

# AIRSPACE 2050

## THREE FUTURES



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## INTRODUCTION



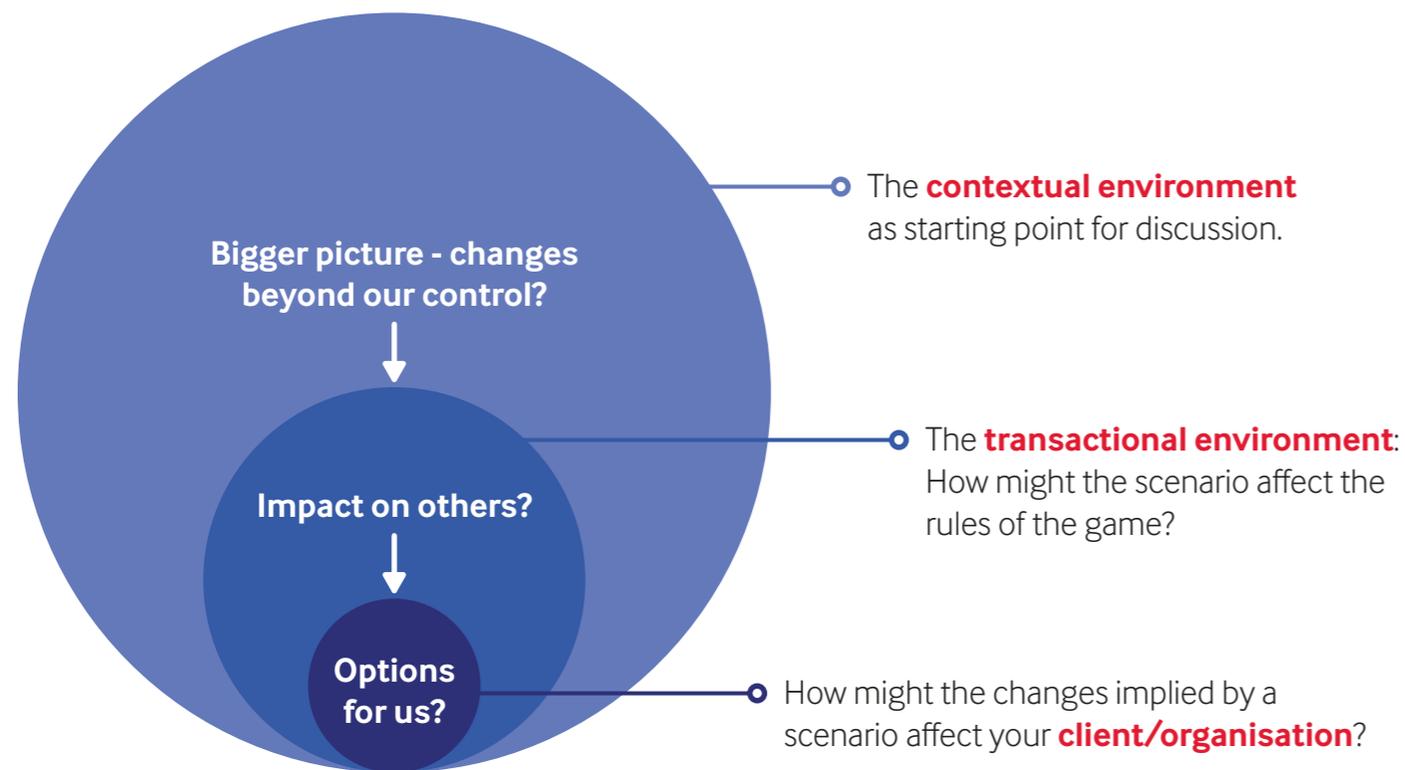
Air transport has enjoyed relatively unconstrained growth of around five per cent per year since the dawn of mass travel after the Second World War - growth enabled by an expanding world population, increasing affluence, globalisation, and technological progress. This has in turn driven the global system that regulates air travel, as well as huge investments in transport infrastructure, new aircraft with all their underlying technologies, and a host of businesses to serve the needs of passengers and freight carriers.

The growth pattern has been disrupted by recessions, terrorism, pandemics and other significant events, but has always returned to trend within a short period. At the time of writing, the Covid-19 pandemic represents by far the greatest disruption to air transport ever, creating a sharp fall in flights unlikely to be entirely reversed for several years. Nevertheless, recovery and a return to normal growth are foreseen eventually (see note on Covid-19 on p23). Consideration of the future focuses mainly on how to mitigate the environmental impacts of air transport, and how to usher in new markets such as drone deliveries and urban air mobility (UAM) – developments enabled by technologies such as autonomy, electrification, connectivity and artificial intelligence.

In order to provide some fresh perspectives, the ATI has created three alternative scenarios which might play out around the year 2050. These are challenging but plausible futures. They are not predictions, but envision potential outcomes arising from the call to action on climate change, from technological disruption and geopolitical change, from burdens put upon the regulatory system, and from changing demographics and attitudes. They are based on unclear and unknown factors, risks, events, and uncertainties. They may or may not materialise; or they may materialise substantially differently. They are designed to make sense of an uncertain future in a complex and changing environment, to facilitate wider stakeholder engagement, to challenge thinking, and to test the sector's resilience to challenges that may lie ahead.



The scenarios were created through an 'outside-in' approach which seeks to identify the key uncertainties in the contextual environment - a structured way of thinking about uncertainty.



The development of the scenarios was supported by actors across the contextual and transactional environments including the ATI and its stakeholders, Government departments, the aerospace industry, automotive organisations and Catapults. Further contributions were made by over 50 individuals representing 40 different organisations, including airport operators, airlines, regulators, local transport authorities, air traffic control, energy companies, trade bodies, skills development agencies, start-ups, insurance, banking, lessors, academia, NGOs, sustainability experts and environmentalists.

The three scenarios – **Techopoly**, **Eco-it-alone**, and **Good in-tensions** – are described briefly in the following sections along with their key events and transitions, their drivers, and a list of the main challenges arising under each. This is followed by a brief description of the methodology used and the ways in which the scenarios can be used to test planning assumptions frequently made in business.

The ATI is keen that organisations use these scenarios as a practical help to planning. The final sections of the paper therefore set out some suggestions about questions to ask and ways in which the material here can be used to challenge strategic thinking. The ATI has already used these to good effect in sector workshops and within individual businesses, and looks forward to continuing engagement with stakeholders on the scenarios and their implications. We will develop this approach further over time, using scenarios as part of our strategy development process, and reviewing whether we are successfully supporting the UK aerospace sector and technology development for the challenges ahead.

# Themes, uncertainties and assumptions

Our three scenarios were developed from an extensive analysis of 8 thematic areas, making connections between potential events and issues to weave stories that lead to the alternative, plausible and challenging futures described on the following pages.



Technology impacting on air transport



Air transport demand and social acceptability



Climate change and environmental impact



Public funding of R&D in aerospace



Geopolitics and demographics



Legal and regulatory issues



Business and operating models



Talent, skills and capability

# *The skies are full of movement, but safe...*



## SCENARIO 1

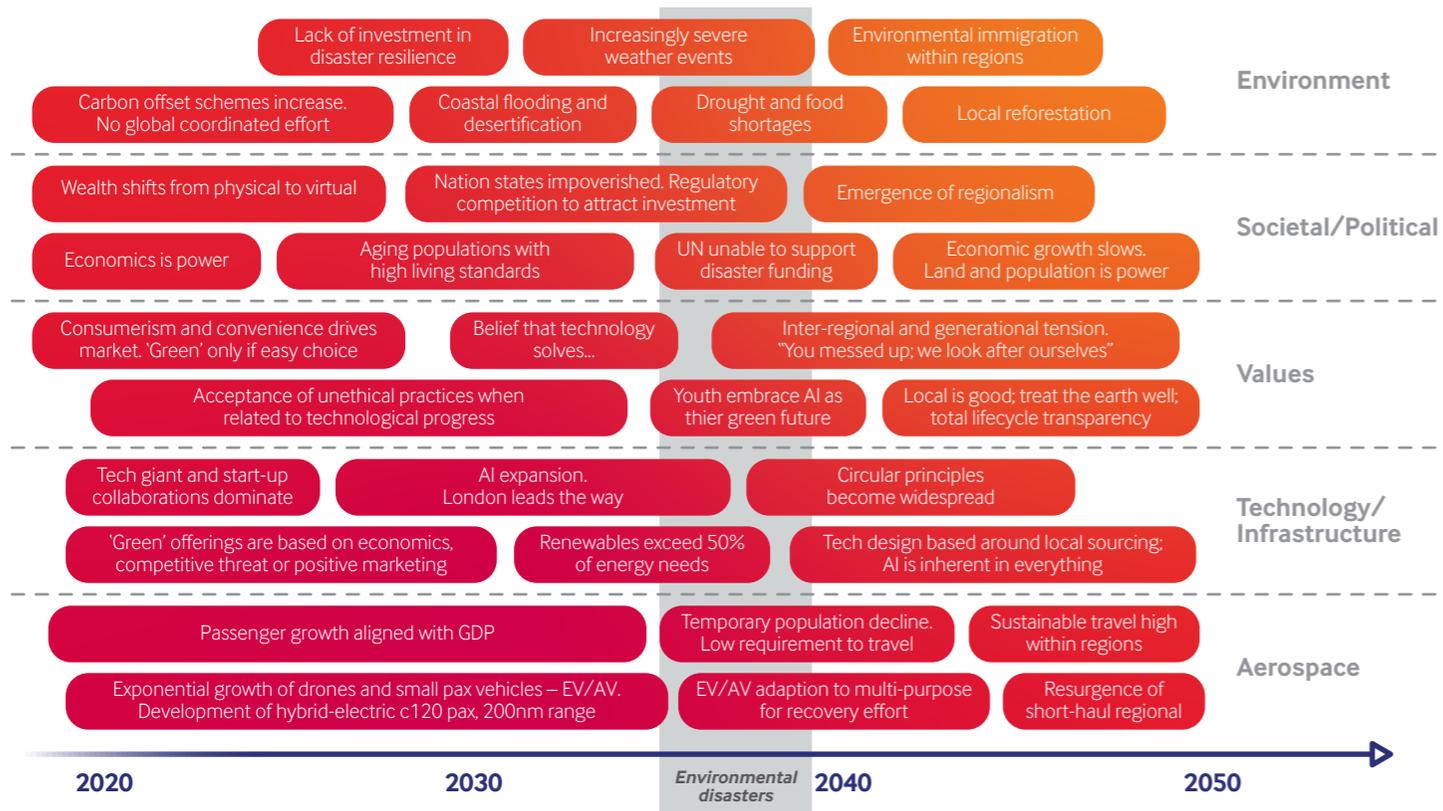
# Techopoly

The key features of this world are:

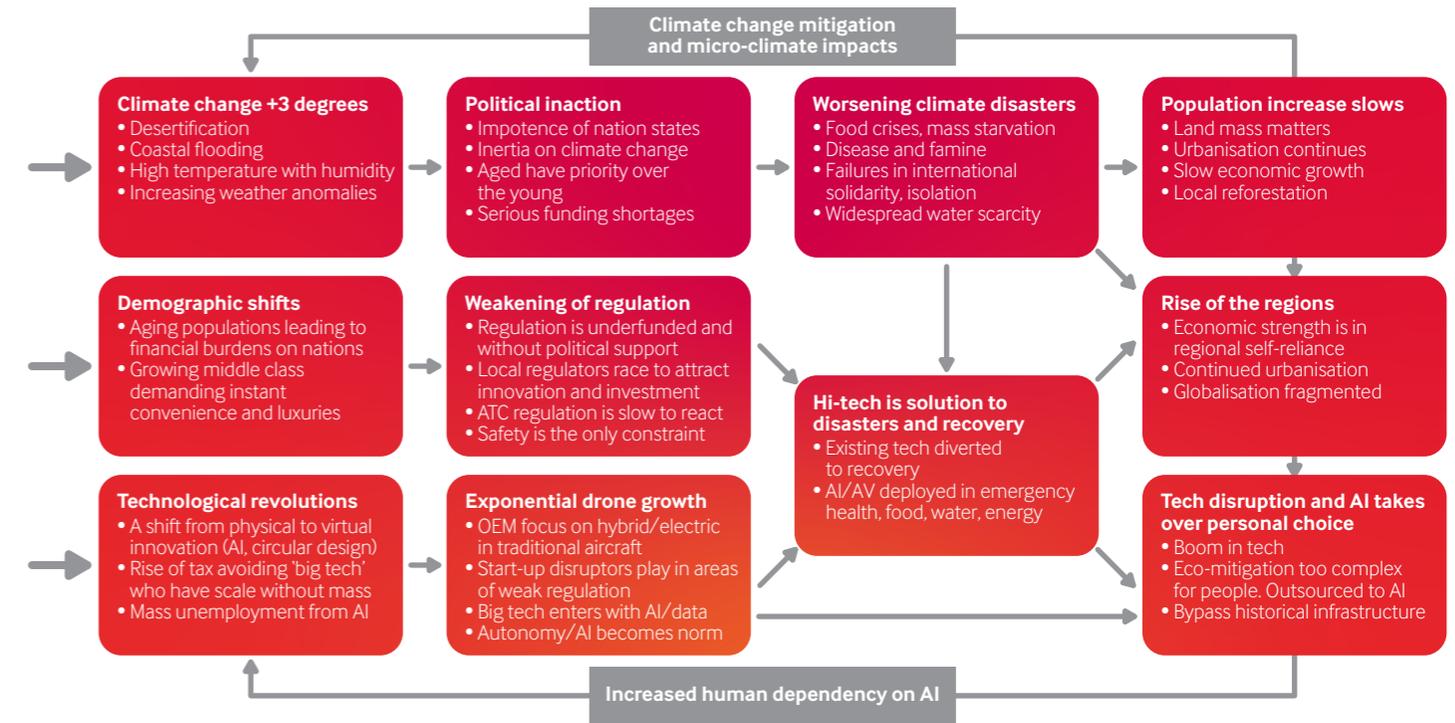
- + Consumerism and convenience
- + Tech giants and aerospace start-ups
- + Aging populations burdening states
- + Wealth shift to virtual world and difficulty recovering taxes
- + Uninsurable climate-related disasters triggering fundamental global change
- + Retreat into regional solitude for survival
- + Europe and China are in a R&D race

In this world, society is driven by consumerism and convenience. Weak governments and their regulatory regimes compete intensely to attract the latest innovation. Climate change challenges have been left mainly to the markets and technological fixes as clean energy, AI and battery-driven mobility have exploded into daily life. Tech giants and aerospace start-ups have made technologies such as autonomous, on-board air traffic control for drones work in land-rich areas such as Africa, China and India. Regional demand for air hopping has been driven by an emerging, mobile middle class from these same areas. In parallel, Europe and China have invested in electric and hybrid-electric short haul flights. Breakthroughs occur at the R&D level, but other priorities take over. A sharp increase in severe weather events sees a seriously weakened and resource stretched international community failing to support countries devastated by flooding, drought, and disease. The world becomes increasingly regionalised as recovery efforts get underway. International flights fall away and there is renewed, serious interest in commercialising autonomous vehicles capable of operating in a variety of modes and mission environments with drone traffic. Airspace mobility has diversified into a complex set of regional systems using a wide range of tightly interconnected air transportation vehicles autonomously hopping between locations and the occasional airport hub. The skies are full of movement, but safe.

## Key events and transitions in the **Techopoly** timeline



## The main drivers of **Techopoly**



## Key challenges on the path to **Techopoly**

- + Can the shift from internationalism to regionalism take place peacefully, especially if driven by failures to support populations exposed to natural disasters?
- + Will nation states continue to allow tech giants to exert so much influence? Can technology stay aloof from geopolitics?
- + Will society continue to allow data collection and accept a dominant role for artificial intelligence?
- + Will the benefits from accelerated, unregulated innovation outweigh the risks?

*The skies are emptier  
but they are cleaner...*



SCENARIO 2

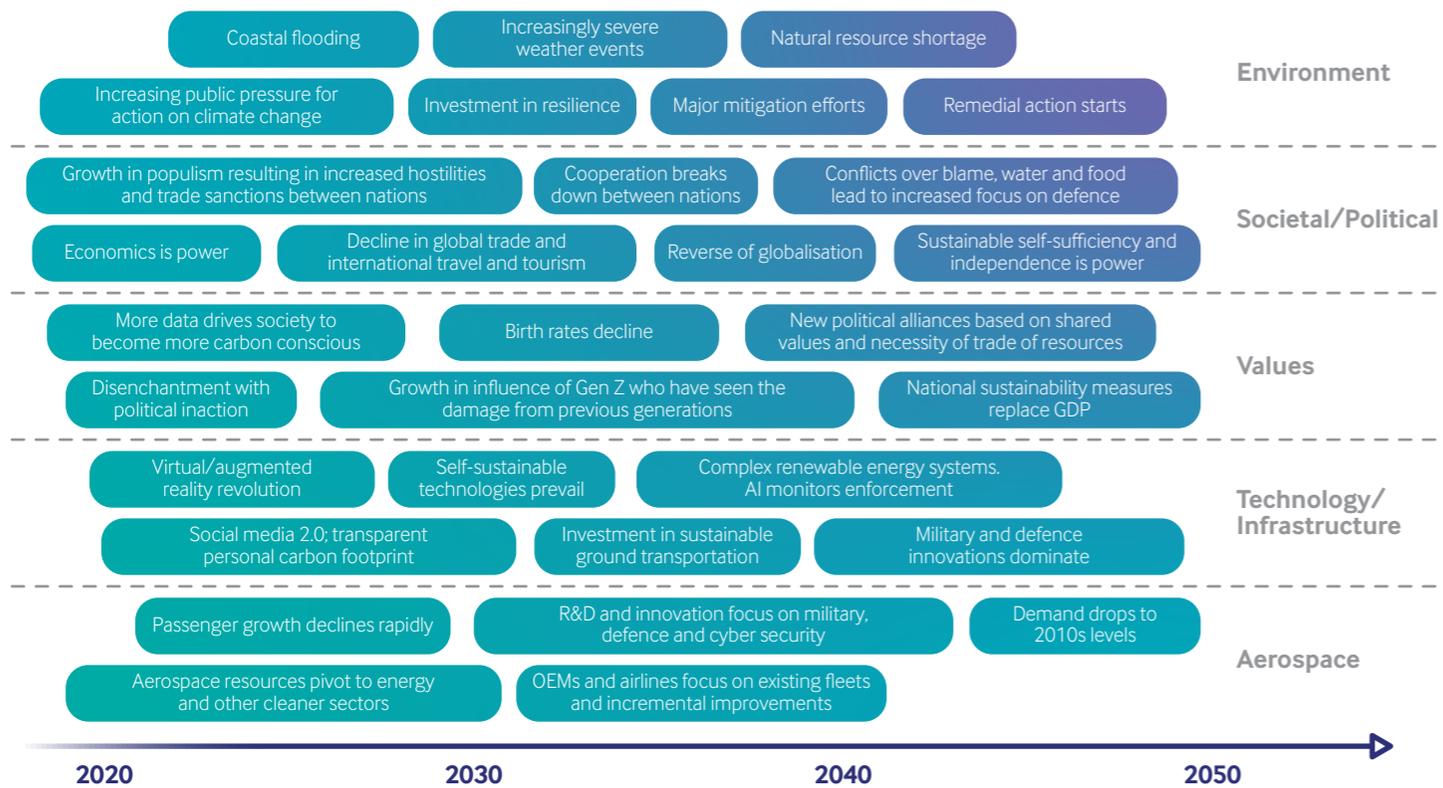
## Eco-it-alone

The key features of this world are:

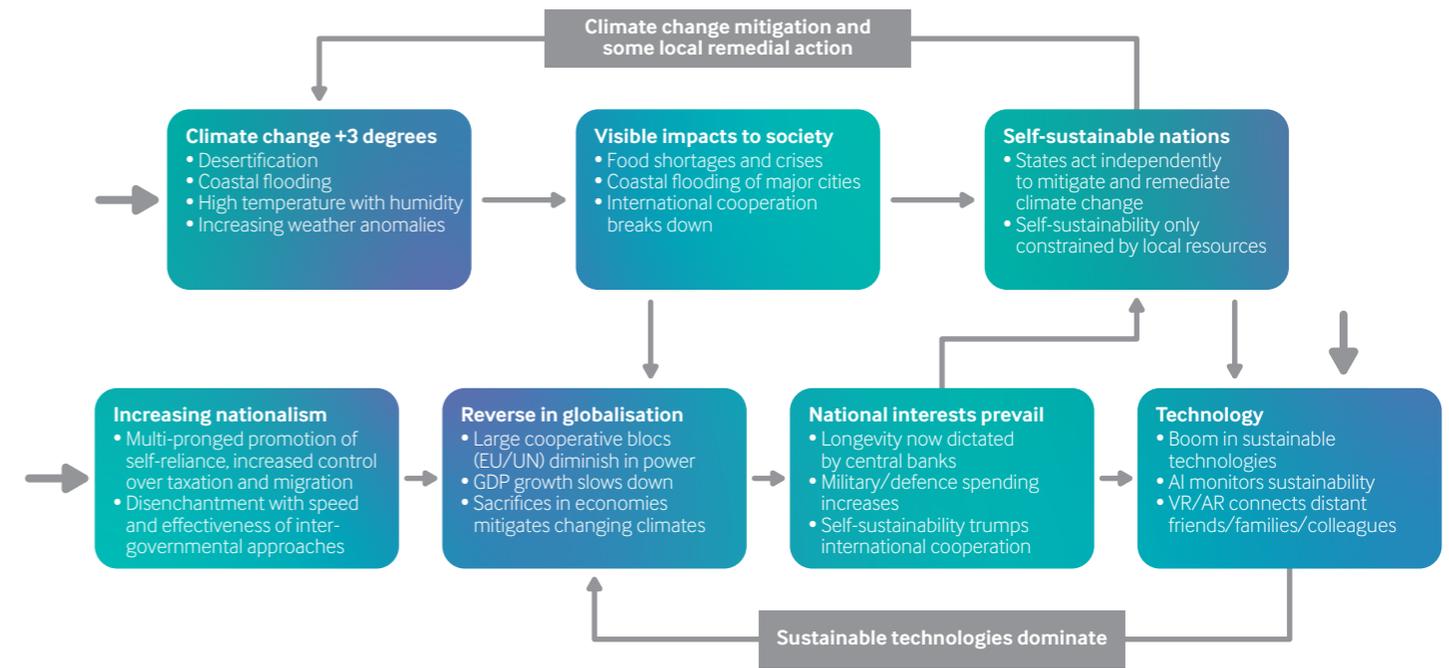
- + Carbon-conscious society, disenchanted with the lack of inter- governmental cooperation and action
- + Increased hostilities, trade sanctions and populism
- + Reverse in globalisation and decline in air travel
- + Aerospace sector pivots towards energy, defence, and other forms of mobility
- + Nation states strive for energy self-sufficiency
- + Boom in artificial/virtual reality and a revolution in ground transportation
- + Sustainability replaces GDP as a measurement of societal success

Society, industry, and financial markets are spurred into action to avoid the increasingly visible cliff edge of climate change. An ongoing round of global blame and resource-based conflicts has driven most nation states to go it alone in terms of energy independence and sustainability. Complex renewable energy systems, electrical mobility and AI micro-monitoring of industrial and domestic processes have the highest priority. GDP as a measurement of societal success has been replaced by a broader range of (national) sustainability criteria. The resultant impact on global trade and international travel has been mostly negative as countries go it alone in a race against the consequences of 250 years of industrialisation. International mass tourism and aerospace have suffered, with many in the aerospace sector making the pivot towards other markets where their capabilities can be applied, like energy and defence. The skies are emptier, but they are cleaner.

## Key events and transitions in the **Eco-it-alone** timeline



## The main drivers of **Eco-it-alone**



## Key challenges on the path to **Eco-it-alone**

- + Will society continue to invest in mitigating climate change impacts in the absence of visible progress?
- + Will society be willing to sacrifice freedoms enjoyed in the interests of reducing environmental impact that will take decades to take effect?
- + Can industries like aerospace successfully reapply their capabilities to new markets and opportunities?
- + How can smaller nations edge away from international cooperation without becoming the vassal of a superpower?
- + How does a society become self-sufficient and independent and yet remain attached to hi-tech, mostly foreign, solutions?

*...but is it too late?*



### SCENARIO 3

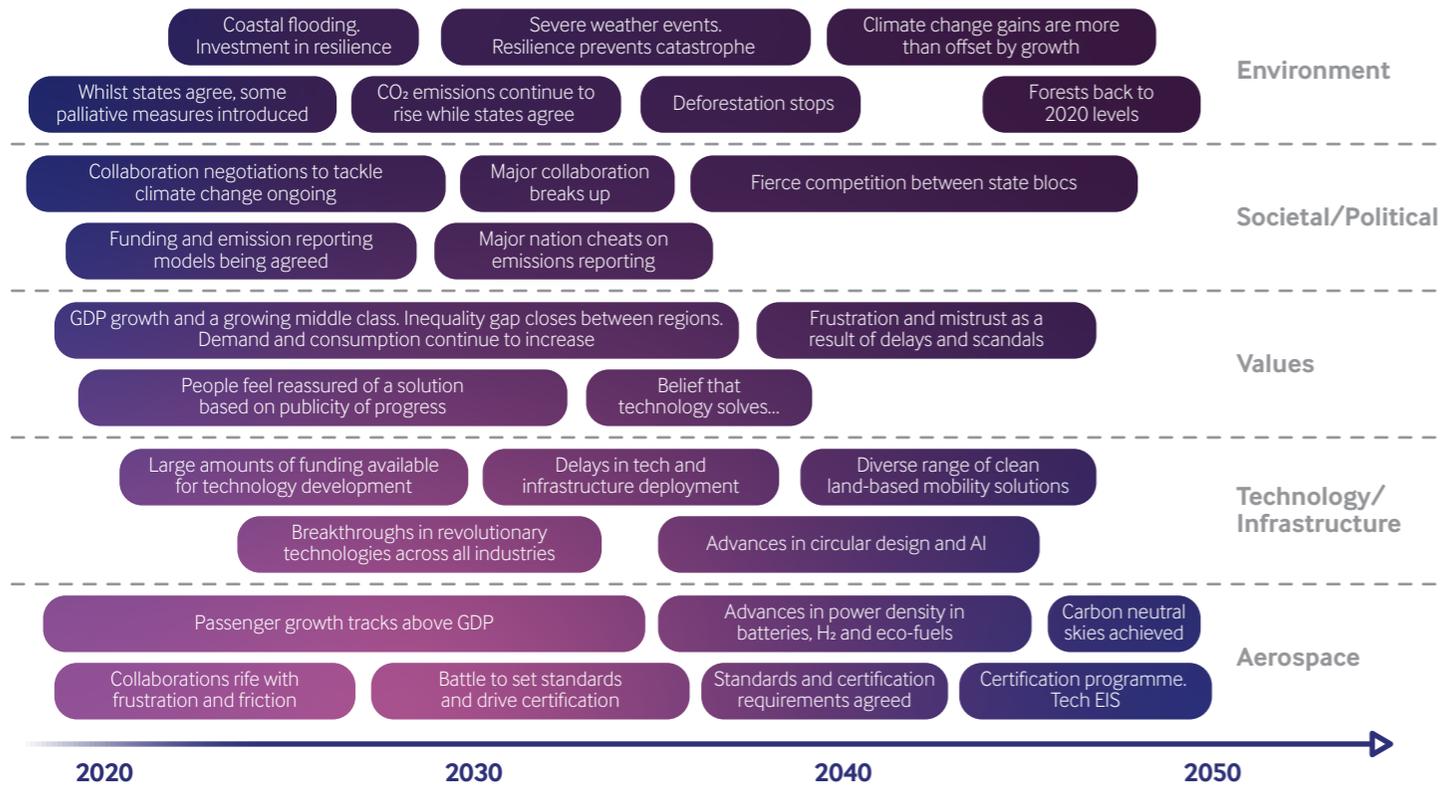
## Good in-tensions

The key features of this world are:

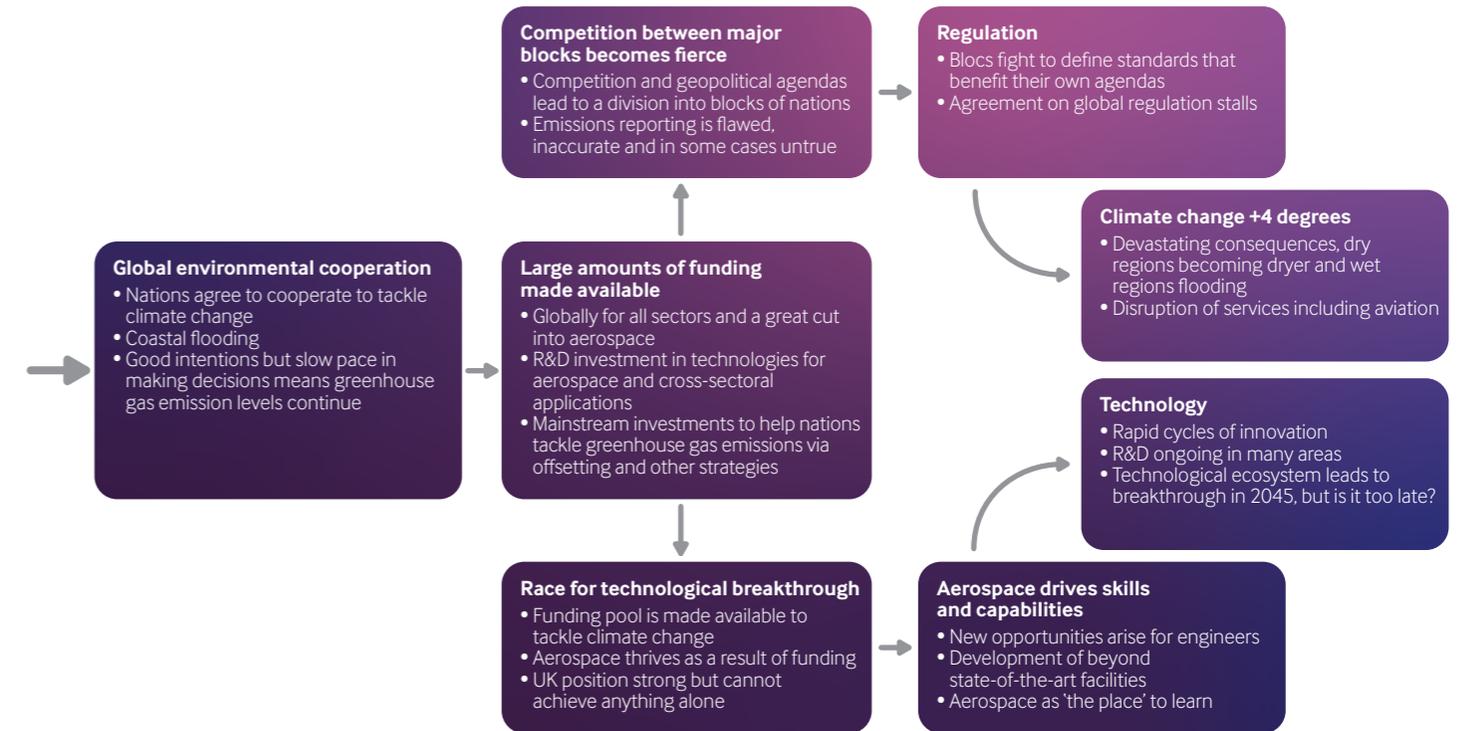
- + Continued prioritisation and pursuit of GDP growth
- + Less inequality
- + Global coordinated response to climate change thwarted by bureaucracy
- + Growth outstrips climate progress
- + Society feels reassured by leaders that a climate solution is coming
- + Delays and emission reporting scandals occur, eroding confidence
- + Progress on climate change is 10-15 years behind plan, but breakthroughs eventually materialise

The international community comes together to tackle climate change by seeking ways to mitigate growth in greenhouse gases in a serious and comprehensive way. Unfortunately, years elapse between those good intentions and action. The potential impact is diluted by friction and competition between different groups of nations. The world continues to pursue significant economic growth, fuelled by improved productivity and a closing gap in inequality between the major regions. Global demand and consumption grow strongly across all sectors of the economy, and this, notwithstanding a number of scandals, results in the concerns of many scientists about the climate being dismissed. Assured of a substantial and steady stream of state and private funding, all the major CO<sub>2</sub> polluters – mobility, agriculture, construction, and energy - make major advances in terms of circular economics and carbon neutrality. In mobility, a diverse range of technologies such as circular design, AI, power density in batteries, hydrogen and eco-fuels deliver the much-needed breakthroughs. But is it too late? The skies are now both busy and carbon neutral, but the high levels of accumulated CO<sub>2</sub> are causing major environmental disasters.

## Key events and transitions in the **Good in-tensions** timeline



## The main drivers of **Good in-tensions**



## Key challenges on the path to **Good in-tensions**

- + Does society agree that global cooperation is the right way forward and will it be patient enough to wait for the right technologies to be implemented?
- + Will competition between blocks remain peaceful or will it lead to trade wars and even conflict?
- + Will environmental disasters triggered by accumulating greenhouse gases be managed by the international community?
- + Will regulators be able to stay ahead of, or even aligned with, disruptors?
- + Is technology implemented in time to save the planet or is it too late?

# Cross-analysis of scenarios

The themes, uncertainties and assumptions were explored through workshops and interviews, generating a large number of potential contextual uncertainties that could impact the use of airspace in 2050. As the scenarios were developed, these uncertainties were then reduced to a critical list of six. Table 1 below shows how the critical uncertainties play out across the three scenarios:

UNCERTAINTY	Techopoly	Eco-it-alone	Good in-tensions
<b>GEOPOLITICS</b>	International community weakened. Regions fall back on themselves for support	Nation states reassert their authority and power	Strong globalisation but is dogged by competition and conflict between blocs
<b>APPROACH TO CLIMATE CHANGE</b>	Initially leave it to the market. Tech will solve. Deep adaptation at end	No time to waste. Act now, without delay	International cooperation is only viable approach
<b>STANDING OF EUROPE</b>	Moderate, inward looking and protectionist	Weak, loosely coupled. Nation states have the lead	Strong, outward looking and engaged in global cooperation
<b>WHOSE INTERESTS DOMINATE?</b>	Initially consumer, economic, innovators, tech giants and disruptors. Youth at end	Survival interests rule. Nation states, environmentalists and regulators in the lead	Inter-governmental institutions and lobbyists. The aged. Geopolitical interests via blocs
<b>ENERGY &amp; TECHNOLOGY</b>	Initially, all energy sources optimally. Lesser of two evils prevails. AI, processing power, AV, batteries. Move to circular at end	Self-sufficiency for energy with integrated renewable-fed storage. Higher tech society. AI monitors sustainability	Clean energy set of solutions implemented throughout sectors. First mover wins. Standards and compliance battles. AI/circular tech
<b>REGULATORS vs. DISRUPTORS</b>	Competition between regulators to attract hi-tech investment, especially in mobility	Strong local standards and regulations. Sustainability values prevail over economic	Cautious. Slow to give clarity but relatively benign. Nation states encourage change

Table 1: Key contextual uncertainties and how they play out across the scenarios

The eight themes were further explored in the workshops to generate a set of assumptions (one per theme) that were revealed as prevalent in much of the sector’s planning. These assumptions were then mapped across the scenarios. Table 2 below illustrates how valid the assumptions are when tested against the scenarios.

KEY ASSUMPTION	Techopoly	Eco-it-alone	Good in-tensions
<b>Regulation remains largely unchanged</b>	Regulation shifts from central air traffic control to onboard models	Regulation remains largely unchanged, but airspace is rationed	Regulation remains as is with addition of emissions monitoring
<b>Global GDP keeps growing</b>	Initial growth followed by collapse and major economic re-alignment	Significant slowdown	Global GDP keeps growing
<b>Current mass air transport model (i.e. hubs) remains unchanged</b>	Major demand shift toward short distance exploitation of skies	Air transport model (hubs) retained but significantly rationed	Current mass air transport model (hubs) remains unchanged
<b>Technology openness between nations and markets continues as is</b>	Technology openness between nations and markets continues as is	No longer a priority – civil in decline and some defence related agreement	Geopolitical competition polarises technology sharing with global blocs
<b>Widespread demand for air travel continues globally</b>	Conflicts diminish international air travel. Regional travel grows	Climate policy and societal priorities diminishes all air travel	Widespread demand for air travel continues globally
<b>Aircraft markets and families segment as they do today</b>	Aircraft market disrupted by advent of electrification and AI	Aircraft markets and families continue to segment as they do today	Disruption in short-haul markets, new classes of aircraft/segments
<b>No significant competing modes of transport emerge</b>	Drones and hopping models of transport dominate	Green land-based mobility dominates	No significant competing modes of transport emerge
<b>Aerospace remains attractive place for skills and innovation</b>	Aerospace remains attractive place for skills and innovation	Not attractive – last person standing	Controversial – attractive to some, anathema to others

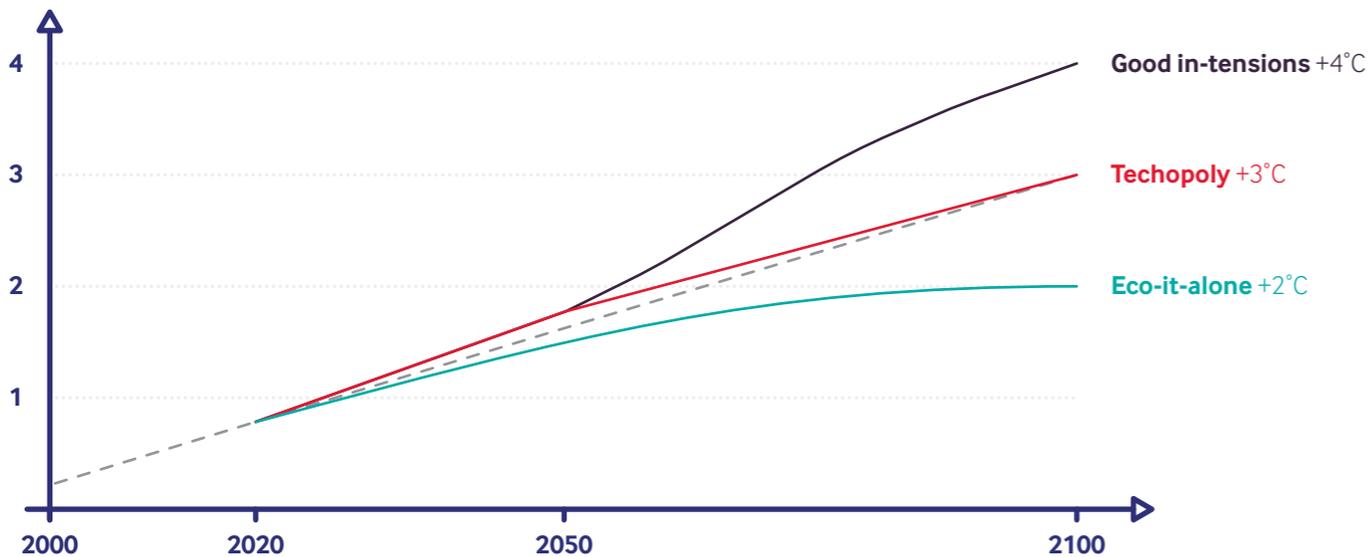
Table 2: Eight key assumptions (one per theme) to be challenged by at least one scenario (NB: A white box represents assumption is consistent with today’s view and unchanged for that scenario)



## CLIMATE CHANGE

All three scenarios use the same climate change outlook for the period 2020-2050 – a pathway towards a global radiative forcing level of 6 W/h/m<sup>2</sup>, equal to plus 3 degrees by 2100. This is considered a plausible outcome by the International Panel on Climate Change. This avoids any one scenario being influenced by a specific choice around climate change and enables direct comparison across the scenarios about how they would deal with the climate change challenge and what impacts that might have.

Beyond 2050, because of how the different worlds develop and tackle climate change, their outlook for the period 2050-2100 varies substantially. None of these scenarios should be seen as a preferred option or panacea, and together they are not intended to represent an exhaustive set of possible futures - they are each plausible, challenging and relevant.



Temperature change forecast at 2100 for each scenario.

## OUT OF SCOPE

A number of potential developments were ruled out of scope of the scenario set. These include major wars, 'magic' technologies in the outer range of plausible technical progress, the breakup of the United Nations or European Union, or a complete collapse of the international financial system.

## COVID-19

The three scenarios were developed prior to the Covid-19 pandemic. Covid-19 has starkly confirmed that the future is uncertain; although pandemics frequently feature when considering the future, the impact of Covid-19 on the economy, our way of life, and on aviation were not foreseen. Nor were the geopolitical behaviours and supply chain issues that it has stoked. Notwithstanding Covid-19, we consider the three scenarios in this paper to remain fundamentally valid potential destinations. But Covid-19 (and other pandemics that might follow) may influence which of these scenarios we find ourselves in by triggering or exacerbating the underlying factors analysed in this paper. Some of the uncertainties for air transport created by Covid-19 are set out below:

### IMPACT ON SOCIETY'S ATTITUDES

- + **Do we need or want to travel as much?** For some, the pandemic may change attitudes toward travel permanently, for environmental reasons, perceptions of risk, or awareness of other options and benefits to not travelling.
- + **Will we be allowed to travel as much?** Flying is restricted through government action to prevent transmission. Will there be long-term measures to constrain flying?
- + **Can we afford to travel as much – either for the sake of our purse or the environment?** The economic blow will affect affordability and new constraints on industry may lead to an increase in costs in the near term. The 'shock' could heighten environmental awareness, further influencing choices.

### Societal uncertainties:

Spend, save, move, stay, travel more, travel less, change habits and behaviours.



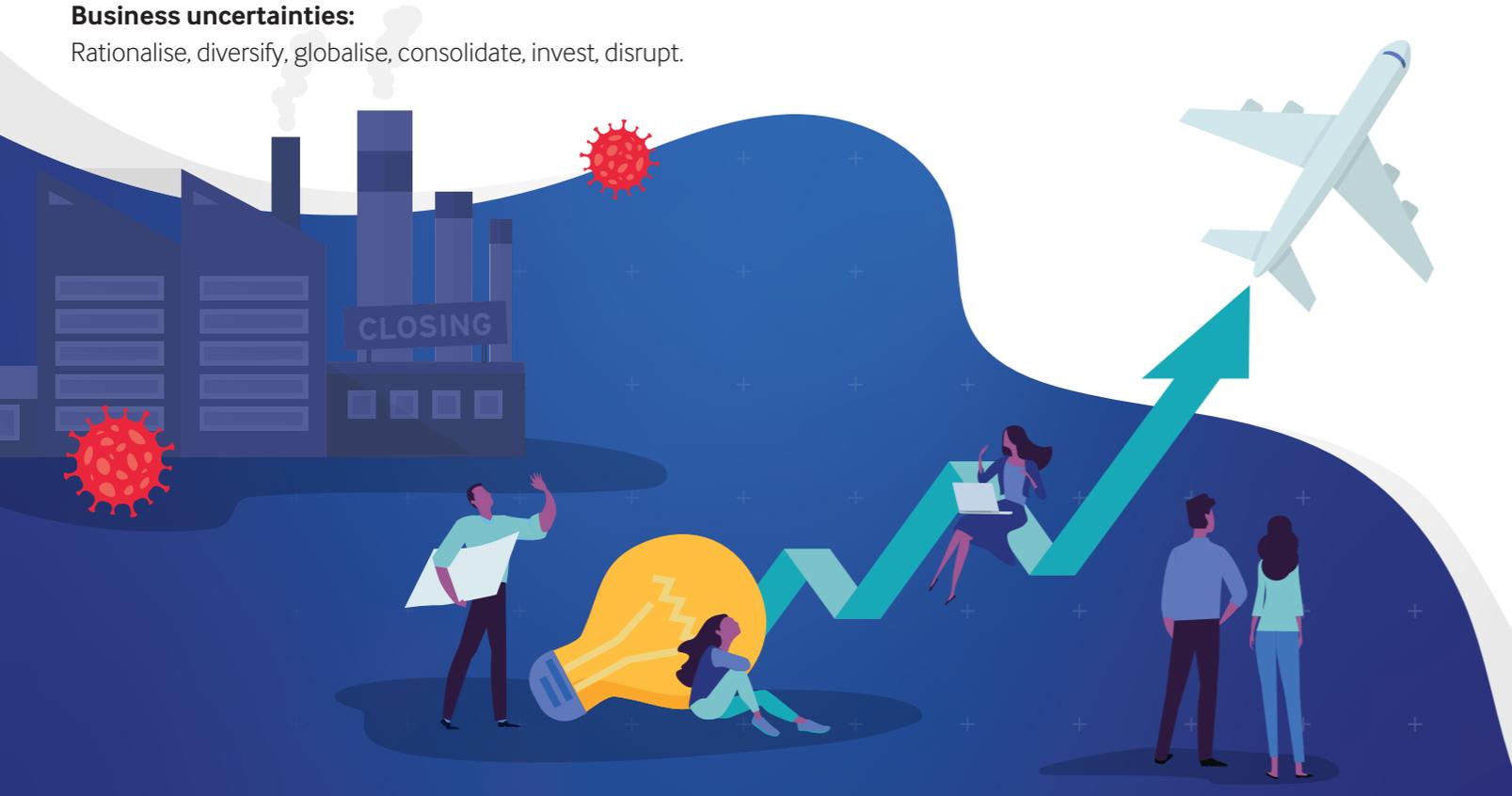
## IMPACT ON BUSINESS

Do we need to travel for business as much? Many businesses are discovering productivity and wellbeing benefits from home working. Some have announced permanent changes to working policies. Communications tools have been used at an unprecedented scale, driving up adoption in the workplace and simultaneously pumping more investment and competition into these products that will serve to improve them further.

- + **How does this affect the way businesses need to operate and build resilience?** For manufacturers reliant on significant labour, rules designed to prevent transmission of disease can be very hard and damaging to productivity. Robots do not have the same problem. Companies with extended global supply chains face yet more complexity – each country being impacted differently, transportation disrupted and differing actions of nation states (and tensions between) adding further uncertainty to doing business.
- + **What opportunities does this create?** The aerospace sector is in a difficult position and the prospect for new investment seems remote. But this analysis may not prevail. Once economic recovery begins, the search for new, promising projects will begin; new entrants may win out against weakened incumbents, disrupting markets. Events may also catalyse action on major challenges like global warming to stimulate and transform economies for the future.

### Business uncertainties:

Rationalise, diversify, globalise, consolidate, invest, disrupt.



## IMPACT ON STATE

- + **State finances:** the measures deployed to protect economies and society from the shock of Covid-19 add to already high levels of national debt around the world. It varies from country to country which could add tension to maintaining level playing fields in the recovery phase. One of the big factors in the three scenarios hinges around the burden on state finances to deal with the aging society and climate crisis.
- + **International cohesion and sovereign capability:** the scramble to obtain supplies in response to the pandemic exposed some issues. Basic personal protective equipment (PPE) is easy to make, but when globalisation has seen manufacturing capacity concentrated in low cost countries developed nations race to secure supplies from the same few locations. The same goes for ventilators, test kits and vaccines. There has been a degree of international cooperation, but also clear instances where nations acted individually. Should nations take a strategic view on local capability, even if not a natural fit for the cost or skill base?
- + **Politics:** As society's behaviours and priorities change how could this affect political priorities going forward? How could it impact the big political issues and affect recent expansion of populist politics?

### National uncertainties:

Market control, fiscal attitude (austerity/invest), political priorities, political behaviours.



## RECOMMENDATIONS

# Recommendations for business

The ATI has used its scenarios in multiple settings to help challenge and unlock thinking, in cross-sector working groups to workshops with individual companies. Below are some of the questions that businesses can use after reading the scenarios to stimulate new lines of thought and develop strategies:

- + What will your market prioritise in these scenarios?
- + Where does power/value reside in the ecosystem in these different scenarios?
- + What is common and distinct in terms of capabilities and technologies across the scenarios?
- + What is your company's relationship to that power structure, assuming the business looks like it does today?
- + What could your business do to pivot capabilities and technology to take best advantage under each of the scenarios?
- + What could differentiate your business in those worlds from other competitors?
- + What actions could your business take today to position and improve its resilience within each of the scenarios and the journey toward them?

The other key use of the scenarios is to help make sense of events and where they might lead. Business could set up systems to monitor key trends and reflect regularly on what those imply for the future, such as:

- + Search terms/social media trending
- + Travel demand/modal trends and attitudes
- + Political agendas, legislation and tax changes
- + Geopolitical trends
- + Financial sector activity
- + Environmental metrics and events
- + Economic and broader attitude indicators
- + Disruptor emergence in parallel sectors



## RECOMMENDATIONS

# Recommendations for the UK aerospace sector

**+ Set an ambitious zero-carbon technology agenda**

- Climate change is the defining issue for the coming decades
- The sector's response to this challenge could have major bearing on direct and indirect factors that shape its future – for better or for worse
- Irrespective of exactly which scenario the world heads toward, an ambitious agenda will drive technological progress that will find innovative applications in all cases.

**+ Drive action and impact on global and local levels**

- Building strong global connections that help to align agendas and drive more overall innovation and technology investment and progress. Without international cohesion, work will be duplicated or hindered, and friction between countries will stall progress
- Locally, ensuring the benefits and advancements made through acceleration of technology are felt and seen by communities, and that we are building strong clusters of innovation activity that enables research to flourish and deliver
- Not doing this risks losing public faith in the sector as a force for good, and therefore loss of support
- Teamwork and partnerships on a grand scale are needed.

**+ Look beyond boundaries for innovation, seek disruption**

- Aerospace companies should seek to collaborate with actors outside the industry and with start-ups
- They are a source of new ideas and technology, some of which benefit from higher development rates in other markets – cutting-edge technologies and skills can 'spill in' to the industry
- Other industries will share capability needs and can therefore share the task of investing in and building these
- Start-ups are far more agile and can solve some problems more quickly and effectively than large companies
- Government should support disruptive players and new entrants to the aerospace sector.

**+ Inject pace**

- Create mechanisms and approaches that deliver new ideas, technology and innovation at speed, and are better at handling risk
- Taking advantage of disruptive opportunities that don't follow smooth incremental transitions requires bold and agile decision-making. There is a balance to strike – but there is a growing argument for prioritisation of speed and minimisation of overheads in the process of innovation

**+ Be ambitious**

- The UK should not be constrained by the past or the present in what it can hope to achieve in the future
- Invite thinking that challenges preconceptions on the art of the possible

# Conclusions

There are challenges ahead, and it may feel uncomfortable, as although the worlds are different to today, the paths to each of them are very clear. Technology has a part to play in each world. The pace of evolution is different but autonomy, connectivity and clean energy have a role in each.

Pressure for action on climate change will only escalate from here. The current trajectory, in various ways, seems at odds with the climate imperative – are we ready for some fundamental changes?

There are high levels of uncertainty in how the world will react to:

- + Climate-related challenges
- + Huge economic shock brought on by Covid-19
- + New breakthrough technologies
- + The changing geopolitical landscape

All have potential to significantly alter the future of aviation:

- + The worlds may require the aerospace industry to evolve in a different way
- + The pace of action is paramount; it is too easy to be complacent or to create barriers
- + A world without global cooperation is likely to be the most devastating for aerospace. The ATI is committed to working with international partners
- + Traditional sectors are likely to see a blurring of the boundaries, and it will be key for the supply chain to think in terms of technologies rather than sectors

## DISCLAIMER

The views expressed in this publication have been based on workshops, interviews and research and do not necessarily reflect those of ATI. The content is provided for general information only and is not an official prediction of future events, the scenarios should be considered as a part of a whole set within the context described in the publication.

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