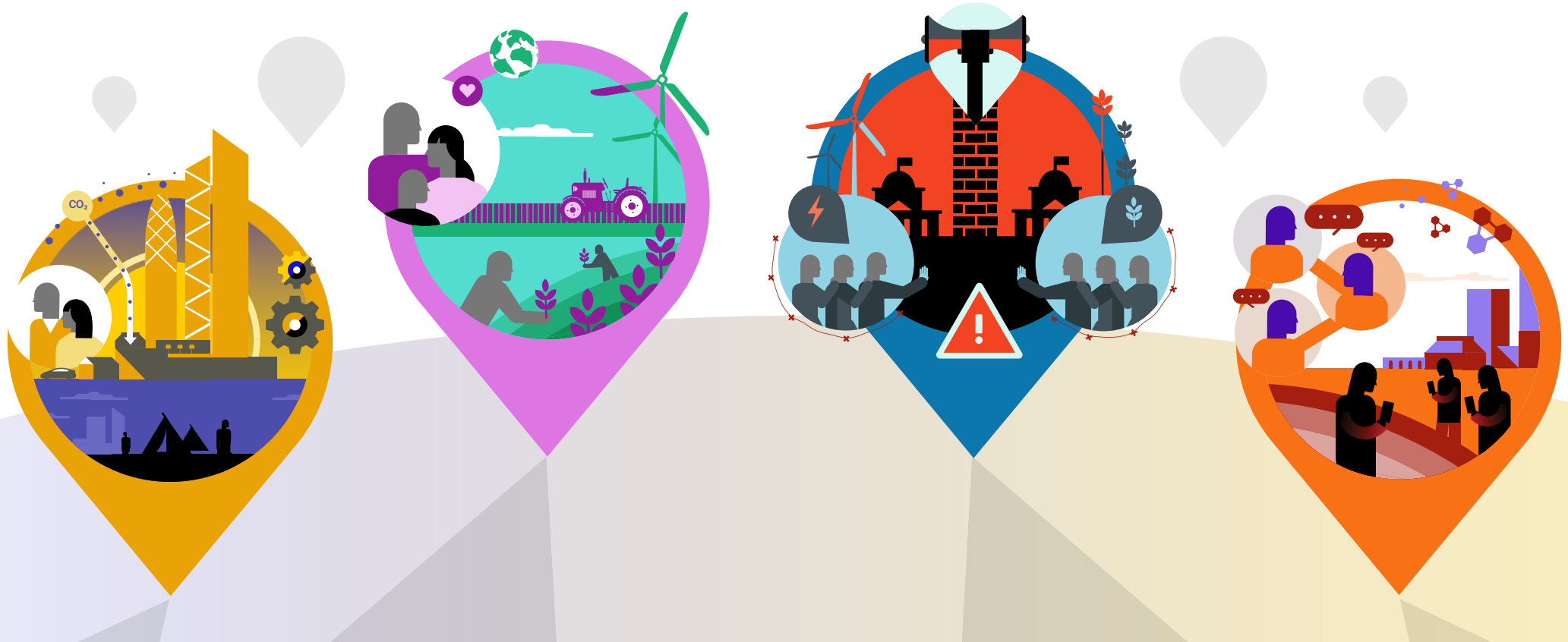


# <2°C Futures



ADITYA BIRLA GROUP

2040 worlds on a trajectory to stay below two degrees centigrade of warming above pre-industrial levels



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# Foreword

Welcome to our <2°C Futures

**At ABG, we have worked hard to create a Sustainable Business Framework that helps signpost us to the requirements and potential hazards and opportunities on the way to 2030 and 2050. It seeks to ensure that we future-proof our businesses so that they continue to be successful in the longer term.**

We as nations, as society and as a business have achieved tremendous progress in the last 100 years. The Aditya Birla Group (ABG) has grown to a US \$44.3 billion corporation, in the League of Fortune 500. Anchored by an extraordinary force of over 120,000 employees, belonging to 42 nationalities, our revenues flow from operations spanning 35 countries. We are competitive and lead in many of the sectors in which we do business. On average globally, in many ways we are living longer, healthier, better lives than ever before. We have a long way to go, but we see progress.

This progress has in some ways benefitted the planet, but it has also challenged the very nature of the ecosystem that our very existence depends on.

We are now in a precarious situation. 193 nations have signed up to the Paris Agreement commitment to keep the global temperature rise under 2°C above pre-industrial levels, yet our stated Intended Nationally Determined Contributions will only keep the temperature rise to 3-4°C. We know the ratchet mechanism has to increase these contributions if we are to keep under 2°C. This will not happen by itself. The 'business as usual' trajectory tells us this. We recognise that the dangers of continuing as normal and not adhering to this commitment are significant to say the least.

At ABG, we acknowledge that many businesses will not contribute until they are legislated to do so. We have worked hard to create a Sustainable Business Framework that helps signpost us to the requirements and potential hazards and opportunities on the way to 2030 and 2050. It seeks to ensure that we future-proof our businesses so that they continue to be successful in the longer term.

Climate change and the herculean task of moving from a business as usual 6°C to a transformational below 2°C trajectory is already shaping our operating environment and our value chains today. But understanding the multitude of effects of this transformation is challenging.

Imagining the best case 2°C future, how will citizens and businesses have been affected?

What will the businesses that have remained sustainable need to have done to adapt their operations, value chains and products so they thrive now, and on the road to this hotter world?

Is adaption technically possible and affordable or are many businesses already doomed to be unsustainable dinosaurs? Will this happen sooner rather than later as emerging legislation, such as carbon pricing, bites?

What other levers do the governments of the world have to enable this change? Will product labelling, traceability and transparency of operations, production caps and allocations, or technology uptake incentives figure in this picture?

Critically important to the business manager, how will the government mandates driving this transformation affect our businesses in the short and medium term?

Global warming has an impact on every part of the earth's ecosystem. For instance, rising water levels place the biggest cities along coasts at tremendous risk. Some of the biggest cities like New York, San Francisco, Miami, London, Barcelona, Mumbai, Kolkata, Hong Kong etc. will be impacted significantly. Many of these contain our customers and are major markets for our products. How and where may we meet the needs of future consumers?

Global warming will impact agriculture through changing water availability and temperature extremes. In many developing economies, a large majority of the workforce is involved in agriculture. High temperatures will impact production of basic crops, leading to hunger and pose a challenge to society in continuing to uplift people from poverty. For the farming business and the farmers themselves, no water means no income, potentially forcing unplanned mass migrations. What does this do to our workers and our markets if more people are forced to migrate?

**In order to study which of our businesses are candidates for continued success along the road to a 2°C hotter world and those that are not, we must take a cold hard look at how each one might become unsustainable and for what reason.**

The Aditya Birla Group, and every major company within it, will have to raise awareness at every level. We must be prepared to act which, in some cases, will be disruptive and likely expensive. For instance, we see that as leaders, we will have to transform some of our industries to remove or close the loop on plastics and electronic waste, find water and change our energy matrix. On how this will happen, we believe as leaders we need strong self-regulation to meet international standards, and consequently local legal changes, thus gaining first mover advantage. In turn this helps governments to build effective regulation at multiple levels.

“My personal experience in the soft drinks industry showed how a lack of self-regulation in the industry on sugar levels and developing alternative beverages has invited tax levels of 50 % in Saudi Arabia and 40 % in India.” *D. Shivakumar*

Society, aided by new information technologies and better data collection, will demand disclosure from all our businesses on topics such as compliance, operational performance, supply chains and how they are meeting expectations. And where society does not have enough knowledge or collective influence to do this, governments will need to step in to ensure the greater good is achieved.

In order to study which of our businesses are candidates for continued success along the road to a 2°C hotter world and those that are not, we must take a cold hard look at how each one might become unsustainable and for what reason. Because we cannot predict accurately exactly what the world will be like, we need to use scenarios to test our hypotheses. Currently, we don't believe the playing field on the road to a sustainable world will be level, and we need to understand where we can adapt, and where our competitors perhaps cannot.

Our approach to get us on the 2°C trajectory, and the commitments we make as a leading Indian conglomerate, will to a large degree determine the trust we get from society. Trust is the ultimate and most precious accolade we can get in a

challenging world and we are both really pleased that the Group Strategy and Sustainability teams are working together, supported by Forum for the Future, to help evolve, our knowledge, thinking, strategy and response.

At ABG, we hope that by doing this study we can help people take both mitigation and adaptation seriously today but also give ourselves a competitive advantage in the future. By building sustainable businesses we aim to give ourselves the edge to gain market share from those that are or become unsustainable and who, ultimately, fail.

**D. Shivakumar**

Group Executive President, Aditya Birla Group

**Tony Henshaw**

Chief Sustainability Officer, Aditya Birla Group

# The Aditya Birla Group Sustainable Business Framework

Over the last five years, the Aditya Birla Group has developed and followed a logical Sustainable Business Framework. This framework recognises that the future will be – and indeed has to be – radically different to today. Importantly, it makes it clear that we must avoid acting too late on the knowledge we have if we are to remain successful.

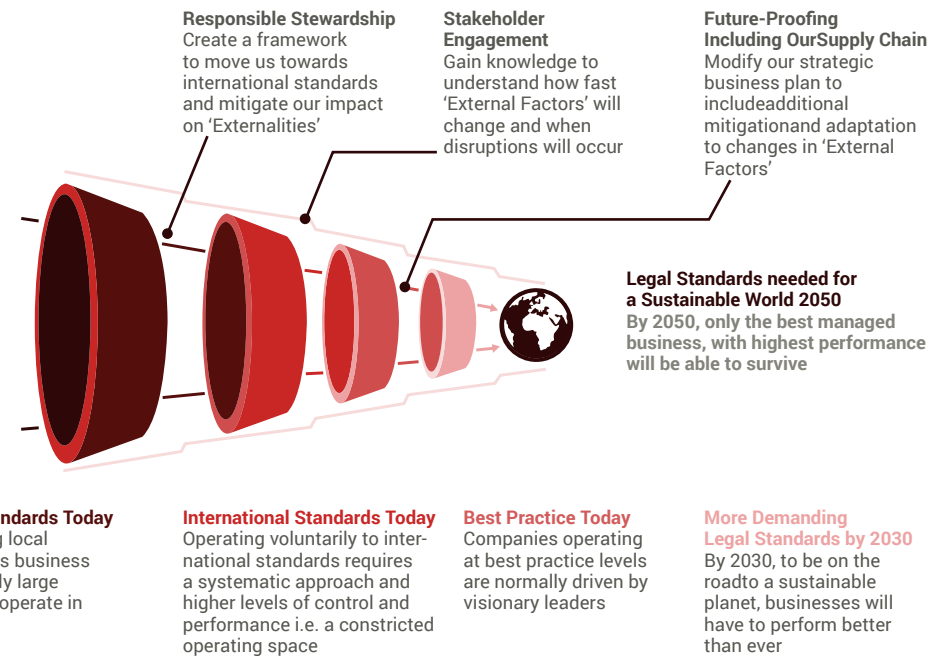
The ABG Sustainable Business Framework takes the form of a funnel, representing the increasingly constrained business operating context over time. As legislation is formed and implemented around megatrends such as climate change, management and protection of biodiversity, control of nitrogen and phosphorus use, prevention of soil and water degradation, control of non-degradable waste etc, we feel it will drive the massive behaviour change and adoption of new technologies and products needed for a sustainable future. Unsustainable businesses will fail because they are not be able to generate cash while performing at the levels required to manage these trends, such as keeping below 2°C of warming above pre-industrial levels.

Only sustainable businesses able to operate within the tightening walls of the funnel will survive. It is ABG's belief that a smaller number of higher performing businesses – together with their sustainable value chains – will exist by 2050 to deliver society's needs.

Much of the focus of the Aditya Birla Group sustainability efforts has been on ensuring that we are legally compliant and that we build management systems that conform to international standards that signpost the requirements of 2050. Further, we are learning to test our business strategies against future scenarios to make sure they are resilient and capable of winning market share into the future.

We summarise this in three steps:

1. ensuring Responsible Stewardship now, adhering to legal requirements and building management systems conforming to international standards across all our operations and, importantly mapping our supply chains
2. engaging in Strategic Stakeholder Engagement to understand from experts how the law, and other factors, is likely to increasingly constrain us
3. strategically Future-Proof our business strategies and our supply chains, really understanding what possible futures lie ahead, what risks and opportunities they present, and actioning now programmes to develop what it takes to fit within the sustainable world represented by the funnel tip in 2050.



ABG believes that legislation required to prevent more than 2°C of warming is the ultimate influence on the walls of the funnel. Throughout the Group, we understand this, are acting now in response and are committed to building sustainable businesses capable of operating profitably within these walls.

We believe that pioneering businesses will pull global society down the funnel by setting new standards for their products and operations and gaining competitive advantage by doing so. Leading practices over time will be codified into international standards and, eventually, into local legislation that will force business down the funnel. Those not capable of adaption will, like dinosaurs, go extinct.

<2°C Futures sets out to explain what the end of that funnel looks like by 2040: the space we'll have to operate within to be successful. Understanding different scenarios of how we as a society might get there and making them part of our business strategy is part of our effort to build sustainable businesses that afford for long term success, starting right now.

# Executive summary

## Our possible futures in a nutshell

**Getting ourselves on a below 2°C trajectory will mean radical change. It will require levers to be pulled by business, government and society, all whilst adapting to the physical impacts guaranteed by our previous emissions.**

The Paris Agreement commits us to limiting global warming to under 2°C above pre-industrial levels. It reflects the universal acknowledgement of the threat climate change poses to our continued survival. The planet has already warmed by at least 1°C<sup>1</sup> and current policy commitments could lead to 2.7-3.7°C<sup>2</sup> of warming, risking runaway warming and a hothouse Earth. The window of opportunity has almost closed and the challenge ahead is almost overwhelming.

Getting ourselves on a below 2°C trajectory will mean radical change. It will require levers to be pulled by business, government and society, all whilst adapting to the physical impacts guaranteed by our previous emissions. For instance, the electricity system must be almost totally decarbonised and mobility electrified; energy efficiency must increase dramatically and the way we produce and consume food will need to shift; flows of capital will need to change and carbon pricing and regulation will likely reshape the business landscape.

Businesses that aim to continue to be successful, and those who wish to proactively find value in a below 2°C future need to understand the risks and opportunities posed by three things:

- The likely physical impacts of climate change and their implications for the entire value chain
- The levers that must be pulled soon to get us onto a below 2°C trajectory
- The way that the socio-economic context could make these levers more or less severe over time

By 2040 the physical impacts of climate change will be more obvious than today. For instance experts expect greater water shortages and more dramatic flood patterns to affect food security. Heatwaves will become more frequent and intense, making some areas unliveable if action is not taken. Much of our coral reefs are likely to have bleached, dramatically affecting the livelihoods and diets of millions of people. The implications of these physical impacts need to be considered now as many of our decisions will determine what risks or opportunities we face

in 2040. For instance acquiring a manufacturing plant in an area likely to be facing water scarcity or intense flooding will virtually guarantee a future loss of productivity. Investing R&D resource in value propositions that help people manage extreme heat or cold would likely be smart.

In order to shift from our current emissions trajectory to one that keeps us below 2°C, there are some levers that simply have to be pulled soon. The electricity system globally will have to be decarbonised somewhere between 2040 and 2060. The internal combustion engine will have to be phased out totally somewhere between 2040 and 2050. By 2040 all new buildings will have to be zero carbon, and approximately 5% of existing stock will have to be retrofitted to the same standard every year from 2030. Heavy industries will have to have reduced their absolute emissions by 40% by 2040 from 2015 levels. And the overall economy will have to be 300% more energy efficient than it is in 2018. To meet many of the models negative emissions technologies that today do not exist at scale will have to be invented and massively scaled by mid-century. To get us on these time-tables means taking some critical actions by 2020 including an end to all new coal fired power plant approvals, cities across the world upgrading 3% of existing buildings to zero carbon each year and a step change in renewable energy generation to 30% of the world's electricity supply.<sup>3</sup>

This is a radically different business landscape. Depending on the industry you are in, different actions will prepare you, but action will be required by all.

How these levers are pulled, and how they are combined with others, will depend on the socio-economic context at that time. Many of the emissions trajectory models assume that the context in 2040, 2060 and 2100 will look similar to today. We know this is unlikely given the change we have seen over the previous 20, 40 and 80 years. For this reason, we need to understand how these levers could impact our businesses in different socioeconomic contexts: for instance, in a world of strict international governance what could we be forced to

The scenarios are tough, and constraining, but they are scenarios for success. They are four different pathways we believe are viable from the standpoint of 2018 to limit warming to under 2°C.

comply with and what incentives could we benefit from; and how can we therefore find success in that 2°C future? How might this differ if international governance splinters into protectionist blocs? To understand this well, we need to consider scenarios that set out different possible futures - not favoured visions or predictions, but scenarios that help people consider the different eventualities. We put forward four which businesses can use to identify risks, opportunities and appropriately plan for success:

- **Efficiency First** : a precarious globalised house of cards where constant and often risky technological innovation, motivated by high carbon prices, is just keeping us on track
- **Redefining Progress** : a digitally connected, yet highly localised world where priorities in many countries have shifted from rapid growth to healthier growth
- **New Protectionism** : a splintered world of protectionist blocs, where tackling climate change is a matter of national security
- **Service Transformation** : a world where the mainstreaming of access over ownership has happened quickly, and globally-applied, individual carbon budgets are traded and tracked

The scenarios are tough, and constraining, but they are scenarios for success. They are four different pathways we believe are viable from the standpoint of 2018 to limit warming to under 2°C. Other futures are available, but most of these involve higher levels of warming and much greater unpredictability from a climate and indeed socio-economic and political point of view. Together, the baselines and scenarios suggest that businesses set to be successful in a <2°C future need to be ready for a complex picture of mutually reinforcing changes including:

- A tough policy landscape and robust implementation
- The end of coal
- A huge transformation in the built environment
- A step change in agriculture and food
- A mobility revolution
- New materials and minerals to the fore

- Detailed monitoring of corporate, and even individual, behaviour
- The emergence of radically different governance and business models
- A change in land use on a massive scale for protection, sequestration and / or energy
- Sea-level rise that poses serious challenges for low-lying coastal cities
- Hotter, more frequent and longer heatwaves and intense flooding
- Increasing migration, particularly from water-stressed areas
- Tackling poverty is critical to all
- An acceptance that technology alone will not save us

The time for action is now if we want our businesses to continue to be successful. According to a report by leading experts: “There will always be those who hide their heads in the sand and ignore the global risks of climate change. But there are many more of us committed to overcoming this inertia”. Finding business value on a below 2°C trajectory is at the least imperative to manage our risks, and at best a source of transformational competitive advantage — and probably sooner than most think.



# The case for action

## There is no business case beyond 2°C

The Paris Agreement on climate change commits us to keeping under two degrees centigrade of global warming beyond pre-industrial levels, and sets an aspiration to keep to 1.5 degrees. It was signed by 195 countries and ratified by the 179 that account for 88.75%<sup>5</sup> of global emissions, including China and India – reflecting a universal acknowledgement of the pervasive threat of climate change to our continued survival.

The 2°C limit is set based on science, simply because going beyond has potentially cataclysmic implications for society and economies everywhere. Rockstrom and his colleagues at the world-renowned Stockholm Resilience Institute point out that beyond 2°C there is a risk we become a “Hothouse Earth” which will stabilize at a global average of 4-5°C higher than pre-industrial temperatures<sup>6</sup>. Amongst other effects, this means a sea level 10-60 metres higher than today. New York, Bangkok, Jakarta, Dhaka, Singapore, Tel Aviv, Washington DC, Manila and Rio de Janeiro are amongst the cities that would be wiped out even at the lower 10 metre projection, whilst entire island nations such as the Maldives, Micronesia and Tuvalu would cease to exist.

It is hard to imagine any viable business case within a Hothouse Earth scenario. Not taking action means putting any business on a certain path to eventual collapse. For those looking to lead businesses that can be sustained in the long run, it is clear the business case exists only for action to stay below 2°C.

Unfortunately, it is difficult to identify those responsible or accountable. The year 2040 (let alone 2050 and 2100), by which many of the most serious consequences of inaction will be felt, is far beyond the usual scope of business planning or political cycles. It is probably beyond the tenure of all but very few CEOs. It is up to us to decide if our legacy will be societal and economic collapse, and time for us to understand that taking no action is a conscious decision in itself.

## Carbon Crunch

The following graphic illustrates just how dramatically emissions must be reduced to remain within a carbon budget of 600-800 GtCO<sub>2</sub> – which is broadly aligned with restricting warming to between 1.5°C and 2°C

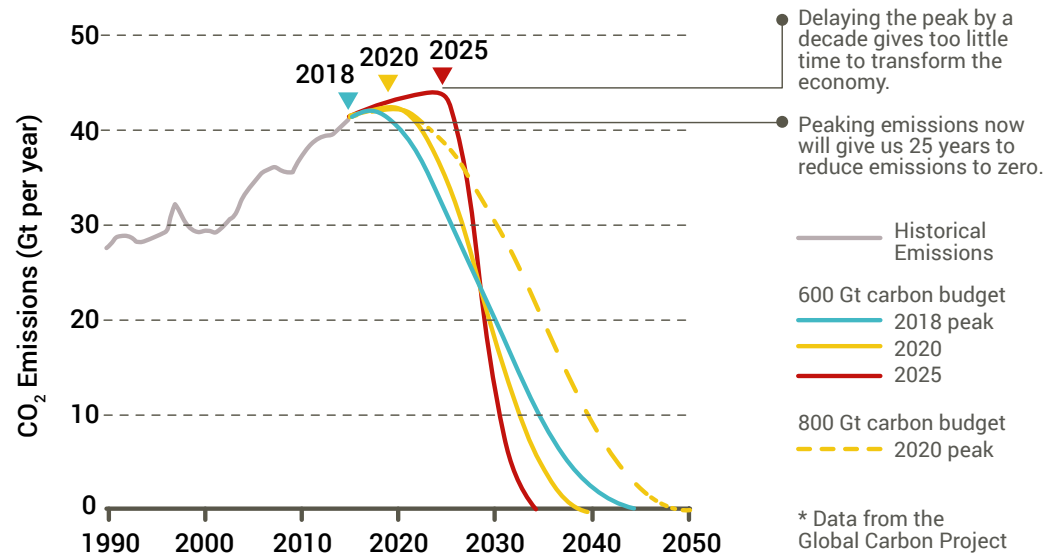


FIGURE 1: Emissions trajectories required to remain within a carbon budget of 600-800 GtCO<sub>2</sub>, assuming no negative emissions (Source: Nature, 2018)<sup>3</sup>

The challenge of staying below 2°C should not be underestimated, and this is why it must shape our planning. It will determine how we get our energy, how we transport our goods, where our markets are, what materials we source and how they're obtained, whether we are competitive, our recruitment strategies, how investors value the business, what our customers value and, ultimately, our bottom line. And it will determine this very quickly for, although the impacts may be long term, our actions now determine what scale of threat we face in the future.



# Using this Report

## How <2°C Futures can help you

The business case for action varies depending on the industry and the 'levers' that will be pulled to get us on a below 2°C trajectory. Some examples include carbon pricing and taxation, investment in innovation, as well as infrastructure change on a massive scale.

This document synthesises the leading scientific thinking on climate change for business leaders, highlights the implications, and explores the levers that will push or pull us into a below two degree trajectory, and how applying them in different combinations could bring about very different '<2°C Futures'. It is a resource to help businesses and other organisations plan, strategise, and identify risks and opportunities.

The planet has already warmed by at least 1°C<sup>7</sup>. The commitments made under the Paris Agreement take us to a hothouse inducing 2.7-3.7°C<sup>8</sup>. To get from our current trajectory to a below 2°C one will require massive change across the globe. To help explore this change, and the implications for business and society, in this resource we summarise:

### Baseline 2040

What the science is telling us is likely to have happened by 2040

- The physical impacts of previous emissions already 'baked into' the system
- The transition levers we must have pulled to reduce and control emissions to a below 2°C trajectory

### <2°C Futures

Four scenarios outlining what the business operating context could look like in 2040 if different combinations of levers are pulled in an effort to stay below 2°C.



# BASELINE 2040

What must have happened to stay below 2°C?

**What will be the likely physical impacts of climate change in 2040?**

**What will or must have happened by 2040 to be on track to stay below 2°C of warming?**

## Physical impacts

Below we set out the 'physical baseline' that we have applied across our scenarios. It is based on projections from a number of sources, including the Fourth National Climate Assessment released by the U.S. Global Change Research Program in November 2017<sup>9</sup> and the January 2018 draft of the IPCC Special Report on 1.5°C<sup>10</sup>, as well as insights gained during expert interviews.

We have deliberately embraced a baseline at the upper end of projections. This is not because we want to be dramatic, but because increasingly scientists are warning the models are behind reality on some aspects such as sea ice loss. In order for any organisation to ensure success on a below 2°C trajectory, it is important to prepare for what experts say is possible.

These are high impact high likelihood risks. When we're investing in facilities, we have to make sure they can withstand these conditions.

# PHYSICAL BASELINE | Likely physical impacts of climate change by 2040

1.5

Globally Averaged Surface Temperature will likely be 1.5°C warmer than pre-industrial times by 2040



## Declining Arctic Summer Ice

First ever essentially sea ice-free Arctic in summer of 2035



## Ocean Health

90% of the world's coral reefs suffer from serious bleaching as a result of ocean warming and acidification<sup>9</sup>  
Marine heatwaves are more frequent and severe



## Sea Level Rise

20cm by 2040 – on top of an 18cm rise since 1900



## Heatwaves

Heatwaves and droughts are more common and more severe across the globe



## Water Availability

Increasing droughts and decrease in water availability



## Severe Winters

Intense winter cold snaps more common and more severe across the northern hemisphere



## Migration

Over 150 million people displaced due to changing climate



## Monsoon

Monsoons become increasingly uncertain and volatile



## Agricultural Yield

3.2% decrease in food availability per person by 2050<sup>21</sup> with most climate-food security related deaths likely in south and east Asia



## Flooding

Intense rainfall events – and associated flooding – are more common and more severe across the globe



## Himalayan Glacier Health

Glacier volume shrinks by 30%<sup>17</sup>, reducing snow accumulation and melt volumes



Mumbai, as one of the top ten cities in terms of GDP-to-risk ratio, experiences flooding losses approaching US\$5 billion annually; Kolkata sees losses of nearly US\$2.5 billion<sup>12</sup>

Severe heatwaves are 8 times more frequent by 2040  
Population exposure to heatwaves increases 15 times<sup>11</sup>  
Temperatures during these heatwaves often approach, and sometimes exceed, 50°C in North India

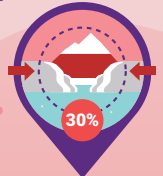
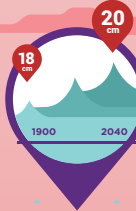
30% reduction in surface water and 20% reduction in groundwater in Central, Western and North-western India<sup>14</sup>

There are 15 million 'internal' refugees across South Asia by 2040<sup>20</sup>, with over 5 million likely to arrive in Indus-Ganga plain in India

The timing, length and strength of monsoon events is increasingly unpredictable

10% decline across all crops with strong regional variation  
Rice and wheat production in the Indo-Gangetic Plains reduced by approximately 20% and 25% respectively

Flood risk is doubled<sup>13</sup>  
Short-duration rainfall events increase risk of flash floods by 20%<sup>14</sup>  
Annual fatalities from flooding regularly exceed 2,000, with tens of millions impacted each year<sup>15</sup>  
Economic losses could regularly exceed US\$15 billion per year<sup>16</sup>



New Arctic shipping routes open in summer  
Reduced reflection from the ice of the sun's rays could accelerate warming

500 million people worldwide dependent on tropical coral reefs for food and livelihood security face major nutrition and economic challenges  
Marine heatwaves cause CO2 releases from seagrasses, hindering efforts to reduce emission

Rapidly rising insurance costs, large scale disruption to logistics and points of sale

New capital investments, acquisitions, infrastructure will need to withstand greater heat ranges  
Greater risk of heat exhaustion, health threats to the workforce

Industry, agriculture, energy crops and households will compete for water as supply reduces  
Water stress fueled communal tensions

Heavy snows and ice will disrupt supply chains and reduce productivity in the north of Europe and US

Increased demand for resources and services such as food, healthcare, shelter, education, livelihoods  
Greater migratory workforce and risk of improper governance

Unpredictable crop growing patterns  
Inflation of crop prices increases cost of food

Global population will likely increase somewhere in the region of 18% from 7.6bn to approx. 9bn in 2040 with India likely to grow 23% from 1.3bn to 1.6bn<sup>22</sup>. Rising demand and falling food availability increases risk of malnutrition and starvation

Vulnerable populations are hardest hit  
Increase in property insurance costs contributing to higher costs of living, lower disposable income and demand for higher salaries  
Demand for resilient infrastructure materials increases

Reduced efficacy of downstream hydropower and agriculture yields



How could a new shipping route benefit your business?

Will your workforce be hit by nutrition challenges?

How would you safeguard coastal plant sites from rising sea level?

How do you think your business / plant might be affected due to consistent 'heat rests' for workforce?

Does your business rely heavily on supply of fresh water?

How might your supply chains be affected by more intense winter storms?

Will your area be able to cope with an influx of people?

How would an increasingly uncertain monsoon affect your supply chains and operations?

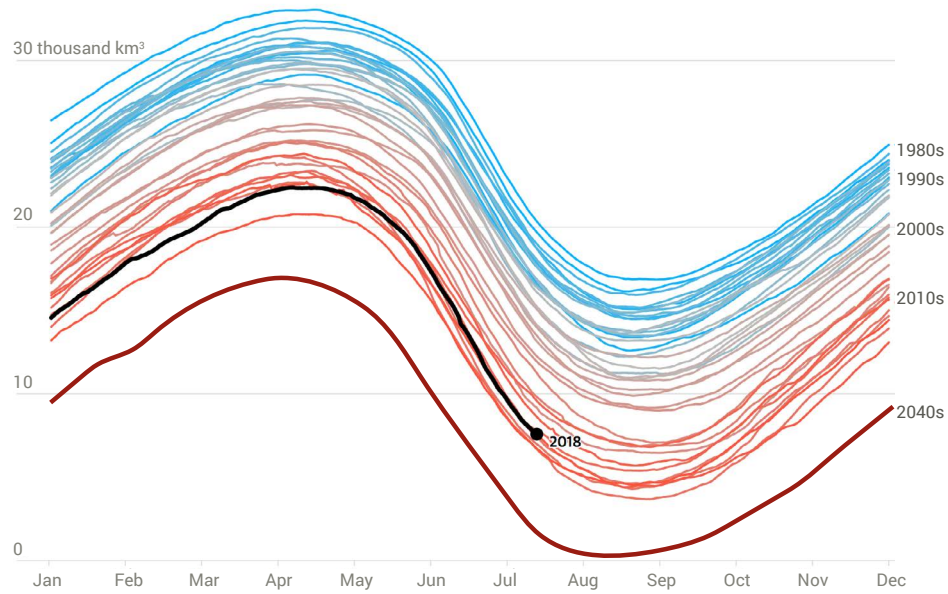
How might inflation due to food insecurity affect your operations?

How might rising insurance costs affect your balance sheet?

Would lower agriculture yields affect your raw material costs?

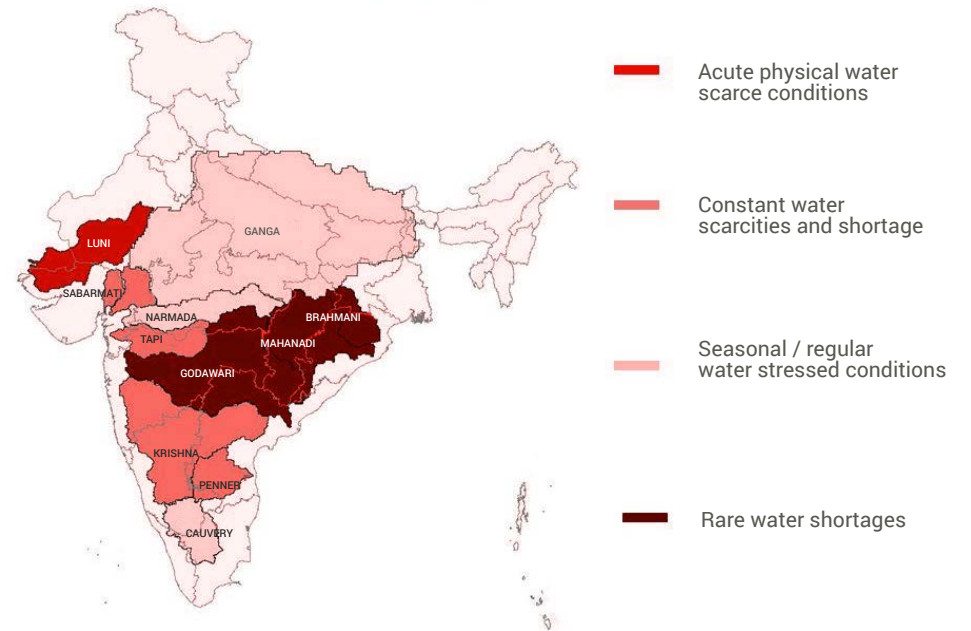
**Figure 2 : Arctic Sea Ice Volume 1979 - 2018 and Projection for 2040**

(Source: The Guardian, 2018)<sup>56</sup>



**Figure 3: Water Scarcity in primarily River Water dependent areas in 2040**

(Source: Ministry of Environment, Forest and Climate Change, 2018)<sup>57</sup>



## Figure 4: Hotspots

projected to have high levels of climate in-migration and climate out-migration in South Asia, 2030 and 2050

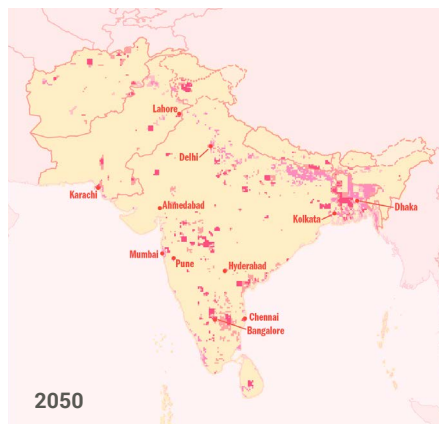
(Source: World Bank, 2018)<sup>20</sup>

### IN-MIGRATION

- High certainty in high levels of climate in-migration
- Moderate certainty in high levels of climate in-migration

### OUT-MIGRATION

- High certainty in high levels of climate out-migration
- Moderate certainty in high levels of climate out-migration

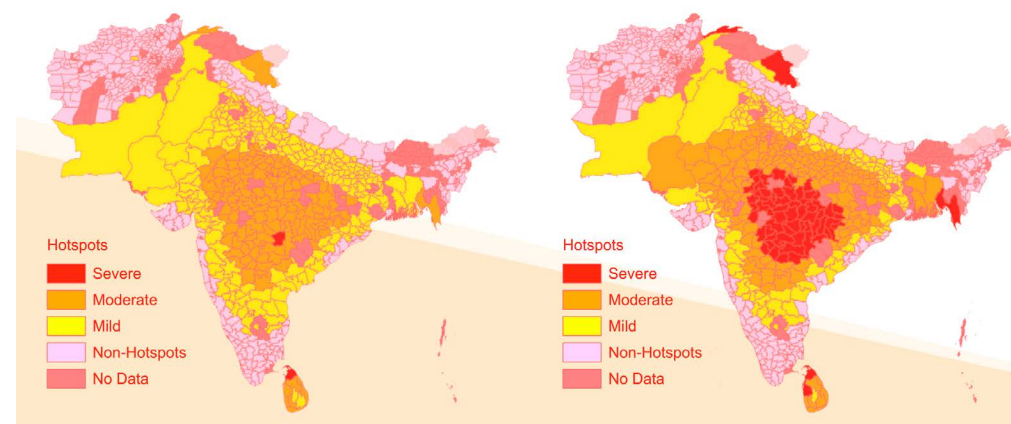


## Figure 5: Impacts of Temperature and Precipitation Changes on Living Standards

(Source: World Bank, 2018)<sup>58</sup>

Hotspots in South Asia by 2030 and, if left unaddressed

Note : These results are based on the mean of the eleven climate models used in this report



## Figure 6: Cities with the 10 highest annual flood costs by 2050

(Source: Nature Climate Change, 2013)<sup>59</sup>



### RUNNERS-UP

- |                        |          |               |          |
|------------------------|----------|---------------|----------|
| Jakarta, Indonesia     | \$1.7bn  | Tampa, USA    | \$0.85bn |
| Abidjan, Côte d'Ivoire | \$1bn    | Boston, USA   | \$0.79bn |
| Bangkok, Thailand      | \$0.73bn | Xiamen, China | \$0.72bn |
| Nagoya, Japan          | \$0.64bn |               |          |

# Transition impacts

## The levers we have to pull by 2040 to stay below 2°C

For the world to be on a trajectory to stay below 2°C of warming, most experts agree that global society has to become 'net negative' – in which we absorb more greenhouse gases than we emit - as soon as 2040, and definitely no later than 2070.

Studies such as Project Drawdown<sup>23</sup> recommend a suite of actions – or 'levers' – to reverse warming. These levers can be pulled in different combinations and at different speed and scale. Below we set out the critical levers that most experts, based on science and complex modelling, agree must have been pulled by 2040 for this to happen.

The levers to pull to get us on a <2°C trajectory

- Decarbonising electricity
- Electrifying mobility – including shipping
- Increasing energy efficiency – including making buildings net-zero in energy consumption
- Changing food production systems and diets
- Empowering and educating women and girls
- Changing land use and soil management practices
- Innovation and scaling alternatives to raw materials – including cement
- Application of smart technologies to production, supply chains and consumption
- Enabling global governance and trade
- Applying policy and regulation at national and state level
- Creating carbon pricing and taxation mechanisms
- Scaling up investment and climate finance – including in emissions reducing technologies
- Creating change in societal and individual behaviour and values

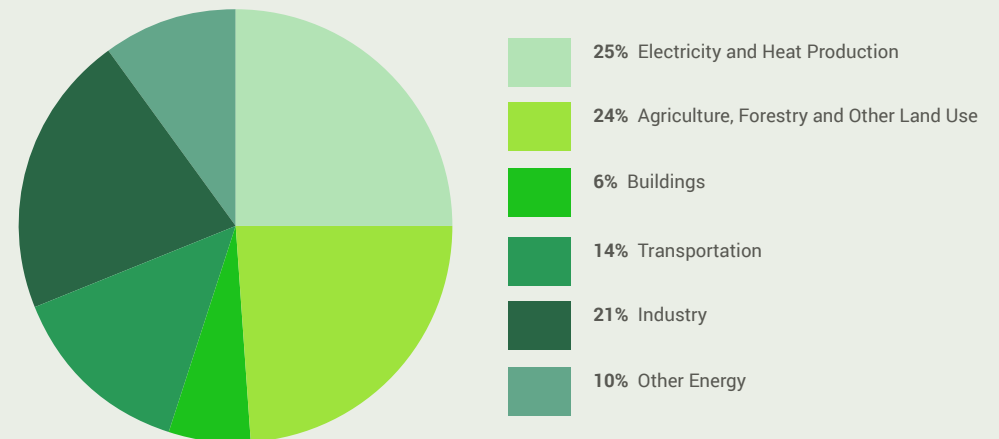
As with tackling all challenges, there is no one silver bullet. It will be a combination of these levers that gets us onto a 2°C trajectory. Some levers simply have to be pulled as they are the source of the most significant emissions reductions – see the Transition Baseline for what these may be in 2040.

How the combination is applied will depend greatly on the socio-economic context. Many of the emissions trajectory models assume that the context in 2040, 2060 and 2100 will look similar to today. We know this is unlikely given the change we have seen over the previous 20, 40 and 80 years. For this reason, we need to understand how these levers could impact our businesses in different socioeconomic contexts: for instance, in a world of strict international governance what could we be forced to comply with and

what incentives could we benefit from; and how can we therefore find success in that 2°C future? How might this differ if international governance splinters into protectionist blocs? The Scenarios will help you plan for these different <2°C Futures.

## Figure 7: Global Greenhouse Gas Emissions by Economic Sector

(Source: IPCC, 2014)<sup>50</sup>



The baseline on the next page is set for 2040, which may feel like a lengthy time horizon for many in business, but it is worth noting that to get us on the timetable above means taking some critical actions by 2020 including an end to all new coal fired power plant approvals everywhere, cities across the world upgrading 3% of existing buildings to zero carbon each year, 15% of all new vehicles sold being electric, 20% more efficient aviation and heavy vehicles, a step change in renewable energy generation to 30% of the world's electricity supply and the mobilisation of \$1trillion from the finance sector in forms such as green bonds.<sup>42</sup>



# TRANSITION BASELINE

The levers we have to pull by 2040 to stay below 2°C



Global economy including India decarbonises at a rate of around 5% per year during the 2020s and 2030s<sup>24</sup>



## Fully Decarbonised Electricity System

- 2020s onwards** Rapid move away from coal
- 2020s and 2030s** Global renewables capacity addition as high as 1000 GW per year
- 2040 - 2060** Electricity generation is completely decarbonised
- 2050** Global RE installed capacity is 20,000 GW Solar, 1500 GW Wind<sup>25</sup>
- 2050 - 2070** Electricity starts to dominate end-use energy consumption



## Electrified Mobility

- 2030** Aviation emissions per kilometre travelled are 20% below 2013 levels - limiting the sector's emissions growth to 29%<sup>26</sup>
- 2030s** Oil demand peaks and falls
- 2035** More than 50% of the world's cars are electric
- 2040 - 2050** Internal combustion engines are phased out globally



## Energy Efficiency in Buildings

- From 2030** 5% of existing building stock is upgraded to zero carbon year-on-year in New York this means over 40,000 a year
- 2040** All new buildings around the world are zero carbon



## Energy Efficiency in the Economy

- 2018 - 2040** Energy intensity of the global economy improves by 2-3% per year



## Heavy Industry

- From 2015** At least 40% reduction in absolute emissions levels across all heavy industry globally<sup>25</sup>



## Negative emissions technologies and land use

- 2020s** BioEnergy combined with Carbon Capture and Storage (BECCS) will require huge investment
- 2030** Significant global land requirements to grow feedstock for BECCS<sup>29</sup>
- 2030s** Roll-out of BECCS up to 25GW per year
- By 2050** Negative emissions technologies will extract and store atmospheric carbon. BECCS, reforestation and regenerative agriculture, enhanced weathering and direct air capture processes. Installed capacity up to 1700 GW<sup>38</sup> removing 10 Gt CO<sub>2</sub>e annually.<sup>37</sup>



## Net positive agriculture

- 2020s and 2030s** Agriculture becomes major focus to build climate resilience
- By 2040** Agriculture has a 'net positive' contribution, releasing less carbon than it 'stores'



## Investment

- 2020 onwards** \$200 billion of public finance and \$800 billion of private finance is invested in climate action each year<sup>41</sup>
- From 2020** Fossil fuel subsidies are slashed
- By 2025** Fossil fuel subsidies are eliminated



## Gender empowerment and education

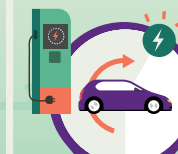
- 2020s and 2030s** Investment in education, especially of women and girls, increases around the world



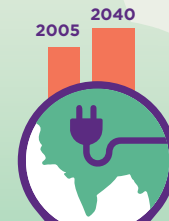
- 2022** Thermal capacity peaks at 235GW, then declines rapidly
- 2025** 275GW of installed renewable energy capacity
- 2027** Renewable installed capacity increases to over 55%<sup>28</sup> surpassing '40% by 2030' projection in INDC<sup>27</sup>
- 2040** Thermal power is phased out completely



- 2030 onwards** All new road vehicles in India are electric



- 2030** India energy intensity improvement exceeds INDC target of a 30-35% improvement over 2005 levels<sup>34</sup>



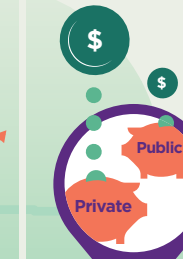
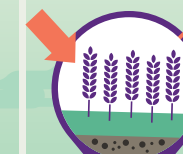
- From 2015** At least 40% reduction in absolute emission levels across all heavy industry including cement, steel and aluminium<sup>36</sup>
- By 2040** All new investments are 'zero carbon'



- By 2030** Afforestation programmes focus on maximum sequestration and surpass the '14% increase in sequestration by 2030' inferred within the INDC targets<sup>40</sup>



- 2020s** There are significant improvements in soil health



How will your electricity-intensive plants move away from thermal power?

How would your businesses adapt to rising petrochemical prices and reduced availability?

How would you ensure that your current and new infrastructure is low carbon moving towards zero carbon?

Is your business on track of 3% year on year energy intensity improvement?

How would you reduce emissions by 40% while still maintaining current production volumes?

How are you ensuring maximum sequestration on your property?

How could your business help increase the level of carbon in soil?

Do your budgets incorporate investment needed for climate action?

Are your recruitment and training approach aimed at increasing the number of women in work and senior positions?

# <2°C FUTURES

## How this baseline may happen

As experts agree that the baseline will or must have happened by 2040, we need to understand what this means for business in different socio-economic contexts. The implications vary greatly depending on how the further levers are pulled. For instance, a market in which global governance on climate change is coordinated and enforced will look very different to one with no global framework for action, but both may be capable of limiting warming to below 2°C.

Here we provide four scenarios in which the baseline 2040 has happened through employing different combinations of the mutually reinforcing levers at different speed and scale to make the best attempt to stay on a below 2°C trajectory.

It is important to note that these scenarios are not predictions, and are certainly not favoured futures. They are plausible scenarios given where we are today, designed to be possible and challenging.

These scenarios are qualitative and based on world-archetypes that Forum for the Future first developed during the Climate Futures scenarios project in 2008<sup>43</sup>. The archetypes have been extensively revised, tested and updated during the research process, and then built out into this new set of scenarios, drawing on expert interviews, desk research, and the intervening ten years of Futures horizon-scanning that we have conducted as an organisation. As an integral part of the process we have also 'sense-checked' our scenarios against a number of external published quantitative scenarios that remain within the 2°C budget, including IRENA's Roadmap to 2050<sup>44</sup>; Ecofys' "Energy Transition within 1.5°C"<sup>45</sup>; the "Alternative pathways to 1.5°C" explored by van Vuuren et al<sup>46</sup>; the 'Low Energy Demand' scenario developed by Grubler et al<sup>47</sup> and Shell's Sky scenario<sup>48</sup>.

None of our scenarios mirror these external scenarios exactly, but the carbon reduction pathways and the quantitative indicators proposed for each scenario fall within the ranges articulated by such quantified scenarios.

We recommend reading them with your company or organisation in mind, considering the following questions:

**If we continue as we are today, what risks would we be facing in this future and what do we need to do to mitigate them?**

**What would our value chain look like in this scenario? How can we move towards that now, in order to secure our future place in the market?**

**What opportunities for influence, new value propositions or innovation do we have in this scenario that would allow us to profit from the transition to a below 2°C trajectory?**

The actions you will take as a result go right to the core of your business strategy, putting you on course to be successful in a below 2°C future.

The four scenarios are:

**Efficiency First**  
**Redefining Progress**  
**New Protectionism**  
**Service Transformation**

	Efficiency First	Redefining Progress	New Protectionism	Service Transformation
Key Transition Levers	A precarious globalised house of cards where constant and often risky technological innovation, motivated by high carbon prices, is just keeping us on track	A digitally connected, yet highly localised world where priorities in many countries have shifted from rapid growth to healthier growth	A splintered world of protectionist blocs, where tackling climate change is a matter of national security	A world where the mainstreaming of access over ownership has happened quickly, and globally-applied, individual carbon budgets are traded and tracked
Global governance and trade	Strengthened international governance and globalised trade	Regionalised and localised trade, but a strong UN oversees global decarbonisation	Protectionist blocs and bilateral resource deals	Internationalist technocratic governance
Regulation and policy	Internationally coordinated and policed, and enacted by business, favours efficiency and 'big ticket' solutions	A 'new localism' dominates, favours small- and medium-scale systemic solutions	Draconian, favours large, centralised, state-backed solutions	Favours innovation, uses AI modelling to anticipate outcomes and adapt
Carbon pricing mechanisms	International carbon pricing regularly increased, with national carbon taxation on whole lifecycle emissions	Used in places to catalyse change, but there is greater emphasis on 'full-cost accounting'	No internationally ratified system, but different versions are used heavily within countries and regional blocs	CarbonCoin global cryptocurrency market with tradeable individual quotas and annual ratchet down
Innovation and digital paradigm	Focus on food production, negative emissions technologies, efficiency, robotax on automation	Highly digital, with seamless connectivity, solutions are decentralised and expected to meet multiple objectives	Focused on national security, geoengineering, resource substitution, biotech and surveillance are priorities	High degree of virtualisation, Decentralised technology
Lifestyle and behaviour	Consumerist, individualist, high expectations placed on business and government action	'Post-consumerist', focused on wellbeing and quality of life	Heavily controlled by the state, with 'patriotic' low-carbon behaviour rewarded	Access over ownership, service living paradigm

# Scenarios

## EFFICIENCY FIRST



## REDEFINING PROGRESS



## NEW PROTECTIONISM



## SERVICE TRANSFORMATION



# EFFICIENCY FIRST



# EFFICIENCY FIRST

A precarious globalised house of cards where constant and often risky technological innovation, motivated by high carbon prices, is just keeping us on track

2022 — 2023 — 2025 — 2029 — 2030 — 2033 — 2036

Global leaders agree transnational governance of food supplies following four years of record heatwaves and droughts

"Woefully inadequate action" found by the Paris Agreement Global Stocktake on emissions reductions, adaptation efforts, financing and technology development

Leap in Nationally Determined Contributions (NDC) commitments made by most countries as the toll of food shortage forces collaboration across borders on areas of high emissions

The final wave of internationally coordinated compulsory purchases of agricultural land pushes all but a small number into urban areas

The 'Robo Tax' trialled in China and Mexico is rolled out by many countries including India and the U.S.

Masdar is finally complete along with the five new coastal desert megacities in Wave 1

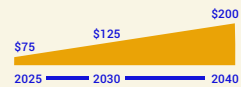
Transnational company Wedunda is stripped of all assets and all senior management imprisoned within three months of being found inaccurately reporting emissions



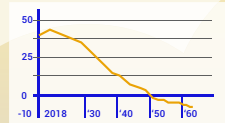
## Carbon Emissions and Pricing Mechanisms

International carbon pricing regularly increases, with national carbon taxation on whole lifecycle emissions

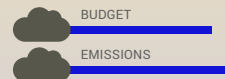
**CARBON PRICE<sup>49</sup>**  
Introduced universally at \$75/tCO<sub>2</sub>e in 2025; reaching \$125/tCO<sub>2</sub>e by 2030, and rising to \$200/tCO<sub>2</sub>e in 2040



**CARBON EMISSIONS / TRAJECTORY**  
Peak around 43 GtCO<sub>2</sub>e/year in 2021 reducing to 15 GtCO<sub>2</sub>e/year in 2040; net-negative emissions from 2050 onwards



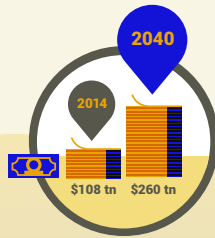
**TOTAL CARBON EMISSIONS BETWEEN 2018 AND 2040**  
725 GtCO<sub>2</sub>e



## Global Governance and Trade

Strengthened international governance and globalised trade

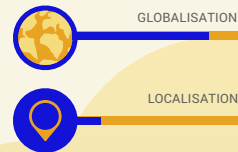
**GDP**  
\$260 trillion - up from \$108 trillion in 2014



## Regulation and Policy

Internationally coordinated and policed, and enacted by business; Favours efficiency and 'big ticket' solutions

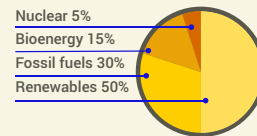
**DEGREE OF GLOBALISATION**  
Overall the world is more globalised with seamless exchange of knowledge; some countries join global collaborations later<sup>51</sup>



**FOREST AREA**  
Increase of 25% over current level



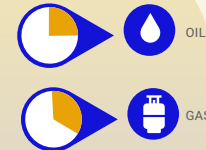
## Energy Mix in 2040



**GLOBAL ENERGY DEMAND**  
20% increase over current level



**MINING / PETROCHEMICALS PRODUCTION**  
Oil use is restricted to shipping and aviation, and under close international governance. Gas still used in industry and electricity production, but fossil fuel sector universally seen as a sector in decline

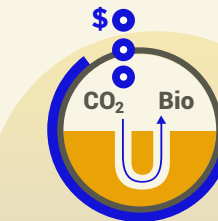


## Innovation and Digital Paradigm

Focus on food production, negative emissions technologies, efficiency; Robotax on automation

**GEOENGINEERING EXTENT**  
BECCS starts to come 'on-line' during the late 2030s, but more slowly than hoped and with many teething problems. Bioenergy investment carries on regardless.

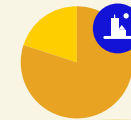
Multiple negative emissions technologies are attracting investment and being embraced



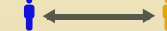
## Lifestyle and Behaviour

Consumerist, individualist, high expectations placed on business and government action

**URBANISATION**  
About 80% by 2050



**INEQUALITY**  
Income inequality persists or improves only slowly. Massive challenges of reducing vulnerability to societal and environmental changes remain



## Social Cohesion

Current levels of social cohesion - with ethnic, religious and social tensions - continue to exist

**TRUST IN BUSINESS**  
Trust in businesses is high - both among governments and citizens



**TRUST IN INSTITUTIONS / GOVERNMENT**  
Trust in government and public institutions had to be rebuilt over the 2020s. Poorer populations generally trust less



**DISPLACED PEOPLE**  
Very high, both due to unplanned and massive planned migration of rural areas into towns and cities to allow for big agrotech and forestry



TRANSITION BASELINE

PHYSICAL BASELINE



# Efficiency First

# 2040

is a precarious globalised house of cards where constant and often risky technological innovation, motivated by high carbon prices, is just keeping us on a <math><2^{\circ}\text{C}</math> trajectory



International governance has set the bar high for business action on climate change. National governments take the international mandate forward, incentivising business to make radical decisions. A network of taxes and incentives has seen the climate resilience and mitigation industry grow dramatically. The majority of productive land is now corporately managed using robots and AI to maximise the efficiency of calorie production for food and bioenergy, watched closely by the International Efficiency Monitoring Service and its sensors.

Rapid innovation and deployment in energy efficiency, renewables and storage, combined with a limited but growing implementation of negative emissions technologies, has enabled an economy on a path to net zero by 2050. Massive infrastructure investment and city building programmes are struggling to keep up with the effects of land use change and urbanisation policies as people flood to cities and towns.

Cities are run by joint ventures between government and large corporations to manage the frequent drought and flood emergency events most effectively but, because of the desire for short term gains and an underbelly of corruption, find themselves constantly having to top up defences and repair every year. Systems we rely on for day-to-day life are precariously close to collapsing and, whilst on one hand we seem to be in a 'golden age of technology', the complex layers of constant innovation and unintended consequences feel like a shaky house of cards.

## GLOBAL CONTEXT

A globalised world in which multinational governance has regained strength. The international climate agreement has been translated into global carbon tax and pricing mechanisms with high prices are being introduced early and quickly ramped up, making it prohibitively expensive to emit carbon. Multiple tiers of action and leadership emerge globally on climate change, the top echelon of which has created a new, ultra-competitive paradigm which others are forced to follow.

Agriculture and forestry has been forced to intensify and automate as droughts shift the location of productive land. Despite a swathe of protests, the late 2020s saw massive international compulsory land purchase schemes. The 'AgriCity' package saw government-supported bioenergy and agritech industrialists purchase land in return for housing, often in new cities where construction provides jobs, albeit temporarily. This means that very few people now live in rural areas globally. A tax on the use of AI and automation, dubbed the 'robo tax', finances reskilling and basic benefit programmes have been rolled out in many countries with the aim of maintaining economic competitiveness and avoiding social disquiet.

## SOCIETY LIFESTYLES

The consumerism of the early 2000s remains, enabled in part by an established and globalised circular economy. Brands – who are held accountable for the full lifecycle emissions of their products – try to minimise their heavy carbon taxation by providing ultra-low carbon goods.

There are three layers to global society: the ultra-elite who can afford to buy relatively high-carbon goods and invest in the booming industries of artificial food production and bioenergy; an aspirational middle class; and an underclass that simmers with discontent as social mobility has stagnated. Whilst hundreds of millions have risen from poverty due to sustained growth, inequality and underemployment remain a scourge for many countries. Reskilling programmes are having varied success rates across the globe as some cultures find it easier than others to shift their workforces into low carbon sectors.

## BUSINESS

The carbon and automation tax frameworks initially saw massive resistance from business, particularly heavy industry and robotics manufacturers. Capital investment in efficiency was forced through quickly as it became prohibitively expensive to emit carbon; this supported automation through the early years of

**Governments rely heavily on technology to keep a watch on the economy. Growth is seen as a way out of climate change, though heavy industries were hit hard initially and widespread automation has significantly impacted employment.**

taxation. Creative corporate leaders quickly saw the opportunity in hyper-efficient and negative emissions technologies, delivering risky but ambitious solutions by 2040. There is a healthy flow of international capital through the global climate financing agreement, allowing for a higher risk tolerance. The search for efficiency has driven consolidation, and transnational firms now dominate and global business alliances are the norm. Business has no moral stance on the low carbon economy, and is leading progress purely through competitive instinct and a survival imperative. The closeness of business and government provides fertile ground for corruption where governance and accountability are weak.

### **ECONOMY**

Following the narrow avoidance of a crash in China in the early 2020s, globally the economy has experienced decades of sustained growth, helped by AI monitors and real time corrective policy interventions. Governments rely heavily on technology to keep a watch on the economy. Growth is seen as a way out of climate change, though heavy industries were hit hard initially and widespread automation has significantly impacted employment. India is the second largest economy in the world. Along with China, it is a hotbed of innovation, particularly on renewable energy, energy efficiency and infrastructure resilience, thanks to coordinated transnational partnerships. Massive retraining programmes focusing on these areas, together with the construction of new cities, attract people moving from agriculture and other industries hit by automation. India's growing deserts, like North Africa and the Middle East, are home to a massive renewables industry. Coastal Concentrated Solar Power plants fuel massive desalination operations. Together, they power sugar and vat food production centres wherever viable.

### **ATTITUDES TO CLIMATE CHANGE**

The importance of climate change is universally recognised and international agreements have strengthened since the 2010s. People and businesses alike are aware that we are only just staying on course in terms of emissions. But for the majority of populations, status and meaning are still found through consumption. The promise of maintaining this status is used

by business and governments alike to justify higher risk-taking in geoengineering, gene editing and the use of new biotech to capture carbon more generally. Environmentalists advocating for more holistic solutions are not seen as credible. Many remember the good old days of 'natural' food as meals become largely artificial, but memories are still too vivid from the major harvest collapses of the early 2020s to want to return.

### **RESOURCES**

The price of raw materials is extremely high, and supply is volatile. These higher costs mean that a massive circular economy has grown to meet insatiable consumerism. Virgin plastic manufacturing has reduced to 10% of 2018 levels, and all non-micro ocean plastic was mined by 2028. Virgin aluminium production is virtually unheard of. Cement – or binding agents for construction more generally – was identified as a universal R&D challenge in the mid-2020s when high carbon prices coincided with an intensification of international urbanisation policies. The industry significantly consolidated as high carbon emitters could no longer afford to operate, and alternative products saw massive investment. Innovation in the use of timber (now abundant thanks to afforestation programmes) has seen it replace steel in many buildings under 45 floors. Few innovations are seen as off-limits as the need is seen to justify the means.

Huge blocks of land are reserved globally for intensive precision agriculture and carbon sequestration and, by 2040, plans are also in place to dedicate significant space to energy crops for BECCS. Only tiny isolated pockets of wilderness are genuinely protected. Biodiversity is collapsing in most habitats, and de-extinction programmes are trying to reintroduce species with high ecosystem value such as bees, as agriculture is dependent on swarms of more expensive robotic bees.

### **POLITICS**

City governments, often formed of partnerships between the public and private sector, put national policies into action and are bound by international agreements. The corporate partners are often subsidiaries of massive transnational organisations, and

**Coupled with massive improvements in renewable energy and storage, technological solutions are constantly proving just enough to stay on trajectory for below two degrees of warming.**

they work hard to share innovations, expertise and tactics to make “their” cities more competitive. But their often short-term investments are constantly tested to the limits as they are increasingly bombarded with more frequent, serious weather events.

Internationally, there is general agreement on managed migration, but old arguments flare up regularly as more new influxes seek refuge in already stretched countries. The International Relocation Fund does give receiving countries a budget per migrant for infrastructure funding, but the physical improvement that results is often too late for the individuals concerned.

### TECHNOLOGY

Technology is the driver of massive efficiency gains. International collaboration on negative emissions technologies – run from a network of experimental facilities including one in Hyderabad – focuses on adapting species such as krill, kelp and algae to better sequester carbon. The majority of trees planted today are modified to take more carbon dioxide from the air.

Coupled with massive improvements in renewable energy and storage, these solutions are constantly proving just enough to stay on trajectory for below two degrees of warming. Some years are near misses, and concern for other planetary boundaries, such as biodiversity, is growing. Questions are often raised over the efficacy of BECCS, and whether investment should be redirected given that emissions are on a knife edge.

Large scale concentrated solar power supports desalination and reforestation programmes in coastal deserts. Many of the world’s largest port cities were part of an internationally coordinated investment programme on sea defences, but every year almost all are shut at least once due to storm surges and cyclones. Anything other than ultra-efficient air-conditioning has been outlawed internationally. Building underground has been mandated in new cities where the temperature regularly passes 46° with humidity of 50% – the ‘wet bulb’ temperature at which the human body can no longer regulate its heat. Infrastructure is constantly creaking under the weight of unpredictable changes in weather, and is patched up after each assault.

### COPING WITH STORMS IN MUMBAI

Despite being part of the International Port Protection Mission, Mumbai suffers in major storms. The massive sea walls take most of the impact from any storm surges, and the modified mangroves which were part of the IPPM slow the flow further, but many areas still see flooding as high as 75cm.

Talanceraj, the transnational parent of the corporate partner in Mumbai’s City Government, dispatch rapid response teams within hours of any storm warning, quickly assessing the damage through a network of city sensors and cameras.

The underground parts of the metro struggle to avoid inundation and some fear a difficult decision may be on the horizon as constant pumping of water rampantly uses energy, even with ultra-efficient machines.

### SIGNALS THAT INDICATE THIS SCENARIO COULD COME ABOUT FROM TODAY

- Scientists are rushing to create new “evolution assisted” coral that can survive in hotter waters  
<https://www.fastcompany.com/90188094/scientists-are-speeding-up-evolution-to-build-climate-change-resistance>
- Low-carbon cities are a US\$17 trillion opportunity worldwide  
<http://newclimateeconomy.net/content/press-release-low-carbon-cities-are-us17-trillion-opportunity-worldwide>
- A small group of giant companies—some old, some new—are dominating the global economy; 10% of the world’s public companies generate 80% of all profits  
<https://www.economist.com/news/special-report/21707048-small-group-giant-companiessome-old-some-neware-once-again-dominating-global>
- Bill Gates is advocating an income tax on robots – a ‘Robotax’  
<https://qz.com/911968/bill-gates-the-robot-that-takes-your-job-should-pay-taxes/>
- Cities have long been swelling with the influx of climate migrants  
<https://www.scientificamerican.com/article/cities-with-climate-migrants/>
- China is amongst a group of countries already planning new cities  
<https://www.theguardian.com/world/2017/apr/04/china-plans-build-new-city-nearly-three-times-the-size-of-new-york>

# REDEFINING PROGRESS



# REDEFINING PROGRESS

A digitally connected, yet highly localised world where priorities in many countries have shifted from rapid growth to healthier growth



The 'Facebook Inquests' begin, initiating a global rethink of the role of social media platforms

A major class-action climate lawsuit against 'big oil', brought forward by the Bangladesh youth movement, wins

Digital billionaire Nihal Akilesh elected to presidency of the U.S.

The World Bank's Wellbeing Index is launched; By 2030, it replaces GDP as the standard measure used to rank national performance

Bangladesh announces a managed retreat; mangrove restoration plan covering its entire coastline

More than 50% of UN signatory nations have some form of Universal Basic Income (UBI) scheme in place

International agreement on tax implementation enacted by major economies, making it illegal overnight for banks to transact with non-signatories

France formalises a maximum 4-day working week

UN FAO data suggests that over 60% of the global population have adopted vegetarian diets<sup>53</sup>

Car ownership drops to below 10% across cities worldwide



## Carbon Emissions and Pricing Mechanisms

## Global Governance and Trade

## Regulation and Policy

## Energy Mix in 2040

## Innovation and Digital Paradigm

## Lifestyle and Behaviour

## Social Cohesion

Used in places to catalyse change, but there is greater emphasis on 'full-cost accounting'

Regionalised and localised trade, but a strong UN oversees global decarbonisation

A 'new localism' dominates. Favours small and medium-scale systemic solutions

No new investment post-2025, but legacy plants still in operation; Small-scale renewables work alongside flagship mega-projects (eg, offshore wind) to dominate the electricity system

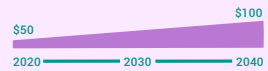
Highly digital, with seamless connectivity; Solutions are decentralised and expected to meet multiple objectives

'Post-consumerist', focused on wellbeing and quality of life

High

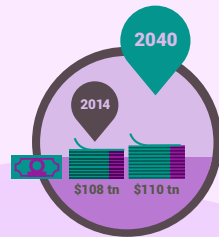
### CARBON PRICE

Used and set locally, typically between \$50 and \$100/tCO2e during the 2020s and the 2030s



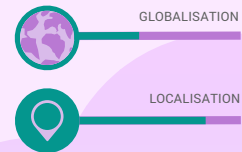
### GDP

\$110 trillion in 2040; GDP is no longer the metric of choice for country success



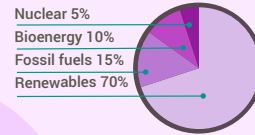
### DEGREE OF GLOBALISATION

Mixed; Economies have become localised where possible, but international cooperation and information-sharing is high



### FOREST AREA

25% increase in forest cover (and huge increase in coastal mangroves)



### GLOBAL ENERGY DEMAND

40% decrease from 2018



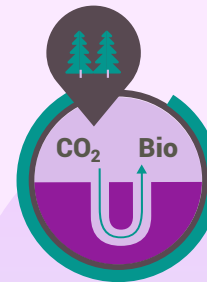
### MINING / PETROCHEMICALS PRODUCTION

Access to minerals forms the basis of remaining international trade; Petrochemical production is minimal



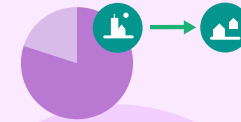
### GEOENGINEERING EXTENT

Natural systems are used extensively to store carbon



### URBANISATION

High, but new drive for simplicity leads to re-ruralisation



### INEQUALITY

Lower than present



### TRUST IN BUSINESS

High - given new legal obligations for business to demonstrate social purpose



### TRUST IN INSTITUTIONS / GOVERNMENT

High



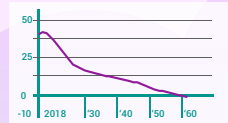
### DISPLACED PEOPLE

High, but relatively strong support mechanisms in place



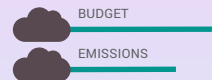
### CARBON EMISSIONS / TRAJECTORY

Peak around 42 GtCO2e/year in 2020. Very steep reductions through the 2020s, dropping to 10 GtCO2e/year in 2040; net-negative emissions from 2060 onwards



### TOTAL CARBON EMISSIONS BETWEEN 2018 AND 2040

500 GtCO2e



## TRANSITION BASELINE

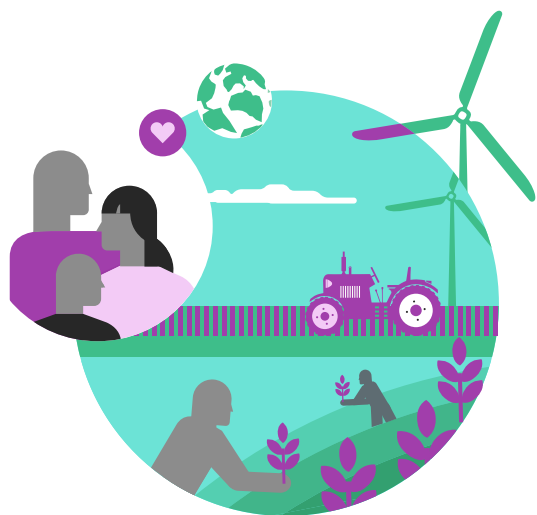
## PHYSICAL BASELINE



# Redefining Progress

# 2040

is a digitally connected, yet highly localised world where priorities in many countries have shifted from rapid growth to healthier growth reflecting the changing aspirations of next generation leaders.



New priorities of wellbeing, restoration and ‘quality of life’ have gained traction across the world. A ‘new localism’ has come to dominate both economics and politics, and community ownership of assets is commonplace – yet communities are, through digital technology, more globally networked than ever before. Advances in digital services have seen global energy demand significantly reduce despite rises in population, income and activity.

‘Grow healthier, not faster’ has become a common narrative in many countries. The global economy now grows very slowly, but entrepreneurship and markets are still valued, and brands that can demonstrate clear social purpose have ferociously loyal customers. It has become illegal for banks to enact transactions with territories that do not comply with redefined rules on tax transparency, fundamentally reshaping global financial flows even for countries where priorities have not changed.

## GLOBAL CONTEXT

Political ideals have slowly aligned with sustainability, wellbeing, and quality of life, in part driven by the increasing impacts of climate change. Other global challenges – from poverty and inequality to the unavailability of jobs and housing for the young and perceived inefficacy of ‘traditional politics’ – have also fuelled the shift. A new set of bold, disruptive business leaders are using their influence to advance and legitimise ideas such as Universal Basic Income and autonomous vehicles.

Such innovative thinking gained traction amidst a strong backlash against the neo-nationalism of the early 2020s as the extent of ‘fake news’ and societal manipulation was revealed during the ‘Facebook Inquests’.

The ‘new localism’ pervades politics and economics. Community empowerment enables the emergence of community-owned energy and telecommunications systems, and the buy-back of grids and other ‘community-strategic’ assets.

Despite its emphasis on community and localism, society is not isolated. Communities are more globally networked than ever before, with ideas being shared freely. Single-issue interventions fall out of favour and efforts are made to find solutions that meet multiple goals.

People continue to work, consume and profit within a market-based economy. But citizens view money as a means to different ends. Governments, particularly at the city and local level, are active participants in local economies. Businesses and technology are obliged and expected to serve society. By 2040, the past era of ‘western’ mass consumption is largely looked back on as one of gross excess.

## SOCIETY LIFESTYLES

Experiences invoke more social status than assets and wealth in most countries. Diverse communities find common cause in advocating simpler and more sustainable lives. There has even been a small but noticeable shift away from urban living towards smaller communities and rural living. Vegetarianism and, increasingly, veganism dominate diets around the world.

Women’s rights and education for girls have been prioritised in many places, with an explicit recognition that education is not just a basic right, but one of the most effective ways to tackle climate change.

A 4-day work week and work-share programmes have become standard. The success of widely embraced UBI systems has been mixed. Some created resentment from the outset amidst accusations of ‘lack of fairness’; whereas others were well-received. Somewhat ironically, however, a number of the cities that gained a reputation for having the ‘best’ systems during the 2020s attracted so much in-migration during the 2030s that they are now at risk of being overwhelmed.

Digital platforms allow people to monitor their fitness, stress levels and emotional health. With a high degree of trust in institutions and technology providers, and strong frameworks to ensure individual control over their personal data, people have become comfortable with sharing such data with their friends, communities, and even businesses, in the name of wellness and openness. Ever-more powerful algorithms are able to offer personalized recommendations and services that are perceived as pleasant and welcome rather than intrusive. People want to know their impact on their environment, communities, and the world at large.



**Ecological restoration has become commonplace, with an emphasis not just on storing carbon but maintaining biodiversity and ecological processes.**

## **BUSINESS**

Over time, business structures that reflect millennial values have gained strength. Cooperatives and collective ownership models are common across the world, reflecting the growing expectation of social purpose, decent pay and contribution to welfare through taxes. Supply chains have shortened and simplified in the quest for greater transparency and local value creation. Despite the death of excessive consumption, brands that can demonstrate clear social purpose have ferociously loyal customers.

Early social media platforms such as Facebook and Twitter came to be seen as tools for fuelling division and conflict, and have now become regulated 'utilities' operating under strict rules mandating that they 'build community'.

While millennial frustration was a key driver demanding the societal transformation that happened through the 2020s, millennial entrepreneurship enabled it. Young Indian and Chinese entrepreneurs in particular embraced national and regional challenges as the means to make their mark as well as their fortunes.

Pensions Funds were among the first to reflect society's shifting values; promising a more nuanced 'return' that includes a "thriving community for you to retire into" alongside a financial package. Other investors have turned to large infrastructure projects for 'restorative returns' such as offshore wind and coastal-scale mangrove restoration.

## **ECONOMY**

The World Trade Organisation has evolved to support more regional economies. Anti-dumping mechanisms are strong with an aim to cultivate local supply chains. Gross Domestic Product is no longer the litmus test of success. Instead, laws, budgets and targets are littered with indicators of satisfaction and sustainability, and countries compete to score highest in the World Bank's Wellbeing Index.

Carbon prices and, in some places individual carbon quotas, are used by specific communities to catalyse and accelerate change, but are not universal. More nuanced pricing and valuation mechanisms now value multiple systemic factors alongside carbon. This is a world that has embraced a practical form of 'full-cost accounting'.

International trade continues, but is now focused on strategic resources or goods that cannot be easily produced within the regionally-focused economies that now dominate around the world.

## **ATTITUDES TO CLIMATE CHANGE**

Climate change is well understood, and a key societal priority, but with 'systems thinking' to the fore, climate change solutions are expected to address other societal priorities too.

## **RESOURCES**

Solutions to the resource crunch are sought locally; and efforts are made to ensure that all land, marine systems and assets are put to multiple productive uses. Offshore wind facilities typically host advanced aquaculture facilities and, with 'traditional' fishing banned, often also serve as marine reserves.

Excessive heat and drought – and water availability more broadly – still pose insurmountable challenges to a number of regions. Internal and external migration is high, with influxes posing challenges to recipient regions and communities despite international cooperation to support 'in-migration hotspots'.

Regenerative agriculture has been adopted around the world. India's Rural Employment Guarantee Programme has been reconfigured to promote a shift away from water-intensive crops and towards no-till systems. Biochar has been heavily embraced, with local agricultural and food waste serving as feedstock.

Ecological restoration has become commonplace, with an emphasis not just on storing carbon but maintaining biodiversity and ecological processes. In 2025, Bangladesh announced a managed retreat and mangrove restoration plan covering its entire coastline. By 2032, the demonstrable success of this programme in terms of coastal erosion, ecosystem health and fisheries development has resulted in similar plans being embraced by nations around the tropics.

## **POLITICS**

New forms of participatory democracy have been embraced. Local politics in particular has been energised around the world; and a new cadre of mayors, regional and state governments have come to the fore.

Despite the rhetoric that “we are all in this together”, powerful regions are frequently in disagreement. Water resources and the distribution of climate refugees are particular sources of tension.

Despite this, the world has not rejected internationalism. Massive digitalisation has enabled constant interaction and sharing of knowledge between like-minded politicians and communities across the globe. A well-resourced and respected UN oversees a coordinated approach to decarbonisation and provides support for those regions most impacted by climate change.

In practice, however, despite the rhetoric that “we are all in this together”, powerful regions are frequently in disagreement. Water resources and the distribution of climate refugees are particular sources of tension. Such disputes are as likely to be regional as international, and there is an increasing economic and political divide between regions that are coping successfully with the impacts of climate change, and those that are struggling.

Separatist movements emerged in the 2030s as these stresses worsened. Rather than following religious or race-based lines, most negativity is simply directed towards ‘migrants’, regardless of creed or colour.

### TECHNOLOGY

Despite the emphasis on simplicity, the use of technology is very high. Digital internet access has been considered a basic human right since a UN resolution in 2021. The almost universal application of digital systems has significantly reduced energy demand by 40% between 2020 and 2040, despite rises in population, income and activity.

Everyone has a ‘core’ personal digital device that enables seamless dynamic management of all day-to-day needs, from lighting to mobility to groceries, interacting constantly with local service providers to do so.

The energy system is dominated by small and medium-scale renewables, complemented by large projects that can demonstrate widespread benefits, such as combined offshore wind and aquaculture systems.

Cities are being actively redesigned to promote walking, cycling and public transport. Electric vehicles have become the norm, but there is much less emphasis on ownership, with a widespread ‘Uberisation’ of car travel.

### COPING WITH STORMS IN MUMBAI

The success of Bangladesh’s 2025 managed retreat and mangrove restoration plan saw Mumbai start to embrace a similar programme in 2032. The city-wide vote to embrace a managed retreat and resettlement programme from the city’s lowest-lying districts only narrowly passed but, in hindsight, likely saved many lives over time.

A robust warning system, coupled with locally managed evacuation plans means that fatalities are mostly avoided. A rapid international response system is only required on rare occasions to manage health risks.

The damage to property caused by each major storm is considerable, measuring in the billions of dollars. Most costs are collectively managed within communities, using local finance mechanisms. Some localities have invested in adaptation measures. With only 5 years’ worth of growth, the mangroves planted so far have minimal impact on storm surges.

### SIGNALS THAT INDICATE THIS SCENARIO COULD COME ABOUT FROM TODAY

- Many are predicting Millennials are on the cusp of a ‘fierce’ rebellion against current politics  
<https://theearlynow.com/young-people-are-about-to-utterly-transform-climate-politics-16cb3f95f77e>
- The deep upheavals of the last 20 years illustrate the opportunities for rapid change  
<https://theconversation.com/hope-from-chaos-could-political-upheaval-lead-to-a-new-green-epoch-90709>
- Health and wellness is rising in popularity  
<https://www.self.com/story/the-big-booming-business-of-wellness>
- Citizens are already involved in infrastructure projects for instance in electricity in Hamburg  
<https://energytransition.org/2013/10/hamburg-citizens-buy-back-energy-grid/>  
and a crowd funded bridge in Rotterdam  
<https://www.dezeen.com/2015/07/16/luchtsingel-elevated-pathways-bridges-rotterdam-cityscape-zus-architects/>
- Social media and internet platforms are increasingly facing pressure  
<https://www.theguardian.com/commentisfree/2018/jul/31/zuckerberg-haters-social-media-giants>  
<https://www.theguardian.com/commentisfree/2018/may/21/detoxifying-social-media-online-misogyny>

# NEW PROTECTIONISM



# NEW PROTECTIONISM

A splintered world of protectionist blocs, where tackling climate change is a matter of national security

2022 — 2020s — 2023 — 2028 — 2031 — 2034

India rolls out a social credit reputation rating system linked to the Aadhaar identification number

Jordan, Syria and Yemen face ongoing altercations fuelled by a shortage of water

Italy refuses to ratify a long fought and precarious agreement on quotas for refugees

The UN experiences its lowest year of funding in 20 years as members cite home security needs as reasons for reducing contributions

China presents the 5th Zero Hero award to Fei Hung, who tops the low carbon living register of citizens

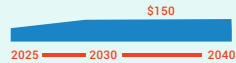
Accusations fly at an international convention as Concentrated Solar Power (CSP) facilities almost identical to India's top-secret Desert Bloom facility are found in Pakistan



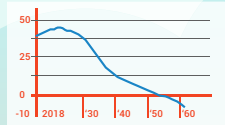
## Carbon Emissions and Pricing Mechanisms

No internationally ratified system, but different versions are used heavily within countries and regional blocs

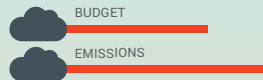
**CARBON PRICE**  
No global carbon price, but adopted in certain countries/blocs during late 2020s/2030s (typically around \$150/tCO<sub>2</sub>e through the 2030s)



**CARBON EMISSIONS / TRAJECTORY**  
Peak around 45 GtCO<sub>2</sub>e/year in 2025, falling to 15GtCO<sub>2</sub>e/year in 2040. Steep reduction in the 2030s (as carbon 'space race' ramps up); Intention to be net-negative 2055 onwards (with frantic investment in NETs/geoengineering)



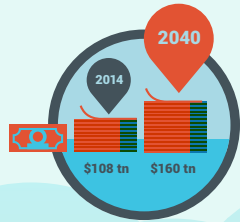
**TOTAL CARBON EMISSIONS BETWEEN 2018 AND 2040**  
825 GtCO<sub>2</sub>e



## Global Governance and Trade

Protectionist blocs and bilateral resource deals

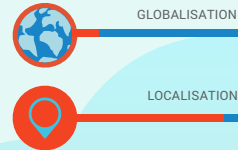
**GDP**  
\$160 trillion in 2040



## Regulation and Policy

Draconian. Favours large, centralised, state-backed solutions

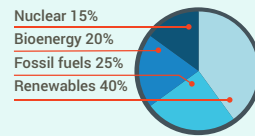
**DEGREE OF GLOBALISATION**  
Low



**FOREST AREA**  
Increases from 2025 onwards as 'national forests' are deemed essential for carbon storage and/or BECCS



## Energy Mix in 2040



**GLOBAL ENERGY DEMAND**  
5% reduction from current levels by 2040



## MINING / PETROCHEMICALS PRODUCTION

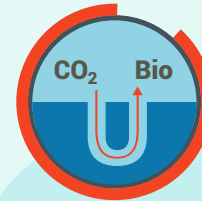
Access to minerals forms the basis of many bilateral deals; Gas dominates the 'fossil fuel sector' and is still used in industry and electricity production, albeit typically with CCS



## Innovation and Digital Paradigm

Focused on national security. Geoengineering, resource substitution, biotech and surveillance are priorities

**GEOENGINEERING EXTENT**  
High, but uncoordinated



## Lifestyle and Behaviour

Heavily controlled by the state, with 'patriotic' low-carbon behaviour rewarded

**URBANISATION**  
Mixed. Current trends continue, but there are active efforts by some states to prevent rural 'out-migration' by keeping agriculture labour-intensive



**INEQUALITY**  
High



## Social Cohesion

High within homogeneous ethnic and religious groupings, but very poor between such groups

**TRUST IN BUSINESS**  
High



**TRUST IN INSTITUTIONS / GOVERNMENT**  
High, despite draconian policies



**DISPLACED PEOPLE**  
High



TRANSITION BASELINE

PHYSICAL BASELINE

# New Protectionism

# 2040

is a splintered world of protectionist blocs, where tackling climate change is a matter of national security. Cultures continue to fragment along religious, values and ethnic lines.



An atmosphere of suspicion underpins international relations as the world has splintered into protectionist blocs, with strategic bilateral deals dominating international trade.

‘Strongmen’ leaders dominate politics, with ‘national interest’ used to justify protectionist – and often capricious – policies and alliances. Tight control of the media has helped create and maintain broad support for such leaders, and for policies and interventions that would, as recently as the 2000s, have been seen as an unacceptable invasion of civil liberties.

The sheer weight of evidence that the climate was changing helped to ‘mainstream’ political concern about climate change in the early 2020s, but it was the emerging ‘threat’ of climate refugees that really drove action.

After a slow start, tough and often draconian measures have been adopted to combat climate change. Simmering tensions, often exacerbated by climate change events, make this world a volatile place, where emerging disagreements are rarely resolved by mediation or compromise.

## GLOBAL CONTEXT

Globalisation has gone into retreat. The world has fractured into protectionist blocs; with states focused on security and access to resources. Governments intervene at all levels of society, promoting centralised decarbonisation and climate adaptation solutions on the one hand; but also monitoring, rewarding and punishing individual behaviour on the other.

With an ‘us versus them’ narrative common within countries, cultures continue to fragment along religious and ethnic lines. Hard borders stem the international flow of climate refugees but massive internal flows provoke simmering discontent in ‘influx cities’.

The UN, whilst still technically active, has been disempowered and is underfunded. The EU has retrenched into a northern European core and has become more aligned with China than any other country due to cooperation on low-carbon technology. Both India and China have established strategic alliances across Asia and Africa, seeking access to land and mineral resources in return for investment.

## SOCIETY LIFESTYLES

Governments intervene directly in how people live their lives. “Citizenship rating schemes”, mirroring and building upon the Social Credit System that was introduced in China in the 2010s, rapidly gained traction across the globe during the late 2020s and early 2030s. Individual behaviour is closely monitored and incentivised by the government, but most citizens have embraced these changes, and the benefits and social status that come with achieving a ‘zero-carbon patriot’ ranking.

Everything from diet and health, to technological and lifestyle choices, and even child-bearing, is covered by such schemes. In India, for example, citizens see their ranking rise by adopting a vegetarian diet. Other countries, especially in the Americas, continue to celebrate the cultural significance of meat-based diets – and have seen a widespread shift to feed-free rotational grazing as a means to justify this on carbon terms. Meat has become a luxury, however, and is a particularly-valued reward for top-ranking citizens.

## BUSINESS

Large state-sanctioned “national businesses” dominate the economy and work hand-in-hand with their ‘host’ states. During the 2020s, these national businesses tended towards established fossil fuel companies, extractive industries, and agribusiness. When the time came for decarbonisation, their influence ensured a focus on large, centralised decarbonisation technologies and strategies.

The late 2020s also saw a series of ‘pseudo’ re-nationalisations, with state-sanctioned companies being handed control of assets deemed in the national interest.

Certain multinationals resisted protectionism and restrictions to trade, closing operations in countries where restrictions were threatened or imposed – and have become a strong voice against protectionism and nationalism (and for minority rights). Based in relatively liberal enclaves, such as the remaining EU nations and Singapore, these companies continue to be vocal opponents of protectionism. State control of media, and the fracturing of the



**Governments rely on hard policy to change how business operates and how people live their lives. The cost to individual liberty has been great. The ‘threat’ of climate refugees has been used by strongly nationalistic governments to maintain legitimacy.**

internet into regional systems, means that their opposition is rarely heard outside of their own blocs.

### **ECONOMY**

Strategic bilateral deals dominate international trade, which is focused on ensuring access to scarce resources. Borders have been closed to goods and individuals from ‘non-sanctioned’ rivals. Once-common food commodities such as tea, coffee and cocoa, and textiles such as cotton, are much less available, and much more expensive than they were in the 2010s.

Cyber-crime is rife. In the name of self-sufficiency and security, little regard is held internationally for copyright laws or intellectual property rights.

### **ATTITUDES TO CLIMATE CHANGE**

The emerging ‘threat’ of climate refugees saw climate change shift rapidly from something to be downplayed by the nationalist governments of the early- and mid- 2020s, into a critical security issue. The perception was that it had to be tackled to preserve national culture and integrity. Climate change and the need to decarbonise rapidly is now used to justify everything from international relations to highly invasive state control over individual behaviour.

### **RESOURCES**

Geographically-specific resources – particularly energy, water, minerals, food and fertile land – are the subject of intense competition that frequently erupts into violence. Water wars were a defining feature of the 2030s across Africa and Asia, and the Brahmaputra River remains the source of severe tension between India and China.

Countries and regions with limited resources, skills or capital to trade find little international sympathy or cooperation. A number of governments are at risk of collapse. And, with hard borders strictly enforced, there are few places for refugees to escape to without facing rapid and severe responses.

### **POLITICS**

Governments rely on hard policy to change how business operates and how people live their lives. The cost to individual liberty has been great. The ‘threat’ of climate refugees has been used by strongly nationalistic governments to maintain legitimacy.

### **TECHNOLOGY**

Large, centralised and state-backed decarbonisation and climate adaptation solutions dominate. Large-scale solar, offshore wind and storage systems dominate electricity production in most places, although nuclear power remains a major part of the energy mix in countries with close links to China. Concentrated solar power has re-emerged as a means to enable desalination, and to exploit cheap, unproductive land for protected cropping-based food production.

Carbon capture and storage (CCS) technologies received huge state support in the 2030s - even after it became clear that a combination of renewables with storage was the most cost-effective way to decarbonise the electricity system. The support for CCS continued in the hope that CCS used in combination with bioenergy (BECCS) would still enable warming to be limited to 2C despite the lack of action in the early 2020s. Large areas of land are now designated as ‘national forests’ and have been dedicated to growing feedstock for such efforts.

Effective decarbonisation and adaptation technologies are seen as a means to ensure state security and advantage, and an innovation-accelerating arms race of sorts has arisen around any technologies that have the potential to build or threaten security. BECCS, and a number of emerging geoengineering technologies, are deemed to fall in this category.

Indeed, as national geoengineering efforts start to scale-up, new tensions are emerging as to where climate should be ‘stabilized’. Equatorial and low-lying states want a return to 350ppm; but Canada and Russia have both – independently – stated their aim to stabilise at 450ppm.



**In the name of security, governments support the development of substitutions for scarce or volatile minerals and materials; as well as promoting circular systems and remotely monitoring technologies for citizens, supply chains and competitors.**

In the name of security, governments support the development of substitutions for scarce or volatile minerals and materials; as well as promoting circular systems and remotely monitoring technologies for citizens, supply chains and competitors.

Food systems have also attracted considerable investment. Some states have sought to prevent unemployment by keeping agriculture labour-intensive. Others have gone for the lower costs of fully automated, precision-cropping systems.

#### **COPING WITH STORMS IN MUMBAI**

Despite the massive efforts that had been made to protect the 'national flagship' city of Mumbai from the impacts of climate change, storm surges occasionally top the sea walls and threaten parts of the city with collapse. Standing water often remains in low-lying neighbourhoods for days, presenting a significant disease risk.

The ongoing costs of Mumbai's sea defences have already become hard to justify. A managed retreat plan has been tabled, proposing the sacrifice of a number of low-lying neighbourhoods over to mangrove and wetlands restoration and new defences. The idea is being heralded as an example of Indian resolve and innovation. Mumbai, albeit a radically changed Mumbai, would still be protected.

#### **SIGNALS THAT INDICATE THIS SCENARIO COULD COME ABOUT FROM TODAY**

- **Trade disputes between US and China are getting more complex**  
<https://learningenglish.voanews.com/a/in-trade-dispute-china-put-import-taxes-on-us-goods/4329125.html>
- **China is being perceived to flex its 'sharp power'**  
<https://www.aspistrategist.org.au/global-dimension-chinas-influence-operations/>
- **Personal reputation rating systems exist in China and are emerging in Germany**  
<https://thefuturescentre.org/articles/217929/germany-edges-toward-chinese-style-rating-citizens>
- **Facebook has a trustworthiness rating for users**  
<https://www.bbc.co.uk/news/technology-45257894>
- **Facial recognition technology is already being used to track identity in India**  
[www.livemint.com/Politics/KNozl8s4UjiGC4vk5X4F9J/UIDAI-allows-face-recognition-for-Aadhaar-authentication.html](http://www.livemint.com/Politics/KNozl8s4UjiGC4vk5X4F9J/UIDAI-allows-face-recognition-for-Aadhaar-authentication.html)
- **Taxes on junk food are being used to shape diets in India and across the world**  
<https://www.theguardian.com/global-development/2016/jul/20/tax-on-junk-food-in-kerala-leaves-indians-with-a-bitter-taste>

# SERVICE TRANSFORMATION



# SERVICE TRANSFORMATION

A world where the mainstreaming of access over ownership has happened quickly, and globally-applied, individual carbon budgets are traded and tracked

2023 — 2025 — 2030 — 2033 — 2037 — 2038

CarbonCoin cryptocurrency overtakes BitCoin

Unprecedented agreement during the climate ratcheting process following 7 years of intense fires, droughts and floods

Global carbon market is reformed and linked to CarbonCoin, with the introduction of tradeable, globally identical individual quotas

The first put options for Miami housing go on sale as mainstream insurers refuse to cover a third of the city

McDonalds' menu across the world is entirely meat-free

India is now 70% urbanised from approximately 33% in 2017

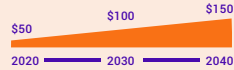
VirtuTrip floats at record-breaking valuation as virtual tourism booms



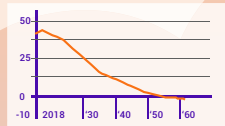
## Carbon Emissions and Pricing Mechanisms

CarbonCoin global cryptocurrency market with tradeable individual quotas and annual ratchet down

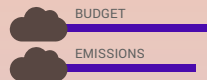
**CARBON PRICE**  
Introduced universally at \$50/tCO<sub>2</sub>e in 2020; reaching \$100/tCO<sub>2</sub>e by 2030, and rising to \$150/tCO<sub>2</sub>e in 2040



**CARBON EMISSIONS / TRAJECTORY**  
Emissions peak at around 42 GtCO<sub>2</sub>e/year in 2020 and decline to around 12 GtCO<sub>2</sub>e/year in 2040; with net-negative emissions from 2055 onwards. Steady decline in emissions in line with pre-set budgets



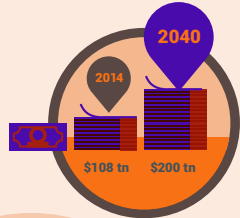
**TOTAL CARBON EMISSIONS BETWEEN 2018 AND 2040**  
650 GtCO<sub>2</sub>e



## Global Governance and Trade

Internationalist technocratic governance

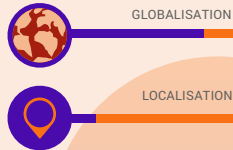
**GDP**  
\$200 trillion in 2040



## Regulation and Policy

Favours innovation, uses AI modelling to anticipate outcomes and adapt

**DEGREE OF GLOBALISATION**  
Strong global collaborations right from 2020

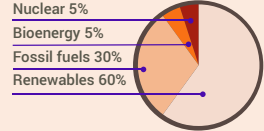


**FOREST AREA**  
10% increase in forest cover



## Energy Mix in 2040

With medium - and small scale solar dominating electricity production



**GLOBAL ENERGY DEMAND**  
20% increase over current level

**MINING / PETROCHEMICALS PRODUCTION**

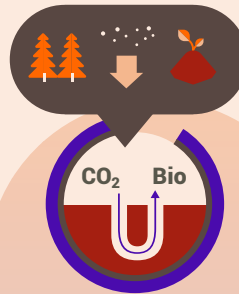
Minerals are extensively reused; Gas still being used in industry and for electricity generation sector in decline



## Innovation and Digital Paradigm

High degree of virtualisation, decentralised technology

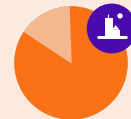
**GEOENGINEERING EXTENT**  
Direct air capture, reforestation and biochar to the fore



## Lifestyle and Behaviour

Access over ownership, service living paradigm

**URBANISATION**  
75% by 2050 and more than 85% by 2100



**INEQUALITY**  
Income and social inequality decreases but still persists in low income countries; overall inequality is the second lowest among the four scenarios



## Social Cohesion

Current levels of social cohesion - with ethnic, religious and social tensions - continue to exist

**TRUST IN BUSINESS**  
Medium. People are sceptical due to reduced face-to-face interactions; people believe that business is led by policy and regulation, rather than leading from the front



**TRUST IN INSTITUTIONS / GOVERNMENT**  
Medium to high; Citizens appreciate open policies but are critical of still-prevalent inequality



**DISPLACED PEOPLE**  
High, individually tracked and directed



TRANSITION BASELINE

PHYSICAL BASELINE

# Service Transformation

# 2040

is experience-led. Service-based living, the mainstreaming of access over ownership, has happened quickly, and globally-applied, individual carbon budgets are traded and tracked.

A shift in economics driven by service innovations such as low-cost driverless transport and decentralised energy has ushered in a low carbon revolution. The service and sharing economy has completely reshaped lifestyles and business across the world.

After a series of extreme climate events around the world, the international climate agreement was ramped up significantly in the early 2020s and given teeth through international enforcement of global carbon pricing. This focus on carbon price and the development of easily tradable individual carbon quotas accelerated the move to new service-based, decentralised business models.

In India and other major countries across the world, citizens are used to, and generally prefer, an 'access over ownership' approach to life. Maximising profit and wellbeing per kg of CO<sub>2</sub> is the aim and this has led to high levels of innovation at every level of society.

## GLOBAL CONTEXT

This world is globalised and highly urbanised, with a population of almost 9 billion. The centre of global economic and political power has shifted eastwards since the 2020s and China now dominates a technocratic internationalist framework.

Climate change has had extensive impact and societies have had to innovate extremely fast to cope with the worst effects. Around the world, defensible key coastal cities have been prioritised for sea defences while others (such as Miami) are gradually emptying and reconfiguring as insurance dries up and their future becomes clear. Frequent droughts have reshaped rural South Asia, intensifying urbanisation. Agricultural yields have dropped despite constant innovation, but there is enough food due to much lower levels of meat consumption. However, fisheries are in severe crisis; commercial fish is in short supply and now by far the majority comes from aquaculture.

## SOCIETY AND LIFESTYLES

The 'access over ownership' paradigm is dominant globally and regarded as the best means to provide decent lifestyles at mass level. Mobility services have supplanted car ownership and there has been a shift from home ownership to flexible 'service living', in which households subscribe to housing that fits their requirements, upgrading or downgrading as necessary as circumstances change. This shift happened rapidly in cities, driven by a combination of favourable economics and changing values as new generations became influential. It also suits the 'new normal' of regular extreme climate events as it reduces the risk that individual households would bear. Large private companies run the service living contracts for the affluent, whereas the poor rely on basic government-run schemes in upgraded slums.

Personal carbon trading on digital platforms has become normal and has led to some reductions in inequality as the poor have sold their surplus to the rich. A levelling of lifestyles has occurred as many carbon-intensive activities like air travel have become far more marginal. Tourism has reduced and now occurs mainly by high speed rail. Virtual tourism is becoming a popular and cost-effective alternative, and virtual experiences are wildly popular.

Diets have shifted to be largely plant-based much more quickly than expected, as innovation in food technology has converged with the carbon trading revolution. Vegetarianism is now simply the modern norm, and meat substitutes are affordable and considered better than the real thing.

Carbon quotas offer opportunity for entrepreneurs but are also a source of tension as they ratchet down each year and no carry-over is permitted. Activists who buy surplus carbon to retire it are lauded and excoriated in equal measure.



**The economy is dominated by innovative and complex global carbon markets based on mature blockchain platforms. CarbonCoin cryptocurrencies and AI link up networks of farmers, traders, manufacturers and consumers who all strive to maximise their carbon savings.**

## **BUSINESS**

The enabling power of business has been at the forefront of the transition in society and lifestyles. Innovative start-ups leveraged technology to give people affordable access to service-based living and were further enabled by the advent of carbon pricing and carbon trading. Financial innovation in decentralised blockchain-based schemes has also been used to maximise the benefits of transition and the most efficient use of resources. Some examples of these applications include: the pooling and leasing of smallholders' land; the rewarding of afforestation; and the creation of 'put options' to manage the decline of cities such as Miami. However many sectors and traditional businesses have been disrupted by the rapid transition, particularly centralised manufacturers with long linear supply chains that were set up for the previous era of individual ownership.

## **ECONOMY**

The economy is dominated by innovative and complex global carbon markets based on mature blockchain platforms. CarbonCoin cryptocurrencies and AI link up networks of farmers, traders, manufacturers and consumers who all strive to maximise their carbon savings. Pension funds invest in carbon-capture schemes with a dual income of cash and negative carbon. The few regions that have favourable geology for direct air capture (such as Iceland) are experiencing a gold rush, while countries with access to cheap labour try to capitalise on carbon sequestration via afforestation and biochar. Carbon-intensive sectors of the economy are in steep decline.

Despite the advent of automation, the low carbon transition has been a net creator of jobs due to constant building and maintenance of resilient low carbon infrastructure, as cities are extended, defended and reconfigured to adapt to climate change and high urbanisation. In rural areas ecosystem restoration is high-priority and uses a great deal of low-skilled labour. Airbnb-style schemes have been set up so that smallholders can lease their land to agribusiness when they move to cities and use the income to set up enterprises and educate their children. A thriving enterprise economy uses decentralised mobile platforms in the informal sector to trade. Middle-class graduates access the global knowledge economy via online work platforms.

## **ATTITUDES TO CLIMATE CHANGE**

Climate change is an accepted reality, and there is real motivation to get the planet 'out of the danger zone' as the transition is now having significant effects on emissions. Incentives are aligned, and opposing voices are marginalised.

Climate migration, however, is controversial at international level. South Asia alone is trying to cope with over a hundred million displaced people and numbers are expected to rise further. Refugees are individually tracked and funnelled towards special humanitarian zones serviced by international agencies, but are not permitted to settle outside of those zones.

## **RESOURCES**

Material resources, particularly rare earth metals and natural fibres, are stretched. The circular economy is mainstream and effective in most sectors. Despite automation it remains labour-intensive and a significant source of employment, particularly in South Asia. Building and infrastructure development is circular, with extensive use of 3D printing, recycled concrete, and design for disassembly and reuse due to the increasing need for 'relocatable communities'. Floating communities are starting to become prevalent in parts of the Ganges Delta.

Water scarcity is a massive issue, almost on a par with carbon. There has been lots of innovation around harvesting, recycling, purification; also desalination is becoming integrated with some forms of solar power generation. However water remains a serious problem for agriculture as droughts become more frequent and aquifers run dry.

## **POLITICS**

There is a utilitarian approach to politics – a focus on 'what produces results' – with heavy use of AI modelling to try to anticipate the results of policies. There has been some success in using AI-tested social policy to reduce social and religious tensions to manageable levels. Transparency is used to shrink space for corruption. Policy generally tries to favour innovation and results, replacing subsidies with x-prize style funding, or smart contracts linked to verification mechanisms.

**Energy demand has increased significantly, due to much greater access, and there has been a big shift towards electrification, driven by the falling costs of renewables and storage and the imperative to decarbonise.**

Strong attempts have been made to provide a basic floor of services for everyone, in terms of education, preventative healthcare and shelter, paid using a basic level of individual carbon credits. Carbon quotas in India function somewhat like a UBI in this respect. Humanitarian and development agencies have merged and employ this approach with displaced communities, whilst providing support for resilient livelihoods. There is lots of innovation from India and East Africa in frugal low-carbon solutions for basic living and healthcare.

### TECHNOLOGY

Technology is largely decentralised. There is widespread use of mature blockchain-based platforms to meet the key requirements of transparency, data protection and verification for the carbon trading system to work. Trustworthy verification is extremely important and is the subject of a constant arms race between AI technologies. A massive carbon fraud almost derailed the CarbonCoin system when it was first created, but was fortunately detected in time.

Biotech is used pragmatically, within an international framework. The moratorium on non-medical human gene-editing has held. Biotech is mainly used to speed up crop-breeding, and to free up land for agriculture by brewing non-food commodities such as textiles, leather, and medicines.

Energy demand has increased significantly, due to much greater access, and there has been a big shift towards electrification, driven by the falling costs of renewables and storage and the imperative to decarbonise. Generation is decentralised but management is dominated by a few large companies who use smart grid technology for demand management and load balancing. Transport is dominated by high speed electric rail. The aviation sector is much smaller and more expensive; short-haul electric flights are the preserve of the rich and long-haul flying is punitive in terms of carbon quotas. Shipping uses electric container ships, but freight volumes are down due to shorter supply chains.

Virtualisation has displaced aviation emissions, but higher-end virtual services are popular and energy intensive, and there are issues around supply keeping up with demand. There remains massive inequality in energy use.

### COPING WITH STORMS IN MUMBAI

The regular storms that hit Mumbai in 2040 confirm the necessity of the massive changes that had begun reconfiguring the city over the previous decade. Storm surges easily top existing sea defences, inundating a vast area that just five years earlier, before the relocation programme, had housed double the population and hosted thousands of enterprises that have since moved deeper inland.

In major storms fatalities are low but frequent, and thousands of homes are often rendered uninhabitable. The service living concept is put to the test. Most of the affected affluent families are quickly moved into new accommodation in lower risk areas, but low-income households from the upgraded slum zones often face lengthy delays and slow re-provision. Households who live illegally in the officially abandoned areas are worst affected but rarely receive help. Many are forced to sell the remainder of their quotas to survive.

In the wake of major storms, the abandoned areas are often enlarged further, based on insurance risk, and defences strengthened for the remainder of the city.

### SIGNALS POINTING TO THIS WORLD FROM TODAY

- China poised to become one of world's largest mobility-as-a-service market  
<https://ark-invest.com/research/chinese-mobility-as-a-service>
- Living as a service - Co-living communities such as Common, Ollie, and Starcity are designed and furnished to cater to a younger demographic at a more affordable price. They emphasize community, charge a membership fee in lieu of rent, and allow tenants to commit to several months at a time or leave earlier than planned.
- AI modelling for social cohesion, facilitating integration between local and immigrant communities  
<http://mindandculture.org/projects/modeling-social-systems/modeling-religion-in-norway/>
- Emerging attempts to use blockchain-based smart contracts (coupled with predictive AI) to reward the prevention of deforestation in the Amazon  
<https://medium.com/@daviddao/predictive-smart-contracts-dc15b9986d8c>



# A note on implications

## What does this mean?

**Staying below 2°C is our best and only hope for enduring sustainable planet for human survival. It requires most businesses to transform their products, power supply, raw material sources, logistics, and operations, internally and within their value chains.**

The role of these scenarios is not to paint a picture of future disaster. They are scenarios for success, in which the world has successfully limited warming to below 2°C. The space for manoeuvre on the road to 2040 is increasingly tight, the funnel of the ABG Sustainable Business Framework constricts quickly and each year of insufficient activity limits our options further by making adaption harder.

It is hard to escape the fact that avoiding more than 2°C warming requires a fundamental transformation of the economy in a matter of decades, with many actions required even by 2020. The impact on business will be enormous.

It will be challenging in the best of scenarios and near impossible where the mutually reinforcing critical levers are not identified and pulled together.

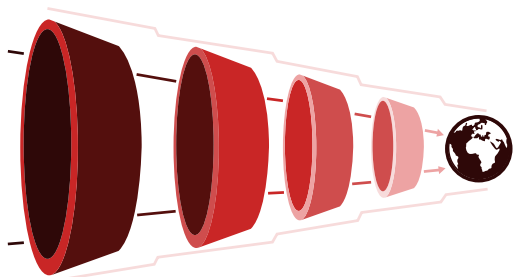
The role of business is therefore not just ensuring that we are on course for net zero emissions within our value chains, and advocating for the conditions that will make that happen, such as: intergovernmental cooperation; effective regulation and implementation; enhanced flows of climate finance; and more accountability over how it is spent. We must also prepare and adapt to the conditions that a 2°C trajectory world will bring as we try to avoid even larger rises in temperature. Pioneering businesses need to pull society down the funnel, proving to international bodies that their best practices can be codified and giving confidence to legislators to provide that push.

Staying below 2°C is our best and only hope for enduring sustainable planet for human survival. It requires most businesses to transform their products, power supply, raw material sources, logistics, and operations, internally and within their value chains. Our investment decisions and actions from now till 2040 will determine whether we can be successful in transforming ourselves to meet the constraints of a 2°C future; whether we can be resilient no matter the levers that are pulled determines if we will be sustainable and allowed to operate. The sooner we act, the more ahead of the field we will be.

Together, the baselines and scenarios suggest that for businesses to be successful in a below 2°C future they need to be ready for a complex picture of mutually reinforcing changes that define the shrinking operating space between the walls of the funnel:

- **A tough policy landscape and robust implementation, including through the increased use of information technology**  
The speed at which the change needs to happen suggests a need to be ready and ahead of tough government policy and fierce enforcement at a business and individual level.
- **The end of coal**  
Although it will be part of the mix for some decades to come, any new investment will face increasingly high funding hurdles. Adding alternatives rapidly to our energy matrix should offer more medium and long term options.
- **A huge transformation in the built environment**  
The sooner we build zero carbon buildings at scale, the easier the transformation will be. This is a huge market opportunity for materials, construction and building management companies.
- **A step change in agriculture and food**  
Whether we take an intensive automation route or a small scale networked one, or indeed both, we need more resilient and productive crops, sustainable aquaculture on a major scale, significant dietary shifts and new regenerative practices. Whilst the major aim is to recarbonise our soils and provide nutrition to a growing population, it is imperative to reduce the pressure on biodiversity and the nitrogen and phosphorus cycles. From greater use of telecoms to better logistics and intelligent fertilisers, this presents an exciting web of opportunity for the proactive innovators.
- **A mobility revolution**  
This isn't just about the massive switch to electric vehicles. We need to plan for a world where ownership, and even travel, is not necessarily the preferred option. IT and the virtual world may play an important role here.

With climate change impacts already demonstrating how unprepared we are globally, and the timetable for action being sooner than most believe, the time for action is now if we want our businesses to continue to be successful and more importantly sustainable.



- New materials and minerals to the fore**  
Whether government incentivise new materials or steadily regulate out carbon intensive and non-degradable ones, our palette of materials will likely look very different to today. Product transformation opportunities will abound.
- Detailed monitoring of corporate, and even individual, behaviour**  
The scenarios show transparency being demanded and used at multiple levels: national security, legal enforcement of standards, or perhaps competition-making through much better product labelling. Companies that can be open faster will likely win client and customer favour first.
- The emergence of radically different governance and business models**  
Whether motivated by transparency requirements or changing consumer expectations, businesses will need to be alive to different ways of providing value, for instance through service models, or a more networked structure.
- A change in land use on a massive scale for protection, sequestration and / or energy**  
The dedication of large of areas of land to reforestation and / or Bio-Energy Carbon Capture and Storage is implied on all trajectories that require negative emissions to avoid warming. As the physical impacts of climate change really bite we will need to protect coastlines and water resources, radically shifting land use in some locations.
- Sea-level rise that poses serious challenges for low-lying cities**  
Though sea-level rise may appear minimal before mid-century, the 20cm rise by 2040 will still water log infrastructure and challenge its integrity more frequently and for longer periods. Protection is possible for some cities, but for many others, in the long run, we will likely require managed retreats.
- Hotter, more frequent heatwaves and intense flooding**  
The wildfires of Portugal, California and British Columbia and floods of Kerala are already showing how ill-prepared we are to cope with more extreme heat and flooding. Value chains reliant on infrastructure, raw materials and people in heat-wave prone areas will likely face ever more serious disruption.
- Increasing migration, particularly from water-stressed areas**  
As more frequent water shortages make agriculture and water dependent manufacturing less viable in a drought stricken area, people and businesses will be forced to migrate – often to places where resources are already tight. The impact on social cohesion, and therefore the disruption to living and to productivity could be high in some areas, making it in the interest of all to learn to manage migration well.
- Tackling poverty will have become critical to all**  
Whether it is through tradable carbon quotas, a strong social security system, a version of Universal Basic Income or a method beyond the scenarios, reducing poverty will be in the interest of all as unequal societies and cities tend to fair worst in times of stress.
- An acceptance that technology alone will not save us**  
There is no point innovating zero carbon food if it is not eaten. And there is little use in improving the efficiency of appliances only for them to be used more. Softer measures such as empowerment of women, education of girls, and widespread behaviour change programmes will be essential.

With climate change impacts already demonstrating how unprepared we are globally, and the timetable for action being sooner than most believe, the time for action is now if we want our businesses to continue to be successful and more importantly sustainable. As some of the leading experts say: “There will always be those who hide their heads in the sand and ignore the global risks of climate change and those that mitigate their effects now and prepare to adapt.”

Leaders are those of us committed to overcoming the inertia we have built. Finding business value on a below 2°C trajectory is the best a source of transformational competitive advantage - and we will need to do it probably sooner than most think.

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