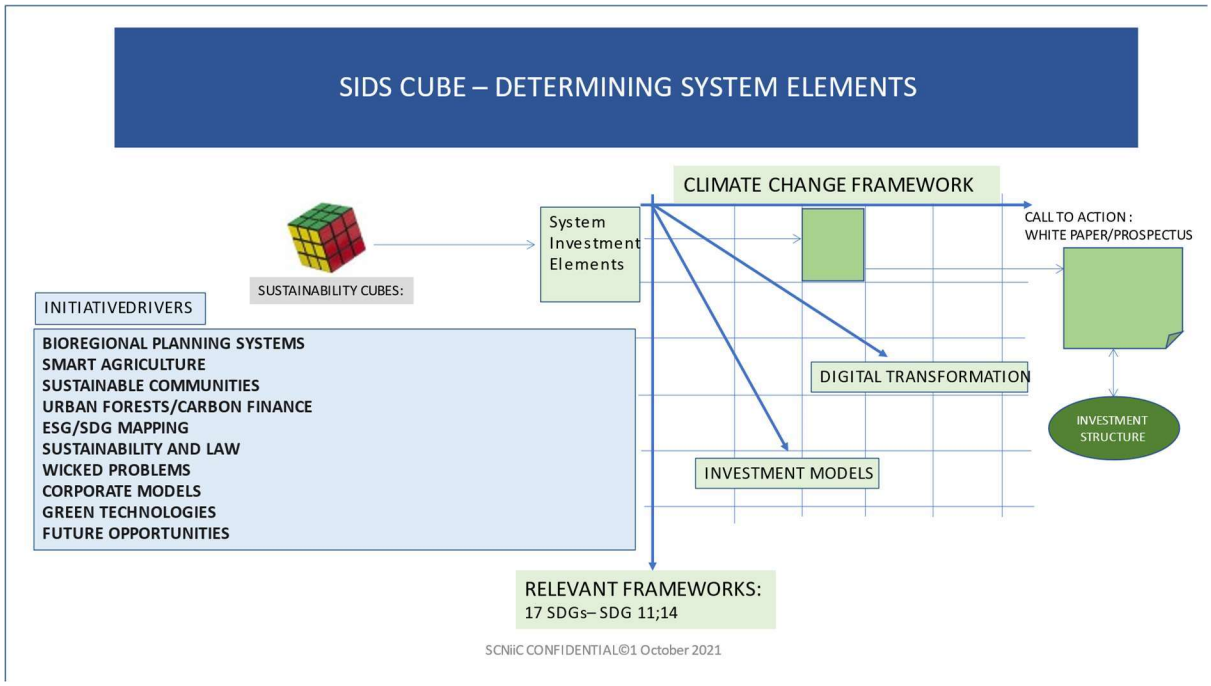


Diagram 2

Initiative Drivers

As indicated in Diagram 2, ten drivers are presented for consideration in the development of the SIDS Initiative. These ten drivers result from the experienced gained in the development of a range of sustainability net-zero initiatives and are explained below.

Driver 1 Bioregional Planning Systems

Bioregionalism is a philosophy that suggests that political, cultural, and economic systems are more sustainable and just if they are organized around naturally defined areas called bioregions. Bioregional planning is the process of facilitating decision making to carry out land development with the consideration given to the natural environment, social, political, economic and governance factors and provides a holistic framework to achieve sustainable outcomes. A major goal of environmental planning is to create sustainable communities, which aim to conserve and protect undeveloped land. The link between UNESCO MAB (Man and Biosphere) Biosphere Reserves and Climate Neutrality and Sustainability are explored with particular reference to UN Sustainable Development Goals, constituting the input dimension of the CUBE under development.

Driver 2 Smart Agriculture

Smart agriculture refers to two different but complementary concepts, i.e. climate-smart and digital agriculture. Two definitions from Wikipedia are presented:

Climate-smart agriculture (CSA) is an integrated approach to managing landscapes to help adapt agricultural methods, livestock and crops to the ongoing human-induced climate change and, where possible, counteract it by reducing greenhouse gas emissions, at the same time taking into account the growing world population to ensure food security. Thus, the emphasis is not simply on sustainable

agriculture, but also on increasing agricultural productivity. "CSA is in line with FAO's[54] vision for Sustainable Food and Agriculture and supports FAO's goal to make agriculture, forestry and fisheries more productive and more sustainable". CSA has three main pillars - increasing agricultural productivity and incomes; adapting and building resilience to climate change; and reducing and/or removing greenhouse gas emissions.

Digital agriculture refers to tools that digitally collect, store, analyze, and share electronic data and/or information along the agricultural value chain. Other definitions, such as those from the United Nations Project Breakthrough, Cornell University, and Purdue University, also emphasize the role of digital technology in the optimization of food systems.

Sometimes known as "smart farming" or "e-agriculture, "digital agriculture" includes (but is not limited to) precision agriculture. Unlike precision agriculture, digital agriculture impacts the entire agri-food value chain — before, during, and after on-farm production. Therefore, on-farm technologies, like yield mapping, GPS guidance systems, and variable-rate application, fall under the domain of precision agriculture and digital agriculture. On the other hand, digital technologies involved in e-commerce platforms, e-extension services, warehouse receipt systems, blockchain-enabled food traceability systems, tractor rental apps, etc. fall under the umbrella of digital agriculture but not precision agriculture.

An important development potentially very applicable to SIDS, is that of Vertical Farming, the practice of growing crops in vertically stacked layers. It often incorporates controlled-environment agriculture, which aims to optimize plant growth, and soilless farming techniques such as hydroponics, aquaponics, and aeroponics.

Driver 3 Sustainability Communities

A sustainability community takes into account, and addresses, multiple human needs, not just one at the exclusion of all others. It manages its human, natural, and financial capital to meet current needs while ensuring that adequate resources are available for future generations. The design of typical communities takes on different shapes, dependent on local circumstances. In this regard it is closely related to considerations related to bioregional planning.

Driver 4 Carbon Finance/Urban Forests

The 3R-C concept is explained by the different methods of reducing, removing or retaining carbon in the environment and atmosphere.

Wikipedia defines Carbon finance as a branch of environmental finance that covers financial tools such as carbon emission trading to reduce the impact of greenhouse gases (GHG) on the environment by giving carbon emissions a price.

[54] UN Food and Agriculture Organisation

Financial risks and opportunities impact corporate balance sheets, and market-based instruments are capable of transferring environmental risk and achieving environmental objectives. Issues regarding climate change and GHG emissions must be addressed as part of strategic management decision-making.

The general term is applied to investments in GHG emission reduction projects and the creation (origination) of financial instruments that are tradeable on the carbon market. It has been forecast that urban areas across the world will have expanded by more than 2.5 billion people by 2050. The scale and speed of urbanisation has created significant environmental and health problems for urban dwellers. These problems are often made worse by a lack of contact with the natural world.

"These problems are often made worse by a lack of contact with the natural world. it is only through re-establishing contact with the natural world, particularly trees, that cities will be able to function, be viable and able to support their populations. The creation of urban forests will make cities worth living in, able to function and support their populations".[55]

Driver 5 ESG/SDG Mapping Applications

Under this driver the transformational relationship between ESG (Environmental, Social, and Governance) and SDG (Sustainable Development Goals) frameworks is explored in a number of applications. Investopedia defines ESG criteria as a set of standards for a company's operations that socially conscious investors use to screen potential investments.

Environmental criteria consider how a company performs as a steward of nature. Social criteria examine how it manages relationships with employees, suppliers, customers, and the communities where it operates. Governance deals with a company's leadership, executive pay, audits, internal controls, and shareholder rights.

The SDGs or Global Goals are a collection of 17 interlinked global goals designed to be a *"blueprint to achieve a better and more sustainable future for all"* (United Nations). The SDGs were set up in 2015 by the United Nations General Assembly and are intended to be achieved by the year 2030, with the following mission statement "A blueprint to achieve a better and more sustainable future for all by 2030".

Driver 6 Sustainability and Law

"Sustainability law" encompasses a variety of inter-related disciplines, the common theme of which is the constitutions imperative of securing "ecologically sustainable development and use of natural resources while promoting justifiable economic and social development"- [56]

The sustainability challenges we face today are greater than any we have previously confronted. Each year we are losing over 5 million hectares of forest, and an estimated 10,000 distinct species. Climate change is accelerating and will have sweeping impacts on marine and terrestrial ecosystems as well as weather patterns. Land, air, freshwater and marine pollution further threatens conditions in the natural environment. These challenges translate into direct impacts on human wellbeing. Poverty, hunger, water scarcity, lack of sanitation and violent conflict can all be linked to environmental problems.

[55] According to Alan Simson, Professor of Landscape Architecture and Urban Forestry, Leeds Beckett University:
[56] IMBEWE Sustainability Law practice, Johannesburg, South Africa.

Sustainability Law is a necessary part of the solution to sustainability challenges. It is not the whole solution – that encompasses a complex system of social, economic and political processes and relationships – but it is an essential component. To achieve sustainability goals, appropriate and well-implemented legal frameworks and tools must be in place. And, importantly, they must be effective. It is not enough that laws are enacted, or even that they are fully implemented – they must work. And to ensure that laws work, we must first understand what makes law effective. What factors contribute to its design, implementation, outcome and ultimate impact? And what can we do to improve it?

Driver 7 Wicked Problems

The complexity of the sustainability problem is daunting. The multiple interdependencies and the varying levels of uncertainty, not to mention the multitude of stakeholders with conflicting short and long-term interests, make responding to the sustainability challenge extraordinarily difficult. The temporal and spatial reach of the needed changes reach every aspect of society.

These kinds of thorny public-policy dilemmas have an evocative name: they are often called "wicked problems". A wicked problem is one that is reflexive, meaning that each attempt to create a solution actually changes the way the problem is understood and perceived. In other words, coming up with new possible solutions causes the very definition of the problem to change. Moreover, wicked problems lack a definite formulation, have no clear set of possible solutions, and offer no obvious means of determining whether or not the problem has been resolved.

Sustainability is a particularly wicked problem, in part because of the lack of an institutional framework capable of developing, implementing, and coordinating the responses necessary to address the problem. As a result, sustainability, like climate change, can be characterized as a "super wicked problem". Chapter 4 of the book referenced earlier provide for a more detailed description of Wicked Problems.[57]

Driver 8 Corporate Models

"We cannot solve our problems with the same mindset we used to create them." Albert Einstein

Einstein's wisdom has never been truer than it is today, where we are experiencing, on a daily basis, huge leaps forward in technological development. With the progress made, it is inevitable that there will be social challenges which will require totally new ways of thinking and corresponding business models. We must all take our responsibility for the development of this new thinking, not only in society but also in business, if we are to create a world which will remain habitable for future generations.

The time has come for a new corporate ethic. Sustainability understanding is growing and becoming an essential component of the business strategy of modern companies. This required understanding, Sustainable Entrepreneurship, translates as the entrepreneurial contribution to sustainable action. In simplified terms, Sustainable Entrepreneurship is about solving the problems of our era, linking these with profitable business strategies, and producing added value for society and business alike by doing so. Sustainability has the potential to function as an engine of growth, profit, and innovation. For many companies, it represents a huge chance to generate clear competitive advantage in the market. It is a guiding principle, an entirely new way of living, and a lifestyle movement which views sustainability not as something to reject, but as a means of creating added value. Is Corporate Social Responsibility (CSR) a New Global Business Language?

[57] Forthcoming Springer publication "Uncertainty Deconstructed – Guideline for Decision Support Practitioners – Bruce Garvey, Dowshan Humzah, Storm le Roux

Driver 9 Green Technologies

"Not a day passes for me without seeing the many ways in which digital technology can advance peace, human rights and sustainable development for all." António Guterres, Secretary-General, United Nations

Environmental technology, green technology or clean technology is the application of one or more of environmental science, green chemistry, environmental monitoring and electronic devices to monitor, model and conserve the natural environment and resources, and to curb the negative impacts of human involvement – again as defined by Wikipedia.

Research and Markets, arguably the world largest research store, introduces their 2020 report – "Green Technology and Sustainability Market Research Report" with the following statement: *"Due to the rising awareness about the harmful effects of greenhouse gas emission on the environment, the need for low-carbon electricity is increasing, which is driving the global green technology and sustainability market. Governments and utility firms around the world are focusing on generate power from renewable sources like the sun, wind, and water, to reduce the carbon footprint. By employing artificial intelligence (AI), the created energy can be stored for cloudy days, when the photovoltaic (PV) panels cannot function. Thus, with an increase in the renewable power capacity and integration of advanced systems to store the energy, the green technology and sustainability market is growing. Compared to $8.3 billion in 2019, the industry is predicted to generate revenue of $57.8 billion in 2030. Green Buildings to be the largest application area till 2030."*

Driver 10 Future Opportunities (Focus Areas)

One immediate example is ***Sustainability in Sport*** delivered through the Creation of Sport Villages.

A further and most important example is ***Climate Justice*** while developing towards a Net-Zero Climate.

It is expected that during the development of the SIDS initiative further focus areas will be identified., of importance in SIDS sustainable development, whilst aiming at climate adaptation.

Support Facilities

In support of the SIDS Initiative, the required facilities are provided through a portfolio of Support Tools and a range of Methodologies, developed over a period of twenty years during a search for robust solutions in sustainability finance. It is important to be reminded that our end goal in delivering sustainable solutions to achieve a net zero environment, is the ability to be able to finance that delivery.

Support Tools

Sustainability Toolbox

The Toolbox aims at providing appropriate assistance (tools) in all kinds of applications, addressing the subject "sustainability finance" holistically, specifically progressing investments from addressing highly qualitative challenges to highly quantitative solutions, delivering the required impact. The content of the Toolbox has mostly been developed internally[58], but rather than "re-inventing the wheel" a considerable number of additional solutions have been obtained externally.

[58] At SCNiiC – Sustainability Climate Neutral Impact Investment Consultancy

Sustainability Wrap

As a financial instrument, the Sustainability Wrap addresses the global challenge nexus of urbanisation, climate change and sustainability through the design and delivery of sustainability-smart communities, being defined as either an eco-district, precinct or city of any size. According to the ODI (Overseas Development Institute – a 60-year old London based think tank) by 2050, 6.5 billion people will live in urban centres – two-thirds of the projected world population. We believe that the construction of housing alone is insufficient for the creation of a sustainable community. What is required is a self-funding "sustainability wrap" comprising a range of development themes, each combined with one or more SDGs, effectively creating an investment model. The combined revenue generated through each of the resulting investment models constitutes the "wrap" applied in discretionary projects towards the well-being of occupants and their natural environment, without an additional call on the project finance. Relevant consulting exercises are available, to create in appropriate applications, a detailed design template: including housing, sustainable infrastructure, urban master planning, a portfolio of fourteen investment models (jointly providing the WRAP) and a portfolio of sustainability products.

Methodologies

Unlocking Intellectual Capital

Investopedia defines Intellectual Capital (IC) as the value of a company's employee knowledge, skills, business training, or any proprietary information that may provide the company with a competitive advantage. It is a SCNiiC mission to assist clients in unlocking of IC in their operations, with a specific focus on the three focus areas of sustainability, climate neutrality and natural capital. The unlocking process is to be followed by establishing a suitable growth strategy. Clients vary from relatively small SMEs to large corporates. In the latter, one approach is to identify smaller functional units within the organisation, to be subsequently treated as if a SME. Considering the three listed focus areas, the process proposed could be considered as the "Unlocking of green capital" referring to the capability and capacity in the organisation to contribute applicable solutions to these focus areas. Intellectual capital is considered an asset, broadly defined as the collection of all informational resources a company has at its disposal to drive profits, gain new customers, create new products, or otherwise improve the business. It is the sum of employee expertise, organizational processes, and other intangibles that contribute to a company's bottom line. Over the last two decades, the term Intellectual Capital (IC) has become synonymous with the knowledge economy, whereby the intangible resources of organisations are linked to the development of value. The strategic framework outlined is to provide a methodology for the unlocking of Intellectual Capital with specific focus on a green economy.

Decision making under deep uncertainty.

A recent comment in a conference paper[59], underlines the wider concerns when addressing uncertainty.

"The term "unknown – unknowns" is now ubiquitous, albeit the vast majority of future uncertain events do not fall into this category. However, it has been used to absolve decision makers from criticism post-event, whereas poor foresight is the prime culprit. Since the start of the 21st century there is increasing talk about uncertainty – particularly in political, economic and social circles – not surprising really, as

[59] "Re-assessing How Uncertainty Should Be Treated To Mitigate Risk: A Management Template", B Garvey, paper accepted for SSIM Conference Taiwan August 2021.

in the two first decades we have seen waves of events that appear to have taken many people by surprise, including politicians, experts, academics, the media, so-called informed pundits, let alone the rest of us. "Uncertainty" is no longer a conceptual slogan but a reality we are living through. Events from 9/11, Covid 19 to the drip-drip-drip of climate change, have elevated the term "uncertainty" much more into the public domain. Or rather the term is exhorted to justify (often in reaction to inadequate responses to earlier events by decision makers) poor performance post event. In other words, the term is too often applied retrospectively to an event that has already occurred so that the impossibilities of yesterday have morphed into today's challenge: "it is one thing to be caught out by a wholly novel threat, and quite another to be toppled by something we knew about all along".

Following from previous methodologies, a framework is available for supporting management to address uncertainty. The framework dissects the main elements of uncertainty so as to inform management and policy makers where the core drivers lie and to reveal how uncertainty can be better recognised and mitigated. Information relating to Uncertainty is highly dispersed with all sorts of different inputs and interpretations.

In the following section an overview is presented on Decision Support Systems, enabling decision making under deep uncertainty.

Decision Support Systems – Decision making under deep uncertainty (DMDU)

Introduction

In reviewing decision support systems, constituting an important component to decision-making under deep uncertainty, we are making use of the book "Decision making under deep uncertainty – From theory to practice." [60]

This open access book focuses on both the theory and practice associated with the tools and approaches for decision making in the face of deep uncertainty. It explores approaches and tools supporting the design of strategic plans under deep uncertainty, and their testing in the real world, including barriers and enablers for their use in practice. The book broadens traditional approaches, Strategic planning for the future has to involve anticipating changes. When these changes are characterized by a high degree of uncertainty, the resulting situation is considered to be "deeply uncertain"— a situation in which the parties to a decision cannot agree upon

"(1) the appropriate models to describe the interactions among a system's variables,

(2) the probability distributions to represent uncertainty about key variables and parameters in the models, and/or

(3) how to value the desirability of alternative outcomes."[61]

An overview of DMDU tools and approaches

Five approaches presented here in the book, in summary form, are:

• *Robust Decision making* (RDM)[62]:

RDM is a set of concepts, processes, and enabling tools that use computation, not to make better predictions, but to yield better decisions under conditions of deep uncertainty. RDM combines

[60] Editors – Vincent A.W.J.Machau, Warren E. Walker, Pieter J.T.M. Bloemen and Steven W. Popper.
The complete book is freely available as a pdf file and can be downloaded from:
https://www.google.co.uk/books/edition/Decision_Making_under_Deep_Uncertainty/gkuQDwAAQ BAJ?hl=en&gbpv=0

[61] "Shaping the Next One Hundred Years: New Methods for Quantitative, Long-Term Policy Analysis", R J Lempert . W. Popper, and S. C. Bankes. MR-1626-RPC, RAND, Santa Monica, California 2003

[62] "Robust Decision Making" chapter 2 in "Decision Making Under Deep Uncertainty", R J Lempert, Springer 2019.

decision analysis, Assumption-Based Planning, scenarios, and Exploratory Modelling to stress test strategies over a myriad of plausible paths into the future and then to identify policy-relevant scenarios and robust adaptive strategies.

RDM analytic tools are often embedded in a decision support process called "deliberation with analysis" that promotes learning and consensus-building among stakeholders.

• *Dynamic Adaptive Planning* (DAP)[63]:

DAP focuses on implementation of an initial plan prior to the resolution of all major uncertainties, with the plan being adapted over time based on new knowledge. DAP specifies the development of a monitoring program and responses when specific trigger values are reached. Hence, DAP makes adaptation over time explicit at the outset of plan formulation. DAP occurs in two phases: (1) the design phase, in which the dynamic adaptive plan, monitoring program, and various pre- and post-implementation actions are designed, and (2) the implementation phase, in which the plan and the monitoring program are implemented and contingent actions are taken, if necessary.

• *Dynamic Adaptive Policy Pathways* (DAPP)[64]:

DAPP considers the timing of actions explicitly in its approach. It produces an overview of alternative routes into the future. The alternative routes are based on Adaptation Tipping Points (ATPs). An ATP focuses on "under what conditions will a given plan fail."

• *Info-Gap Decision Theory* (IG)[65]:

An information gap is defined as the disparity between what is known and what needs to be known in order to make a reliable and responsible decision. IG is a non-probabilistic decision theory that seeks to optimize robustness to failure (or opportunity for windfall) under deep uncertainty.

It starts with a set of alternative actions and evaluates the actions computationally (using a local robustness model). It can, therefore, be considered as a computational support tool, although it could also be categorized as an approach for robust decision making.

• *Engineering Options Analysis* (EOA)[66]:

EOA refers to the process of assigning economic value to technical flexibility. It consists of a set of procedures for calculating the value of an option (i.e. the elements of a system that provides flexibility) and is based on Real Options Analysis. The interested reader would appreciate the fact that the availability of options embody the idea of flexibility and would be interested in the variety of papers produced by Richard de Neufville, a Professor of long standing at MIT. Of further interest, with particular reference to infrastructure related decisions under uncertainty, are two books:[67]

[63] "Dynamic Adaptive Planning"" chapter 3 in "Decision Making Under Deep Uncertainty", W e Walker, V A W J Marchau, J H Kwakkel, Springer 2019.
[64] "Dynamic Adaptive Policy Pathways " chapter 4 in "Decision Making Under Deep Uncertainty", M Haasnoot, A Warren, J H Kwakkel, Springer 2019.
[65] "Info-Gap Decision Theory" chapter 5 in "Decision Making Under Deep Uncertainty", Y Ben-Haim, Springer 2019.
[66] "Engineering Options Analysis", chapter 6 in "Decision Making Under Deep Uncertainty", R de Neufville and K Smet, Springer 2019.
[67] Flexibility in Engineering Design – Richard de Neufville and Stefan Scholtes, The MIT Press; and flexibility and Real Estate Valuation under uncertainty – Richard de Neufville, Wiley Blackwell.

Strategic Options Analysis (SOA)

In this section a shortened summary of the method is presented by way of continuity with other decision support systems briefly presented. Chapter 8 of previously referenced *Uncertainty Deconstructed*[68] provides a detailed description of SOA also known as Morphological Analysis (MA)..

Morphological analysis (MA) belongs to a broader set of methods in the decision support area known as Problem Structuring Methods (PSMs).

MA can be defined as being:

"….a method for systematically structuring and examining all the possible relationships in a multidimensional, highly complex, usually non-quantifiable problem space. The basic idea is to identify a set of variables and then look at all the possible combinations of these variables……and reduces the chance that events will play out in a way that the analyst has not previously imagined and considered." [69]

In a morphological model, there is no pre-defined driver or independent variable (or parameter). Any variable, or set of variables or discrete conditions within the main variable – can be designated as a driver. It is this ability to define any combination of conditions as an input or output that gives morphological models such flexibility. Thus, given a certain set of conditions, - what is inferred with respect to other conditions in the model? This "what if" functionality makes MA an extremely powerful tool, and when combined with software, allows researchers to explore viable alternatives in real time from very large configurations of variables and conditions (also known as the Problem Space).

This flexibility in determining what the main variables and parameters to a problem are, makes MA a particularly useful tool for developing Exploratory scenarios whilst encouraging high levels of objectivity.

MA fits our criteria for modelling uncertainty, especially when dealing with large amounts of intangible data, and can be updated and modified in real time, especially where it incorporates strong facilitation with "stretched" teams of multi-disciplinary experts.

Operating at the fuzzier end of the uncertainty/risk spectrum, a central feature of morphological analysis is the flexibility it provides to parameterize a problem complex, acting as scene setter for other decision support methods. In this case, the results of a morphological model can provide input for the development of other (possibly more complex) models such as those highlighted earlier.

It should be pointed out that the term Strategic Options Analysis (SOA) is a perfectly acceptable substitute for Morphological Analysis (MA) in the context of this publication.

Conclusions

The plight of small islands states have gone unnoticed for a long time. It is only in the last decade, largely through their own endeavours that the international community have started to take notice.

SIDS offer a particular challenge to the implementation of suitable deliverable adaptation solutions, e.g. relative geographic remoteness, technological sophistication and the availability of finance. The broad initiative outline presented in this chapter have been in various phases of development since

[68] Forthcoming Springer publication "Uncertainty Deconstructed – Guideline for Decision Support Practitioners – Bruce Garvey, Dowshan Humzah, Storm le Roux

[69] "Structured Analytic Techniques for Intelligence Analysis", Heuer Jr. R.J. and Pherson R.H., CQ Press. 2011.

its inception in 2009 in the Maldives. In the mean time major solutions have become available in sustainability finance along with maturation in advanced digital solutions, all these to be jointly and collectively integrated into the initiative investment model.

We have one major objective, i.e. to enable a compelling SIDS focused bankable investment model to facilitate the flow of net zero adaptation finance.

We are treating the SIDS initiative effectively as a “wicked” problem, with full respect for associated risk not allowing short term solutions that could lead to longer term disruptive unintended consequences.

6 AN OVERVIEW OF GREEN METAVERSE

It is our objective to develop a metaverse solution primarily applied as an innovative investment model, to attract potential investors in a compelling portfolio of Concept-based investment opportunities, represented by NFTs (non-fungible tokens). The available Concepts-library provide the primary input to the NFTs so designed to address the delivery of sustainability and climate neutral (Net-Zero) impact investment solutions. In order to achieve this, the collaboration of several parties is required in the production of the accompanying investment proposal (Financial Masterplan) forming an integral part of the NFT, hence the need for an ***advanced virtual collaborative environment.***

Depending on the nature and specification of the selected Concept, the progression from Concept definition to delivery of an Investment proposal would typically involve the participation of skill sets from different "pockets" of expertise, constituting a ***collaborative environment.***

It is entirely feasible that a selection of skill sets could be geographically dispersed, leaving little opportunity of being around one table during various stages of project co-ordination.

It is also entirely feasible for a project team to have a requirement for sharing various resources, with advanced models pertaining to different aspects of the project solution, being one example.

The Covid-19 lockdown taught us, as consultants, the practical use of video conferencing, effectively connecting a geographically widely dispersed audience into a ***virtual collaborative environment*** (obviously with due respect for time differences).

In order to improve the design quality, various selected technologies contribute significantly. With the proviso that we are capable of efficiently applying and sharing said technology within the design environment in a virtual manner. In many ways the required technologies are not yet fully meeting this requirement.

This leads to the definition of the design environment as an ***advanced virtual collaborative environment.***

The solution is proposing a new approach to the delivery of global sustainability and climate neutral (green) investment, developing a ***green metaverse-based impact investment platform (GMViiP).***

"Green" addresses the sustainability and climate neutral (net-zero) aspects of the delivery objective;

"Impact investment" aims at delivery resulting in a measurable impact;

The ***"Metaverse"*** and it's potential future in delivering advanced technologies, provide the required ***advanced virtual collaborative environment*** as a scalable and transferable platform for a variety of users, such as Central Banks, Governments, Financial Institutions, Professional Consultants and Project Developers, in addition to all forms of Delivery Contractors.

WHY THE METAVERSE?

Suffice to submit that the metaverse is poised to become the next generation of the internet (suggested as Web 3), providing a more powerful and purpose-built infrastructure for connecting virtual 3-D worlds while supporting a myriad of user experiences for consumer and business applications.

A more formal definition is offered by metaverse expert Matthew Ball [70]:

"***The Metaverse is a massively scaled and interoperable network of real-time rendered 3D virtual worlds which can be experienced synchronously and persistently by an effectively unlimited number of users with an individual sense of presence, and with continuity of data, such as identity, history, entitlements, objects, communications, and payments***."

The proposed GMViiP is based on the following premises:

While there is an extensive global on-going conversation taking place on the subject "green" (mostly sustainability and climate neutrality), success in obtaining our goals can only be achieved through cost-effective delivery. This in turn is only achievable through appropriate financial solutions. In other words, sustainability and climate neutrality have to be financed, in order to be delivered.

Successful delivery is also achieved through a focus on the FIT nexus (*finance* – *innovation* – *technology*), a principle which always provided a successful basis for strategy development throughout the sustainability finance journey referred to earlier.

The Decentralised Finance ecosystem, in development since the early definition of the blockchain concept, accelerates the supply of suitable digital financial instruments, making it easier to convert qualitative issues into quantitative investment solutions while using investor compelling delivery vehicles such a non-fungible tokens (NFTs).

Finally, a good design concept, developed into a fully quantified investment proposal, should be considered on par with investable work of art. This is realistic if one considers the broad collection of expertise that had collaborated with project developers in compiling the investment proposal.

As has been proved with digital art – ***Value (perceived or real) is in the eye of the beholder***- in this case the value is largely derived from a compelling investment return delivered by the converted concept.

It is therefore entirely justifiable to issue the investment proposal as a NFT on the blockchain.

A primary function of the GMViiP is therefore to create and deliver a valuable digital asset, based on the selected Concept, derived from the library of concept designs (investment models). To this Concept design sufficient and appropriate value is added through extensive collaboration by the design team.

The ***visualisation*** process (considered a form of "digital art), commences with the initial Concept, and is incorporated in the resulting investment proposal. A professional application of visualisation, with a full understanding of the Concept in question, could be used for effectively introducing the Concept in question to the relevant audience of decision makers, of which policy designers, financial regulators and project investors are the most important.

UNIQUE SELLING PROPOSITION (USP)

The GMViiP offers the following unique selling proposition:

Unlocking intellectual property (IP) focused on sustainability and climate neutrality available as a library of Concepts. The IP library currently comprises in excess of four hundred Concepts.

[70] Ball recently published an authorative analysis – "The Metaverse and How it will Revolutionize everything"

Unlimited growth potential given the current and expected growth in technologies, within the Metaverse.

The Metaverse is already in the early stages of what is considered ***an advanced virtual collaboration environment***. A continuous increase in capability and capacity is expected, especially with regards to visualisation, processing power, tele-communications and overall digital content.

 # Unlimited, highly specialised collaboration access to a variety of specialists, in areas in support of the focus area.

METAVERSE KEY ADVANTAGES AND STRENGTHS

The following key advantages and strengths make a major contribution to the overall GMViiP USP:

Increased digitisation, underpinning overall collaboration capability of the platform, especially with expected growth in advanced visualisation technology such as virtual reality (VR), augmented reality (AR) and extended reality (XR) and in addition to 5G/6G telecommunication technologies.

Transaction security is underpinned by continuous developing and improving blockchain technology, especially in regard to security and energy usage;

Almost instantaneous unlimited global party-to-party communication reach and access;

Extensive interaction opportunities, largely enhanced through visualisation and other digital instruments, applied to the benefit of typical platform users such as investors and project delivery clients.

The development of a prime investment proposal based on a selected Concept is a function of the extent of successful collaboration between project partners, all representing highly specialist areas.

In this regard, it is interesting to note that Boeing is currently planning to completely design their next commercial passenger plane on the Metaverse.

7 STRUCTURE OF GREEN METAVERSE IMPACT INVESTMENT PLATFORM

THE POWER OF THE PLATFORM

The primary objective of the Green Metaverse Impact Investment Platform (GMViiP) is to use the Metaverse (MV) as an investment tool, applying the MV-based ecosystem, aimed at enhancing collaboration between participating parties in a globally based network of "*professional pockets of expertise".*

In the MV-based network, collaboration aims at delivering a quantified investment product, initiated from a CONCEPT, representing focused sustainability and climate neutral characteristics, presented as a *Concept Investment Proposal*, subsequently fine-tuned (using the development procedure, including extensive modelling and simulation) within the MV ecosystem and delivered back into the real world via selected Delivery Platforms.

It is strongly believed that the level of collaboration and hence the quality of the final product will be enhanced from the available MV underpinning technology and its expected on-going improvement with time.

A suitable GMViiP VISION "*aims at the establishment of a sustainability and climate neutral focused digital finance-based impact Investment structure based on the Metaverse*".

Accompanied by a MISSION statement:

Focus on solving wicked problems relevant to sustainability and climate neutrality;

Apply system thinking in order to produce investment-ready green solutions;

Establish, develop and maintain the 5Cs underpinning Net Zero Delivery:

- Credibility (e.g. solutions acceptable to risk adverse investors);
- Consultancy (development and delivery in collaboration with other parties);
- Conceptualisation of solutions, applying the 6I's:- Innovation; Issuing Impact Investment Instruments and Investment Models;
- Coin creation (tokenisation);
- Capital Structure Innovation;

Implement an investment structure with the following key objectives;

- The platform to provide answers to typical frequently asked questions from potential investors:
- Consider the stated objectives jointly as a "wicked" problem and to apply system thinking in order to arrive at the systems architecture for a desired platform delivery solution.

- Serve as catalyst in developing “smart government platforms – accelerating change to smart society.”
- Provide a broad spectrum of potential investors with the capability of achieving a measurable impact through low-risk investment, contributing towards sustainable development in both developed and developing countries.
- Develop appropriate delivery vehicles capable of providing measurable sustainability and climate neutrality solutions.
- Develop innovative solutions in applying advancements in digital technologies towards achieving overall objectives.
- Use blockchain technology to provide platform investors with a secured investment platform.
- Provide a compelling sustainable reward system to Platform investors, providing both short-, medium- and long-term results.
- Provide continuing awareness of the reality of future climate calamity while offering positive solutions towards mitigation and adaptation.
- Address shortcomings in green finance and introduce materiality in the offering.
- Introduce the concepts of a *green think tank* and *green swans*.
- Provide an effective virtual gateway between international knowledge “pockets of expertise” and the continuous delivery of solutions adhering to stated objectives.

In the Platform business-model the Platform co-ordinates the supply of Content between Suppliers (professional collaboration network participants) and Users (Investors) and will be further discussed.

The platform business model as applied in the GMVIP allows for a wide range of Concept proposals to be addressed.

On a macro level it also allows for a range of challenging *wicked problems* to be considered as Concept themes.

A few suggestions are:

- Developing Countries -- Long Term Energy Strategies;
- Bio-diversity Loss;
- The Climate Crisis;
- The Food and Hunger Crisis;
- The “Cost of Living” Crisis;
- Social Housing;
- Decarbonisation at Corporate, National and International (global) level;

SYSTEM COMPONENTS AND FUNCTIONS OF THE GMViiP STRUCTURE

The various components are reviewed and referenced to Diagrams 3 and 4.

Diagram 3 indicates that the GMViiP provides the Business Model underpinning Content, linking Concept Suppliers (Content) in the real world via the Metaverse eco system in a Virtual World, delivering a Concept Investment Proposal back to Users in the real world.

Diagram 3 lists the three key system components jointly constituting the GMVIP as:

- Real world Content Supply;
- MV ecosystem in Virtual world;
- Real world delivery platforms

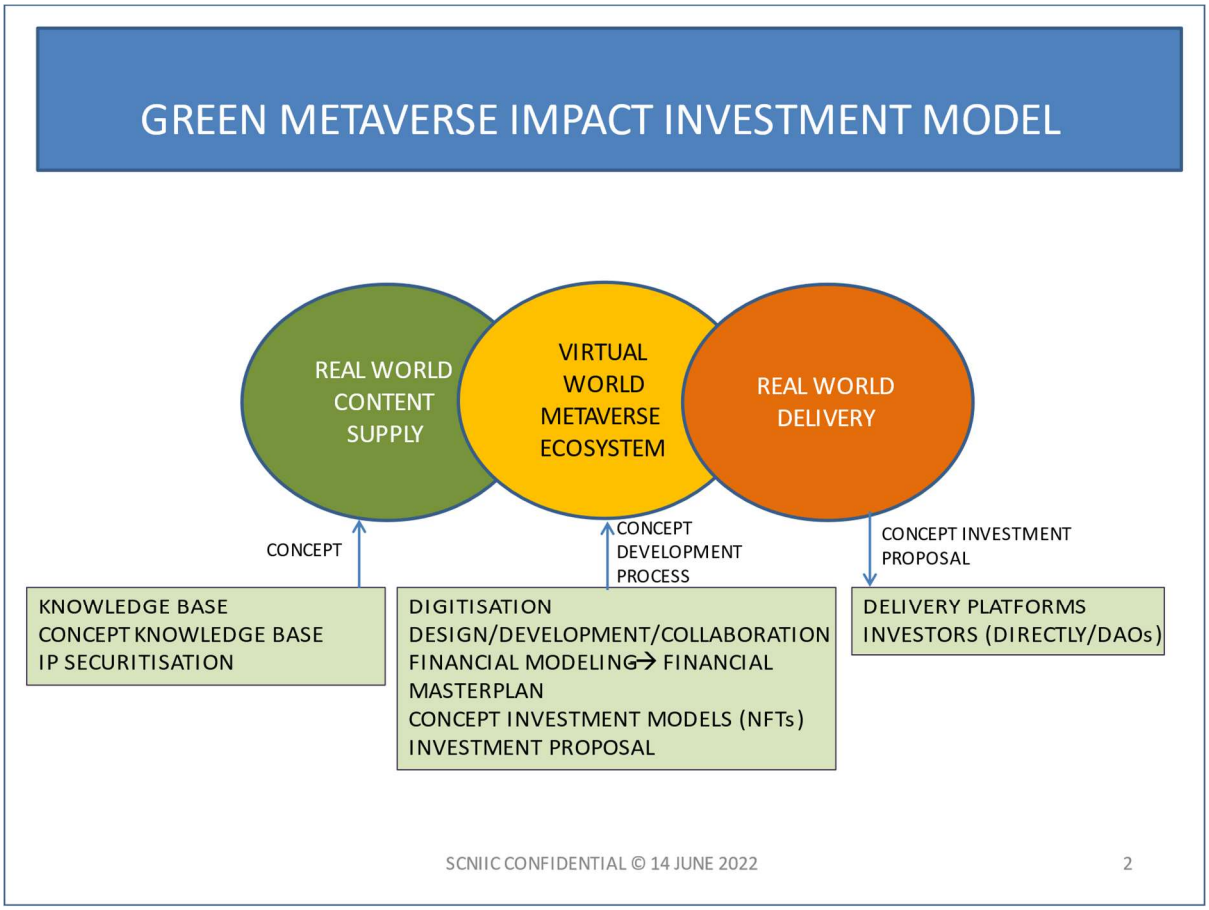


Diagram 3

GMViiP FUNCTIONS

In diagram 4 below, nine C's are shown, constituting the Metaverse ecosystem, all jointly and in an integrated manner contributing towards operational efficiency and profitability of the GMViiP. These nine "delivery tools" are briefly introduced.

Consulting

Focused on need analysis and the required delivery modus operandi, as provided by the platform, Experienced consulting input is required in order to provide the potential investor with a quantified investable product. The SCNiiC group provides extensive experience and expertise in sustainability finance, represented by the Knowledge Base previously referred to.

Concepts

Concepts are generated for on-going need analysis and solution development using the knowledge base as a reference library, to be processed via the GMViiP development process (Diagram 4), advancing towards financed project delivery.

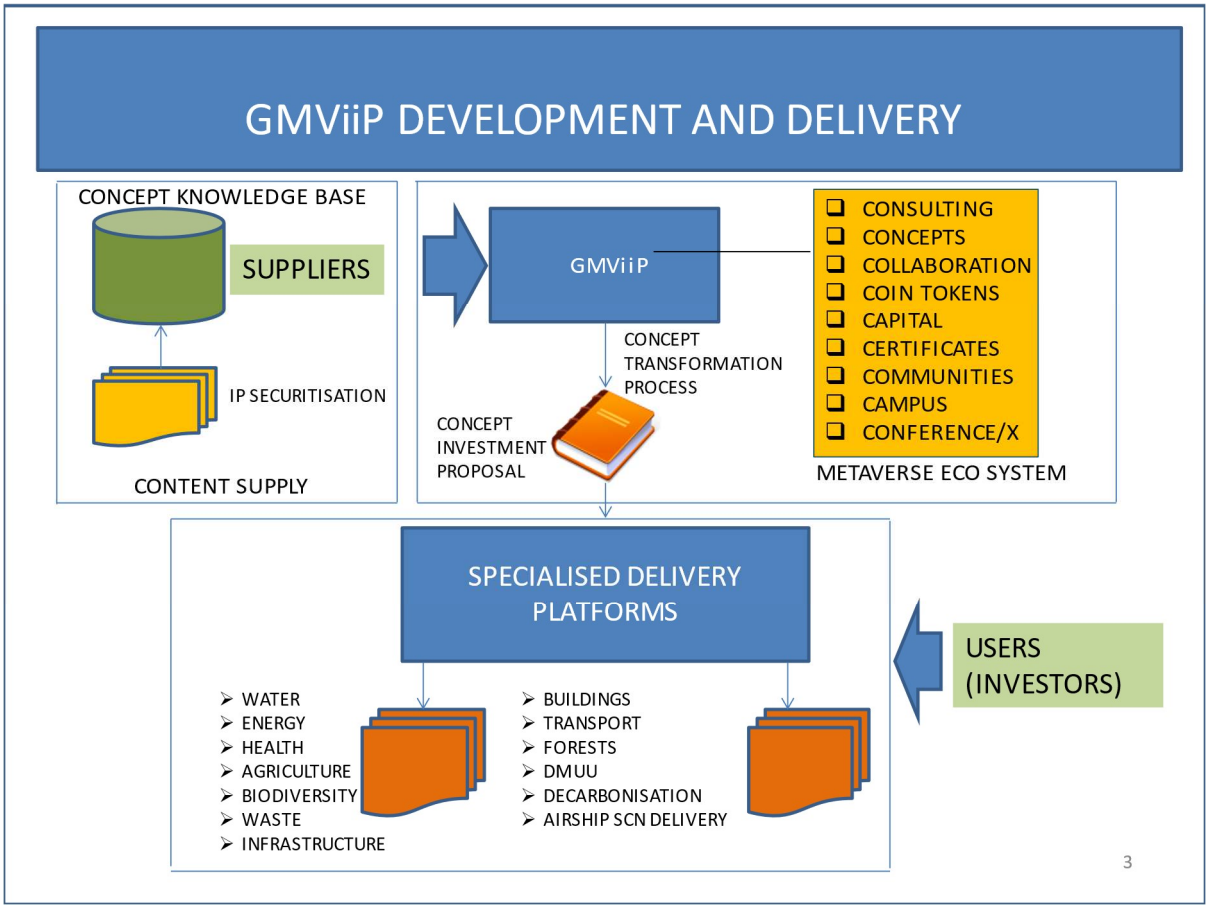


Diagram 4

The availability of this knowledge base, containing several hundred Concepts for deliverable quantifiable investment opportunities, is focused on sustainability and climate neutrality, and very much considered a USP of the proposed GMViiP.

Collaboration

Collaboration is at the heart of design and development of concept delivery. The application of specialist knowledge, sourced from global "pockets of expertise" is enabled by the MV ecosystem with a broad range of underpinning technologies in the GMViiP and will be further enhanced by the projected on-going growth in these technologies in coming years. Visualisation (VR/AR/XR) and communications (5G/6G) are of particular importance.

In order to maximise collaboration, it is planned to grow and develop the knowledge base into a global source of professional expertise through a HUB network, focused on sustainability and climate neutrality impact investment finance.

Capital

Sustainability and climate neutrality impact can only successfully be delivered if properly financed and delivered. It is the intention to use the GMViiP to raise funding for the projected capital budget using suitable digitisation of long-established capital markets solutions, presenting investors with a variety of investment objectives and a compelling choice of quantified and deliverable projects meeting highly credible impact investment standards.

Certificates

By certificates is understood the use of environmental and climate change concepts for the creation of tradeable instruments as GMViiP deliverable products.

Carbon emission certificates, carbon retention certificates and environmental certificates are cases in point.

Digitisation of the concept in question is the starting point in the platform process.

Non-fungible tokens (NFTs), based on environmental and climate change concepts, could be considered as an alternative form of tradeable certificates.

Communities

Two forms of communities are considered in the development of a long-term GMViiP strategy:

Sustainable community projects, whether as part of rural areas especially in developing countries, or as part of urban precincts in both developed and developing countries. These types of communities could perform a highly contributory role in their local area as part of a delivery platform, especially with regard to long-term sustainability and climate neutrality.

A second form of community is created through the use of DAOs (decentralised autonomous operations), as an investor alternative in delivery platforms.

Campus

As part of a virtual real-estate development within the GMViiP, various clusters of expertise available will be jointly presented to potential investors as a campus, allowing easy access to the relevant source of expertise. The campus therefore provides an easily accessible front-end to the global knowledge base, experience and expertise offered by an unlimited number of participants.

This campus aims at offering on a single virtual site in the metaverse, similar facilities to any other campus i.e. class rooms/theatres, meeting/seminar rooms, libraries and recreation facilities. The suggestion is that each of these facilities performs a specific role in the relationship between client/investor/user and supplier i.e. GMViiP and expertise participants/contributors and the Concept developing process arriving at a quantified investment product. This product to be finally delivered via a Delivery Platform (DP), where each DP will also have an access point on the campus.

It is believed that this approach is unique to the metaverse and provides for highly focused access for all participants.

Advanced metaverse technologies will aim at enhancing the utility of each of the campus facilities listed above.

We are inspired in presenting the Campus component by the XEROX PARC (Palo Alto Research Centre), the original birthplace of many original inventions that became part and parcel of the computer industry since the birth of the personal computer, such as Windows, the mouse, local area networks (the ethernet) and the postscript language, later developed as portable document format (PDF).

XEROX PARC is an excellent “case study” of real-world collaborative innovation on one physical site – whereas the GMViiP is proposed to be a global virtual environment.

5Conference/X

An extension of the campus facility is delivery platform orientated virtual conferences with participation of the global knowledge base.

A further extension of Conferences will be on-going partly permanent virtual exhibitions, where companies (as GMViiP suppliers) could offer specialised products and solutions.

THE HOW OF APPLYING THE METAVERSE - THE CONCEPT TRANSFORMATION PROCESS

The simplified system architecture for the proposed MVIP is depicted in Diagram 3.

The step-by-step transformation process from Concept to a quantified bankable Investment Proposal is depicted in Diagram 4, with each step briefly considered below.

Digitisation

The CUBE (reference Diagram 2 page 51) is used to adjust the Concept on the Input dimension guided by a selection of DXP (Digital Transformation Platform) elements on the refence dimension to a Digitised concept on the output dimension.

In appropriate cases, starting from the real-world concept input towards creating a Digital Twin in the Metaverse eco system, could be an effective alternative route to follow.

The elements constituting the Digital Transformation Platform are as previously listed:

Artificial Intelligence, Blockchain, IoT (Internet of Things), Intelligent Sensors, Digital Twinning, Cybersecurity and Cloud Management, Big Data Analytics, Virtual Reality/Augmented Reality, UAVs (Unmanned Aerial Vehicles), Robotics, 5G Networks, 3D-printing, BIM (Building Information Modelling) and GIS (Geographic Information Systems).

The digitised concept will lend itself better to tokenisation and structuring of the NFT.

Concept Development

The first step in this stage is the digital adjustment of the original Concept.

In the next step follows the further development of the Concept towards a quantified investment proposition.

This is achieved in Collaboration with participants representing all the specialist areas required for the specific Concept Investment proposal.

Scenario Planning

One of the first tests for the Concept is immersion in an applicable scenario, with special reference to sustainability and climate neutrality.

Scenario analysis is a method for predicting the possible occurrence of an object or the consequences of a situation, assuming that a phenomenon or a trend will be continued in the future.

Scenario Development Planning

Scenario planning is a way to assert control over an uncertain world by identifying assumptions about the future and determining how your organization will respond.

How do you build a strategic plan for your company if you don't have certainty about the future? That's like laying the foundations of your house on ground that might shift in the future.

Scenario planning is making assumptions on what the future is going to be and how your business environment will change overtime in light of that future.

More precisely, Scenario planning is identifying a specific set of uncertainties, different "realities" of what might happen in the future of your business.

The Scenario Planning Process

- Define focus challenge and the relevant time frame;
- Review past events and alternative interpretations;
- Complete the following steps:

  # Identify driving forces - the big shifts in society, economics, technology and politics in the future

  # Identify critical uncertainties

  # Develop plausible scenarios

  # Discuss implications and paths forward.

One of the first tests for the Concept is immersion in an applicable scenario, with special reference to sustainability and climate neutrality, being the focused challenges.

Simulation

Simulation[71] is the imitation of the operation of a real-world process or system over time.[72] Simulations require the use of models; the model represents the key characteristics or behaviors of the selected system or process, whereas the simulation represents the evolution of the model over time. Often, computers are used to execute the simulation.

Simulation is used in many contexts, such as simulation of technology for performance tuning or optimizing, safety engineering, testing, training, education,[73] and video games. Simulation is used with scientific modelling of natural systems or human systems to gain insight into their functioning,[74] as in economics. Simulation can be used to show the eventual real effects of alternative conditions and courses of action. Simulation is also used when the real system cannot be engaged, because it

[71] Wikipedia

[72] J. Banks; J. Carson; B. Nelson; D. Nicol (2001). *Discrete-Event System Simulation*. Prentice Hall. p. 3. ISBN 978-0-13-088702-3.

[73] Srinivasan, Bharath (27 September 2020). "Words of advice: teaching enzyme kinetics". *The FEBS Journal*. **288** (7): 2068–2083. doi:10.1111/febs.15537. ISSN 1742-464X. PMID 32981225.

[74] In the words of the Simulation article in Encyclopedia of Computer Science, "designing a model of a real or imagined system and conducting experiments with that model"..

may not be accessible, or it may be dangerous or unacceptable to engage, or it is being designed but not yet built, or it may simply not exist.[75]

Tokenisation

Blockchain will tend to the financial landscape and enable an asset to be easily broken down into smaller units, representing ownership, encouraging the democratization of investment in historically illiquid assets.

Whether it be paintings, digital media platforms, real-estate, company shares, or collectibles, everything can be tokenized on a distributed ledger or blockchain. In the GMViiP the focus is on the tokenisation of design concepts relating to sustainability and climate neutrality.

Asset tokenization is the process by which an issuer creates digital tokens on a distributed ledger or blockchain, which represent either digital or physical assets. Blockchain guarantees that once you buy tokens representing an asset, no single authority can erase or change the ownership — the ownership of the asset remains entirely immutable.[76]

TYPES OF TOKENISED ASSETS

FUNGIBLE ASSET TOKENISATION

A fungible asset has two main characteristics:

Interchangeable: Each unit of the tokenised asset has the same market value and validity – for example, Bitcoin: All units of 1 $BTC are exactly the same. They hold the same market value, and are interchangeable. It doesn't matter from whom a $BTC was purchased, since all BTC units have the same functionality and are part of the same network. You can swap one-fourth of a $BTC for anyone else's one fourth of a $BTC, with confidence that your $BTC one fourth holds the same value, despite being one-fourth of different physical coins.

Divisible: A fungible cryptocurrency can be divided into as many decimal places which were configured during its issuance. Each unit will have the same value and validity.

NON- FUNGIBLE ASSET TOKENISATION

A non-fungible token is:

Non-Interchangeable: NFT's can not be replaced with tokens of the same type because each token represents a unique value.

Non-divisible: NFTs are not typically divisible, although F-NFTs do offer fractional ownership of NFTs, such as in the case of expensive fine art or commercial real-estate or an advanced Concept Investment Proposal.

Unique: Each token differs from another token of the same type and has unique information and attributes.

[75] Sokolowski, J.A.; Banks, C.M. (2009). *Principles of Modeling and Simulation*. John Wiley & Son. p. 6. ISBN 978-0-470-28943-3.

[76] https://hedera.com/learning/tokens/what-is-asset-tokenization#:~:text=Asset%20tokenization%20is%20the%20process,either%20digital%20or%20physical%20assets.

NFT Definition and Structure

The concept transformation process as described will provide the final definition of the resulting Concept as a NFT and to be uploaded to the blockchain associated with the GMViiP.

Financial Modelling

The Concept business model will incorporate a cost model and the necessary financial projections, allowing a stress test to be applied.

Concept Investment Model

In this case the initial concept has been fully digitised and transformed in an innovative manner into a business model. As a further step the business model is integrated with relevant complimentary and supportive models of which a financial model will definitely be one.

The Investment model will provide a full description of the concept and its objectives, the transformation process, manners of revenue generation and all relevant financial projections. It will provide an analysis of how sustainability and climate neutrality is to be implemented and where possible a projection on savings in carbon and other greenhouse gas emissions.

SPECIALISED DELIVERY PLATFORMS (SDPs)

Diagram 4 indicates the positioning of the delivery platforms in the overall structure.

Serving as the vehicle for the delivery of the Concept focused NFTs, the delivery platforms are the final step in the process of achieving sustainability and climate neutrality focused impact investment.

The delivery platform needs to meet the following requirements:

- It serves a portfolio of Concept Investment Proposals;
- Providing in each case a Unique Selling Proposition (USP);
- It clearly defines the impact to be achieved in measurable terms;
- It is subject focused (as defined by a specific delivery platform) with special reference to sustainability and climate neutrality in each case;
- It delivers on the cost effectiveness, revenue generation and profitability as projected in the Concept investment Proposal as embodied in the corresponding tokenised NFT;
- The structure allows for a variety of investors e.g. joint venture partners, individual direct investors and investors via a DAO (decentralised autonomous operation) associated with a specific platform;
- The structure allows for implementation, on-going monitoring and feedback.

An initial list of Delivery Platforms is:
The ten components of the Climate Change framework being Water, Energy, Health, Agriculture, Biodiversity, Waste, Industry/Infrastructure, Buildings, Transport (rail, road, air and maritime) and Forestry.

To which an additional four specialised platforms are added:

- DMUU – Decision Making Under Uncertainty;
- Decarbonisation;
- Airships -- sustainability and climate neutrality delivery;
- Small Island Developing States (SIDS).

Suggested criteria in the selection of Delivery Platform for the proposed pilot project:

- Credible joint venture partner(s);
- Clearly defined clarity of purpose;
- Providing relative ease of implementation

PLATFORM DELIVERING STRATEGY

As part of a delivery strategy, three objectives are set:

- Deliver the GMViiP key objectives, stated earlier;
- Explore the listed potential Metaverse opportunities;
    - Investment Opportunities
    - Modelling Tool
    - Decision making tool
    - Education Tool
    - Technology Entrepreneurship support mechanism
    - Social Entrepreneurship support mechanism
    - Metaverse Regulation and Law increasingly being addressed by legal practices[77]
- Explore an initial list of Green Applications to be addressed (next paragraph).

POTENTIAL GREEN APPLICATIONS OF THE PLATFORM

The use of the platform is potentially applicable in the following industries, especially in terms of achieving sustainability and climate neutrality (net-zero transition).

- Industrial Decarbonisation
- Power Industry
- Oil and Gas
- Global Energy Perspective
- Automotive
- Aviation and Shipping
- Steel manufacturing
- Cement manufacturing
- Mining
- Agriculture and Food
- Forestry and other Land Use

[77] Clifford Chance – The Metaverse: Risks and Opportunities for businesses
https://www.cliffordchance.com/briefings/2022/07/the-metaverse--risks-and-opportunities-for-businesses.html

This list constitutes a clear target for the role of Central Banks as policy development advisors to Government and the Finance Industry on sustainability and climate neutrality (net-zero transition).

8 CONCLUSIONS - RECOMMENDATIONS

A personal note from the author/editor:

Following the Covid-19 lockdown period, the completion of “Blackgoo to Blockchain” in addition to making a contribution to “Uncertainty deconstructed”, the second half of 2021 was largely focused on the compilation of an initial list (in excess of 400+) of Green Concepts from the ISDC Knowledge Base.

It has been an objective for a considerable period to be able to negotiate the potential licensing part of this considerable sustainability and net-zero focused resource to a suitable financial institution, one with a definite interest in the promotion of impact investment in this area.

Up to the close of 2021 an increase in Metaverse related incoming newsletters and webinar invitations became noticeable. This inflow provided a focus on the financial industry and their role within the Metaverse with the concomitant question as to the applicability to our primary focus area of sustainability and climate neutrality.

It is envisaged that this initial essay could serve one of three purposes:

- Contribute to establishing an initial ***Green Metaverse Impact Investment Platform (GMViiP***).
- Serve as a platform for an expansion of the essay, in support of wider discussion and Impact Investment delivery by interested parties.
- Be converted into an investment proposal aimed at fund raising for development of the GMViiP.

Concepts are defined as proposed strategies applied towards solving sustainability and net-zero challenges and presented as impact investment models.

In the development of the investment model, the various ultimate goals can be set, i.e.

- Issuing the investment model to be issued as a non-fungible token on the blockchain and sold to investors;
- To be issued as the equivalent of a certificate (such as carbon emission reduction) on a suitable trading platform;
- To serve as advice to a suitable policy recommendation, related to the original Concept input.

From the research on which the essay is based, in excess of four hundred Concept proposals have been conceived, each to be delivered as one of the listed goals.

It is expected that in the delivery of each Concept as an impact investment model, several professional parties will be involved, dependent on the inherent nature of the Concept.

An initiative was consequently launched in addressing suitable financial institutions with a development proposal for a Metaverse based sustainability and net-zero delivery platform. Hence the concept of ”Green Metaverse” was born, resulting in the original draft of this essay during the second quarter 2022.

This version is focused on the role of Central Banks, with regards to sustainability and climate neutrality, providing an advisory role to Governments and other financial institutions.

This is considered a daunting challenge, to be holistically approached through applying system thinking, arriving at a portfolio of system components. For the success of this process, relevant frameworks, as explored in the presented material and summarised here for convenience are used.

Framework 1:
THE GREEN FINANCE CHALLENGE FOR CENTRAL BANKS

As pointed out by Nick Robins, Simon Dikau and Ulrich Volz in their March 2021 Policy Report - There is a dual rationale for action:

First, recognising that achieving a net-zero economy is the best way of minimising the risks of climate change to stability of the financial system and the macro-economy; and

Secondly, making sure that central banks and supervisory activities are coherent with net-zero government policy.

Monetary and financial authorities will need to play a pivotal role in shaping the tools, methodologies, data systems and taxonomies required for net-zero. Crucially, they need to align their own policies and operations with net-zero implementations.

Framework 2:
UNDERSTANDING GREEN FINANCE AND THE DEFINITION OF "GREEN CONCEPTS"

Typical projects that fall under the green finance umbrella include:

- Renewable energy and energy efficiency;
- Biodiversity conservation;
- Pollution prevention and control;
- Circular economy initiatives;
- Sustainable use of natural resources and land.

In Diagram 4, this list is extended with additional specialised delivery platforms.

Framework 3
THE CURRENT STATUS OF PROGRESS FOR GREEN FINANCE

In this section we reviewed the current status of three important elements of the global green finance ecosystem:

- Progress made in the delivering on the 2015 Paris Agreement;
- Delivering of Sustainable Development Goals (SDGs);
- Net-Zero transition finance.

Accentuated were five things the Paris Agreement has achieved — and five things still to work for[78].

[78] https://www.climatechangenews.com/2020/12/09/five-years-five-things-paris-agreement-achieved-didnt/

Framework 4
ALIGNMENT WITH PARIS AGREEMENT GOALS

Since the adoption of the Paris Agreement, financial institutions and other economic actors have taken commitments to 'align' their activities with the goals agreed to by national governments in 2015. A growing body of literature from both the research community and practitioners has emerged on '*alignment' with the Paris Agreement goals* – but to date no overarching framework has been proposed to define what it means and implies in practice.

"Governments and government-backed entities will have an important role to play in helping to finance the transition to ACO (Alignment with Climate Outcomes). The sheer quantity of capital required is one reason. In the energy sector alone, meeting well-below 2°C could require US$1.5 trillion of additional investment per year from now until 2050 (McCollum et al, 2018), up from a total of around US$1.2 trillion of investment in 2019 (Buchner et al, 2019).[79] This story is replicated in other sectors and already constrained private sector balance sheets are probably unable to efficiently raise all the capital needed.

Dr Ben Caldecott, founding Director of the Oxford Sustainable Finance Programme, outlined three interlocking elements that combined make ACO possible for financial institutions:

Measuring, tracking, and targeting using carbon lock-in approaches for assessing (in)compatibility together with confidence levels for given targets;

• Contributing to alignment through instruments across asset classes actually making a difference to the real economy transition, with financial institutions proactively maximising their impact; and

• Adopting appropriate governance, behaviours, and principles and embedding alignment in overarching strategies and key functions.

Framework 5
UNDERSTANDING THE "NET-ZERO EQUATION" AND THE REQUIRED SOLUTION

The McKinsey paper introduced nine independent requirements in three categories, i.e.

- Physical Building Blocks;
- Economic and Societal Adjustments; and
- Governance, Institutions and Commitment.

Framework 6
UN SUSTAINABLE DEVELOPMENT GOALS

The seventeen goals are described in the case study and fully expended on in the given link.[80]

[79] Buchner, B., Clark, A., Falconer, A., Macquarie, R., Meattle, C., & Wetherbee, C. (2019). *Global Landscape of Climate Finance 2019.* Retrieved from https://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2019/
[80] https://en.wikipedia.org/wiki/Sustainable_Development_Goals

Framework 7
CLIMATE CHANGE FRAMEWORK

The ten selected variables, i.e. application areas capable of making a significant contribution to greenhouse gas emissions are *water, energy, health, agriculture, biodiversity, waste. Infrastructure, buildings, transport and forests*.[81]

Framework 8
DIGITAL TRANSFORMATION PLATFORM

The fourteen variables[82] singularly or in combination create a comprehensive digital technology enhancement vis-à-vis all other listed frameworks above, contributing towards delivering net-zero solutions.

Artificial Intelligence, Blockchain, IoT (Internet of Things), Intelligent Sensors, Digital Twinning, Cybersecurity and Cloud Management, Big Data Analytics, Virtual Reality/Augmented Reality, UAVs (Unmanned Aerial Vehicles), Robotics, 5G Networks, 3D-printing, BIM (Building Information Modelling) and GIS (Geographic Information Systems).

DELIVERY OF CONCEPTS

It is expected that in the delivery of each Concept, several professional parties are involved, totally dependent on the inherent nature of the Concept.

It has been experienced that the required professional contributors, could be considered as specialised "pockets of expertise". In previous work, leading to the completion of the essay, we have referred to such "pockets" as "HUBS".

HUBS can take on several forms and some examples are:

- Where a highly specialised capability is centred around one or more individuals typically at an academic institution.
- Where a specialist capability had developed following the completion of typically a masters or doctorate dissertation.
- A specialised consulting practice operating on a relatively small stand-alone basis or as part of larger practice.

Recommendation#1

The development of a network of hubs within the GMViiP to accelerate the delivery of a selection of challenges, alternatively proposed as wicked problems.

[81] The selection was part of a 2008 ISDC Climate Neutral Strategy, implemented at Boschendal Wine Estate in Western Cape Province, South Africa. Similar analysis by the WBCSD – World Business Council for Sustainable Development and the then current IPCCC (Intergovernmental Panel on Climate Change) Assessment report, were combined, producing ten variables.

[82] Selected over several years as a result of a various consulting assignments by ISDC and SCNiiC.

Referring to page 65 where we introduced and proposed a few examples of wicked problems, inter alia –

- Developing Countries -- Long Term Energy Strategies;
- Bio-diversity Loss;
- The Climate Crisis;
- The Food and Hunger Crisis;
- The "Cost of Living" Crisis;
- Social Housing;
- Decarbonisation;

Recommendation#2

Recognise selected SMEs as ideally suited entities for the delivery of sustainability and net-zero strategies, to be developed within a MViiP guided umbrella organisation.

A further example of a pocket of expertise is an SME:

Small and medium-sized enterprises (**SMEs**) or **small and medium-sized businesses** (**SMBs**) are businesses whose personnel numbers fall below certain limits. The abbreviation "SME" is used by international organizations such as the World Bank, the European Union, the United Nations, and the World Trade Organization (WTO).

In any given national economy, SMEs sometimes outnumber large companies by a wide margin and also employ many more people. For example, Australian SMEs makeup 98% of all Australian businesses, produce one-third of the total GDP (gross domestic product) and employ 4.7 million people.[83]

Recommendation#3

In a recent Financial Times article[84] the author Heather Grabbe[85] states that "*Today no climate-neutral economy exists to give everyone the courage to make the leap*."

Proposed is a network of Central Bank driven HUBS working closely with the governments of relevant countries, individually applying the GMViiP underlying principle of an "Advanced Virtual Collaboration Environment", being well placed to address this daunting challenge of financing the rebuilding of the Ukraine as a wrecked country, but simultaneously using the opportunity to deliver an important "model" for climate-neutral economies.

The existing Network for Greening the Financial System (NGFS) appears to be potentially well placed undertakeing a strategy planning and co-ordination task.

[83] Wikipedia

[84] "*Ukraine can be a leader of Europe's green transition*", Heather Grabbe, Financial Times 4th August 2022

[85] The author is senior adviser to the president of Open Society Foundations

Recommendation#4

Develop and present GMViiP support tools and methodologies (such as applied visualisation) as individual HUBS in support of governments and financial institutions.

One positive spin-off from developing metaverse technologies is advanced visualisation. This can fruitfully be applied as a tool in providing an improved understanding of a Green Concept to clients in the delivery loop, of which governments are relevant.

In closing, it might be suggested that an appropriate strategy is required to deliver these four recommendations.

STORM LE ROUX

ASCOT

11th AUGUST 2022