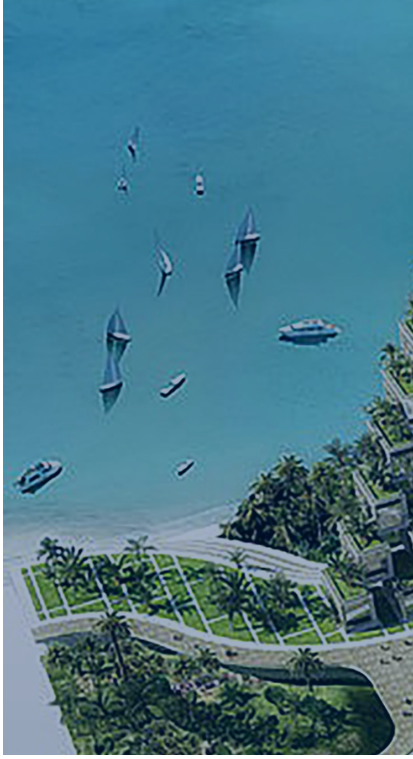
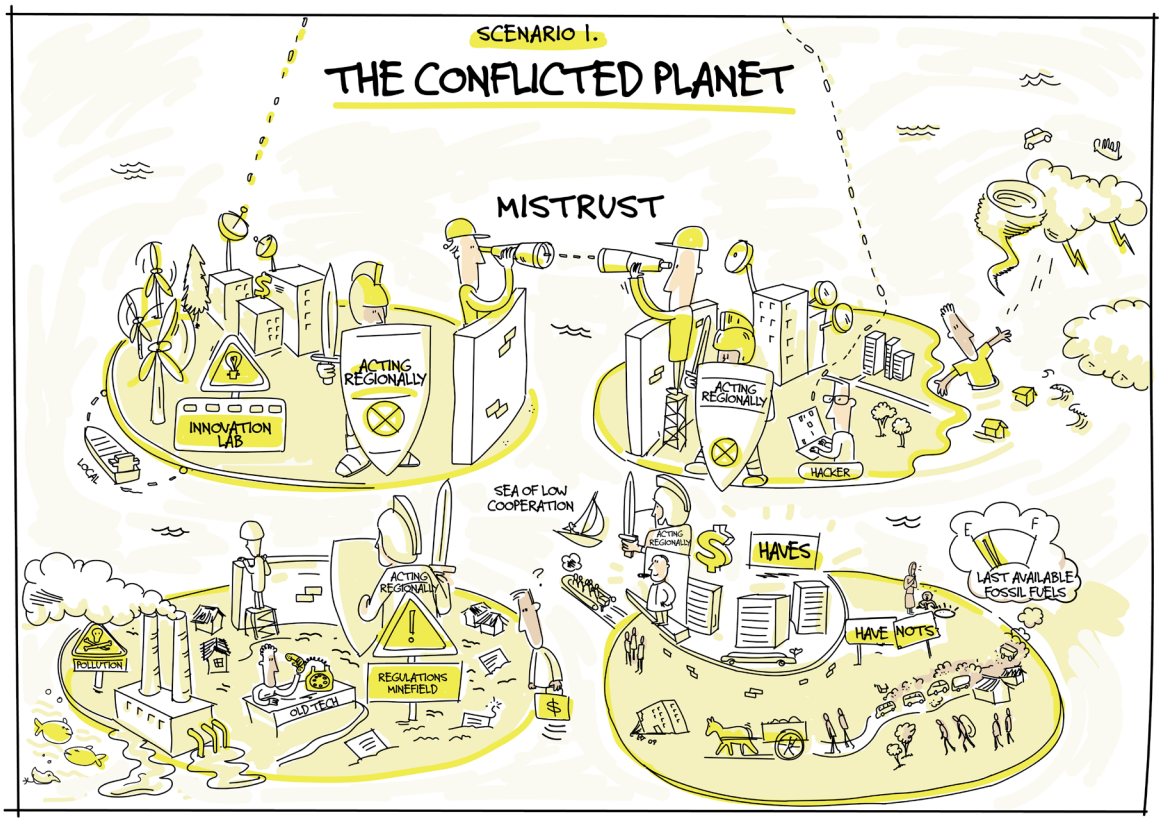
04

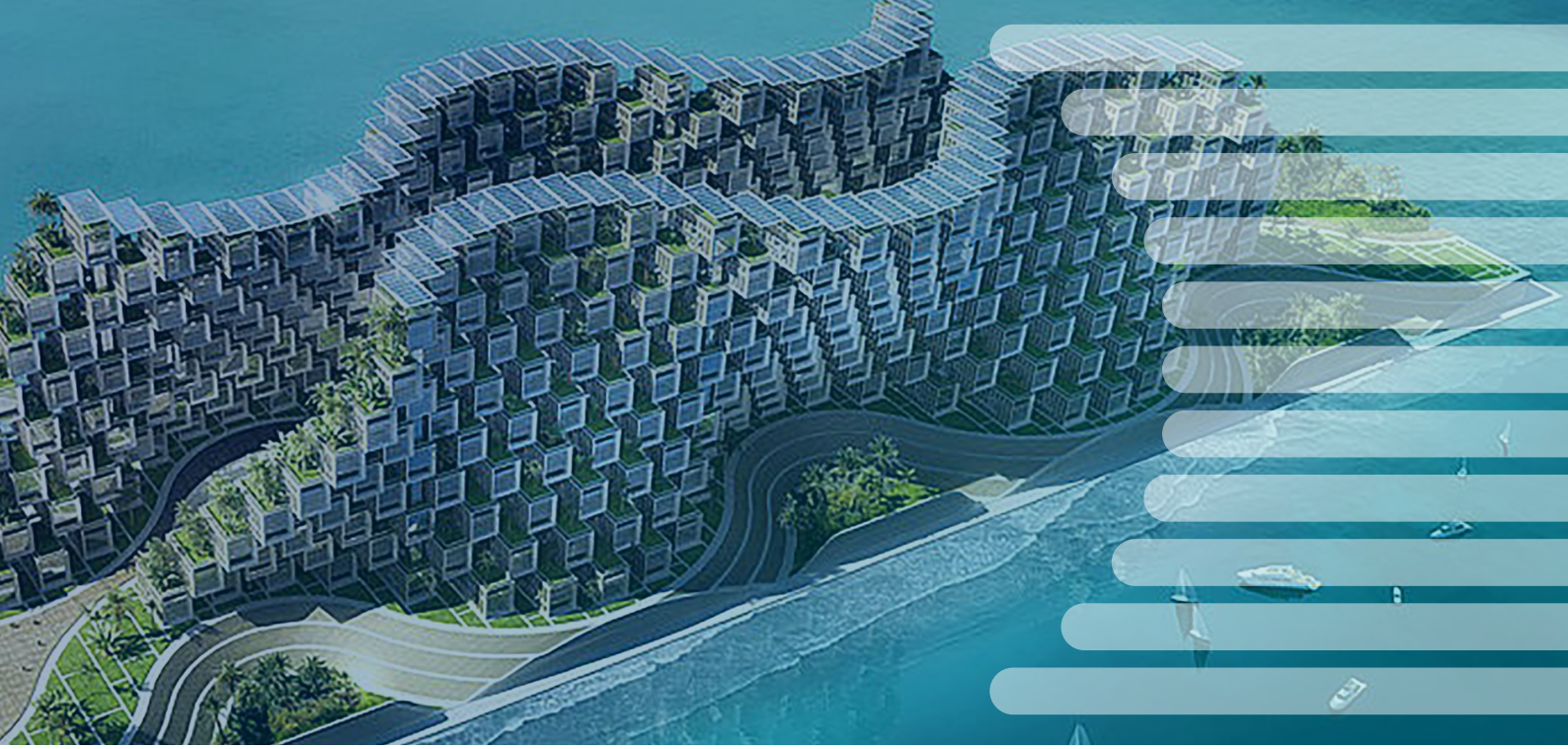
Scenarios and implications for the infrastructure industry



The three scenarios constructed in this report are described below. They offer deliberately extreme, yet plausible, versions of the future. They are not predictions, but are instead designed to prompt debate. We encourage members of the infrastructure community to investigate the potential impacts and implications of these scenarios, and take action to ensure their strategies and plans are resilient to the full range of possible developments.

4.1 Scenario 1 – The Conflicted Planet





4.1.1 Scenario description

Imagine a world where countries, or groups of countries, become increasingly isolated leading to a multipolar(ised) world. The infrastructure industry is dominated by domestic champions that are slow to innovate and slow to adapt to external shifts, such as climate change.

Using the three scenario determinants as a prism, The Conflicted Planet scenario is defined by:

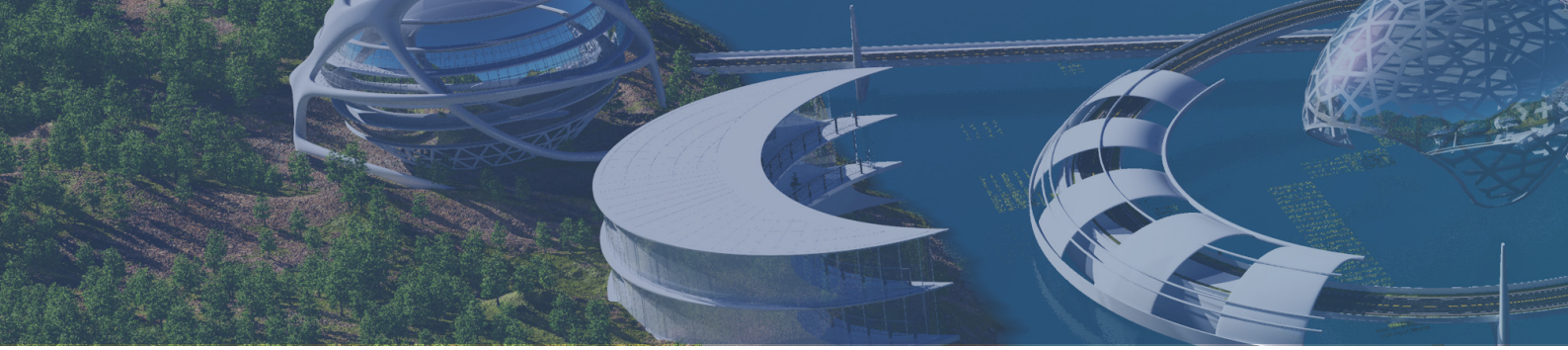
- **Geopolitical context (multipolar)**—Heightened global political competition leads to a reliance on local markets and the formation of regional trade blocs. The infrastructure industry becomes dominated by monopolistic companies with deep connections to government.
- **Pace of climate change (rapid)**—The world moves at multiple speeds to tackle climate change with some regions seeking to mitigate impacts, while others pursue adaptation-based strategies. The infrastructure industry, now increasingly domestic, aligns with domestic climate policy.
- **Technological progress (incremental)**—Incremental development and uptake of new technology hinders productivity growth and climate responsiveness across economies. The infrastructure sectors are acutely impacted as productivity gains lag other sectors.

In The Conflicted Planet scenario, the structure of international cooperation is multipolar and defined by regional allegiances. Geopolitical rivalry shapes all forms of political and economic interactions (domestic and international). Trade becomes politically motivated, rather than following comparative advantage, leading to significant cost inefficiencies in domestic economies. Local economies increasingly rely on local (and regional) factor markets to retain local jobs that might otherwise be lost in a system of open, global trade (for example, a reduction in the offshoring of technology and manufacturing jobs).

Many nations design economic policy to project a strong outward image, resulting in a bias toward monopolistic national champions. These national champions rely on interventionist policies to erect artificial barriers to competition and to provide strategic funding support. In nations where governance norms are not well established, the risk exists that domestic inequality may increase due to the concentration of rents among the beneficiaries of powerful domestic monopolies. On the other hand, nations (and regions) with entrenched governance norms may actually see inequality fall as firms (and governments) increasingly rely on local labour and product markets.

Regionalisation drives local regulatory harmonisation, creating a global economy characterised by a tapestry of regulatory, governance and cooperation systems across regions. Different regions pursue markedly different climate strategies despite the rapid pace of climate change. Some regions take progressive stances by attempting to mitigate climate impacts through incentives programs designed to spark innovation in climate-smart technology, and to transition to renewable power. Other regions are less concerned with climate change, preferring to optimise the economy for short-term growth and employment. The lack of unified climate policy negatively impacts the geographically disadvantaged, and especially the economically disadvantaged in relatively poorer regions, who are highly exposed to the adverse impact of weather-related events. Over time, the shifting climate may increase the number of climate-displaced peoples. [8,9]

The pace of technological progress is incremental. The diffusion of technology is limited with national champions hoarding intellectual property and stymying technological innovations by domestic competitors. Lacklustre technological development, combined with anti-competitive market structures, slows innovation and productivity gains. The general lack of innovation incentives and frequency of state interventions leads to an infrastructure market that relies on public funding streams.



4.1.2 Implications for the infrastructure industry

1. Infrastructure business models shift to focus locally with the emergence of national infrastructure champions

This scenario sees the infrastructure industries shift in orientation and market structure. A once globalised and competitive business becomes domestically oriented and monopolistic (with regulations barriers and public financial support creating artificial barriers to entry). National champions may vertically integrate across sector value chains or scale to the size of large, national holding companies integrating multiple strategic sectors. Given the anti-competitive market structures and limited technological innovation, these champions operate with limited commercial incentives and the political mandate to maximise employment opportunities.

The inherent strength and sophistication of domestic factor markets (labour, capital, technology, building materials) act as fixed constraints on the scale (and capacity) of the national infrastructure champions. Regulatory harmonisation enables firms to compete within regions and, to the extent possible, draw on regional factor markets. It is expected that the relative scarcity of resources encourages coordination within regional blocs, particularly in the water, power generation and building materials sectors.

International infrastructure cooperation (in terms of sharing knowledge, capital and resources) slows despite continued cooperation within some regional blocs. The transnational transport and logistics sectors are the most adversely affected. The reduction in international trade negatively impacts shipping-related industries; shifts patterns of air travel and reduces the attractiveness of air-related assets; and shifts the importance of port-hinterland connections. The travel and logistics industry are constrained by the scale of domestic demand, unless a region establishes a robust trading system, with significant specialisation in last-mile, intra-urban logistics expected.

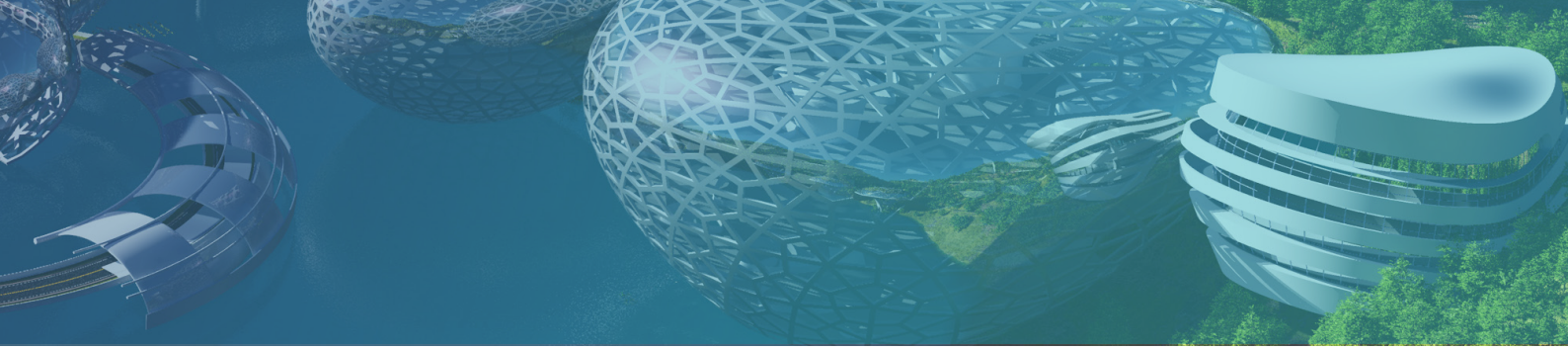
The globalised private and public financial markets for infrastructure reduce in importance. Nations with established savings pools, mature capital markets and sophisticated banking institutions continue to pursue private participation agendas shaped by national champions in the financial and infrastructure industries. The transnational private participation market stalls, however, with limited cross-boundary activity (financial or operational) between regional blocs.

2. National security infrastructure becomes more critical, with a focus on strategic sectors such as energy, water, telecommunications and cybersecurity

In a world where the national strategic interest is paramount, governments invest heavily in sectors viewed as essential for security: energy, water, telecommunications and cybersecurity. Regional blocs are focused on some degree of regulatory alignment to enable formation of regionalised internets that amplify the national interest and limit the flow of information across global regions. Cybersecurity for the telecommunications and energy sectors becomes imperative, in particular the security and ongoing maintenance of data centres or hubs.[10] The scale of investment into social sectors, such as education and healthcare, varies significantly across countries.

Utility sectors and power and water take precedence, with nations attempting to satisfy domestic demand from local factor markets. Vertically integrated national power and water markets are common with power feedstocks and water serving as foundational coordination mechanisms in regional blocs (to overcome domestic resource constraints). Emerging nations with limited resource endowments allow foreign champions to provide basic services from electricity to water and telecommunications, requiring the champions to absorb significant costs related to regulatory alignment, and administrative costs linked to establishing foreign presence.

The fiscal burdens are large to support these strategically essential sectors. The vertical integration of the sectors drives economic inefficiencies exacerbated by highly bureaucratic institutions. The state subsidises basic services to manage domestic inequality.[11]



3. Public infrastructure investment focuses on improving the resilience of the nation's infrastructure stock, revolutionising parts of the industry's value chain

Rapid progression of climate change does not serve to galvanise coordinated global action. Countries and regions pursue divergent strategies with varying degrees of coordination within regional blocs. However, improving the resilience of national infrastructure stocks is a cross-cutting priority. This is likely to have three broad impacts.

First, improving resilience leads to innovations in the building materials sectors. The innovations target materials capable of resisting the intensification of climatic events, or, more likely, process improvements capable of reducing the cost of producing the engineered materials needed to restore asset operations in the case of a severe weather event.

Second, the infrastructure industry is likely to develop more modular ways of constructing and expanding assets in a more climatically volatile world. This agility will enable planners to not only respond after an event, but also to rapidly scale, or retrench, capacity across other parts of the asset networks to manage second- and third-order impacts. Fundamentally, this will mean that the design phase of the project life cycle is commoditised once modular designs are tested and rolled-out, thereby creating significant first-mover advantages for the asset design industry.

Third, the shift to more modular designs, agile network planning and the use of advanced building materials will be complemented by technological innovations. Advanced digital twins covering the full duration of an asset's life (from conceptualisation through operation) and advanced analytics to manage the functioning of critical asset networks are likely to be deployed. These tools will enable planners to forecast impacts on asset networks (including changes in demand) and develop remedial solutions.

These changes may be more muted in emerging markets. Technological diffusion is likely to be limited unless significant concessions are granted on market access, competition, factor market access, and political allegiance. This is likely to create powerful incentives for domestic innovation, provided national champions do not crowd out smaller firms, as emerging nations seek domestic solutions to combat the changing climate.

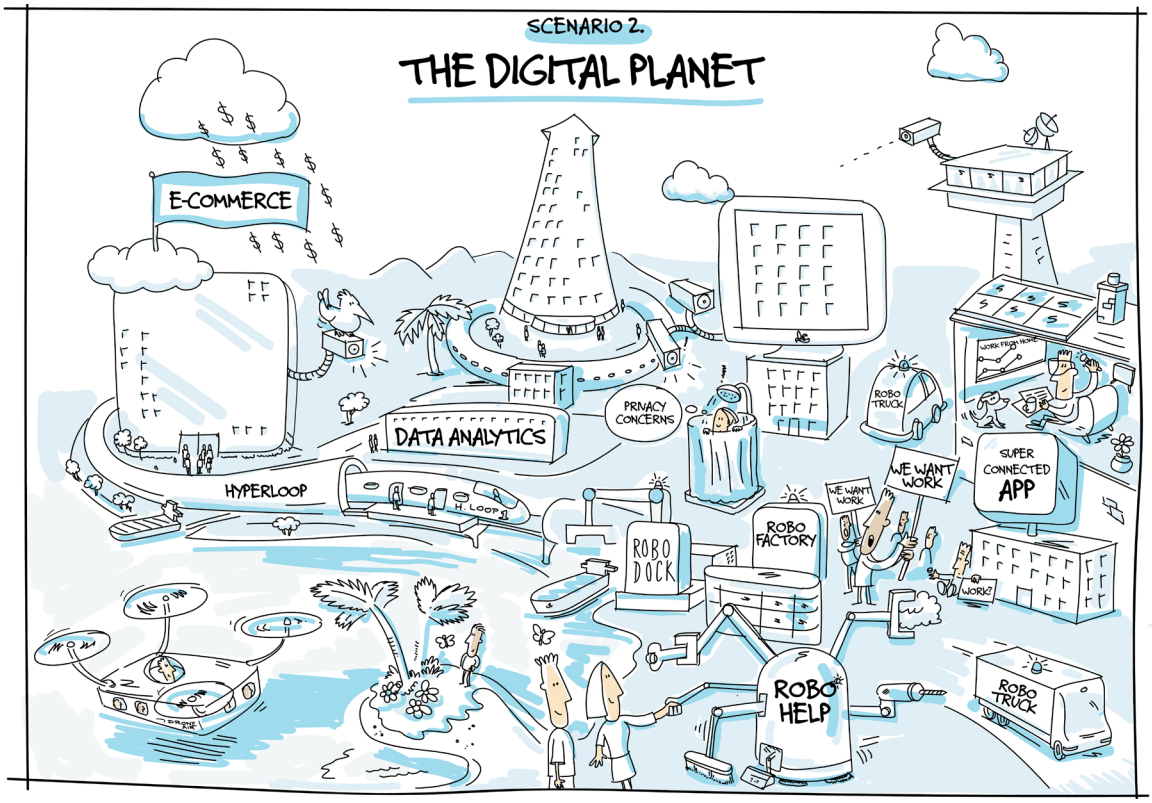
4. Preoccupation with the national interest limits global regulatory coordination and efforts to manage global public goods

The reorientation of the infrastructure industries toward local monopolies (depending on sector and location on the value-chain) reduces the importance of multilateral cooperation. Common practices in project preparation, procurement best practices, shared expectations on construction standards, and sophistication of asset management post-construction either regionalise or dissipate. Global coordinated action against poor governance practices and wasteful spending are also less common as national governments exert 'national interest' narratives over the domestic infrastructure industry.

Environmental legislation, including carbon emission targets and sustainability standards, vary significantly across regions reflecting national (or regional) priorities. Those nations with the financial ability, political alignment and risk exposure improve the resilience of existing infrastructure assets in the face of increasingly frequent and intense natural disasters. While some intra-regional cooperation is expected on environment protection and climate change adaption (and mitigation), the scale is limited to those regions facing the greatest risk from shifts in weather events.

The erosion of multilateral fora to tackle global challenges has second- and third-order impacts on socioeconomic issues, particularly for emerging nations that benefitted from the financing and expertise available from the deceased international financial institutions.

4.2 Scenario 2 – The Digital Planet



4.2.1 Scenario description

Imagine a world transformed by technology where every facet of life is touched by data, analytics and robotics. Technological innovation is rampant, controlled by large companies that have steadily reshaped the infrastructure industry.

Using the three scenario determinants as a prism, The Digital Planet scenario is defined by:

- **Geopolitical context (multilateral)**—Broad-based geopolitical cooperation deepens economic, financial and social connections across countries, with the private sector taking over some of the traditional roles of national governments. The infrastructure industry is led by the private sector with the state stepping back to play a light-touch regulatory role.
- **Pace of climate change (managed)**—Collective responses to climate change are well established with clear adaptation and mitigation actions in place. A combination of global cooperation and technological progress revolutionise the infrastructure industry's responsiveness to climate change, affecting the way services are provided to consumers, as well as the tools, processes and materials used to develop assets.
- **Technological progress (disruptive)**—The infrastructure industry is revolutionised by technology firms capable of planning, delivering and operating vast networks of climate-responsive assets.

In The Digital Planet scenario, the role of government organically reduces as the private sector's influence increases across economic, social and political facets of life. Transformational advances in technology and digitisation enable business models that generate high returns on capital to the owners of technology. The role of government centres on managing and arbitrating tensions within the economy and between industry and society. Specifically, governments safeguard social interests by managing the labour displacements caused by rapid technological advancement; the competitive structure of industrial markets to reduce unnatural monopolies forming; the equitable access to data pools to reduce obstacles to innovations; and the international coordination required to overcome transnational challenges, such as climate change.

Structural discontinuities in labour markets are a natural by-product of rapid and broad-based technological advancement. High-skilled employment (particularly data science, engineering and robotics jobs) and automation have fundamentally displaced more technical crafts and lower-skilled manual occupations. Wealth distribution becomes increasingly skewed to a smaller number of people in high-value, highly skilled jobs. Governments increasingly focus on managing the labour market to ensure sufficient investments are made into training and education to provide citizens with the opportunity to participate in the modern, technologically-driven economy.

With technological innovation hard-wired into the fabric of global society, and barriers to entry low with free access to data, entrepreneurs consistently bring products and service to the market trying to displace incumbent firms. Large incumbent firms buy

out successful start-ups to maintain their market position in the face of fierce competition from other established firms. But this is a continual competitive threat that fosters technological innovation. In emerging markets, the situation is different. A reliance on foreign technology (and technology providers), the lack of deep pools of risk capital, and a smaller pool of graduates with the right technology skills constrain entrepreneurship. While it is less likely that positively reinforcing innovation systems evolve in constrain emerging markets, there may be a higher potential for 'leapfrog' innovations.

Technological progress is disruptive in The Digital Planet scenario. Advances in material science, computer science, data science and robotics power a technological revolution that disrupts industrial, consumer and social markets. The digitisation of real life leads to the creation of digital twins that describe, analyse and predict consumer behaviour and real-life demand patterns enabling real-time adjustments on the supply side of product markets and network industries. Climate change is no longer an issue warranting 'policy space' due to coordinated global action to reduce carbon emissions and the broad-based application of climate-smart technology and building materials.

In this scenario, the nature of the infrastructure industry changes fundamentally. Technology firms reshape the market by replacing or acquiring traditional building materials firms, builders, asset owners and operators, and service providers. Data is the critical currency for the industry's firms as the crucial input to the integrated and comprehensive digital twins that manage asset networks from planning, through construction and operations. The availability of personal data, combined with relatively light-touch privacy regulation, have transformed the user experience across asset classes, enabling deeply personalised services.

4.2.2 Implications for the infrastructure industry

1. Private companies are the primary supplier of infrastructure assets and services with business models reliant on technology and advanced data analytics to improve efficiency and customise services

Private sector participation (and complete ownership) is the dominant vehicle of asset delivery and management. Technology and the insights available from advanced analytics fundamentally alter the industry's economics by lowering the cost base; boosting construction productivity; raising the revenue potential of providing infrastructure-linked services; and broadening opportunities for data monetisation.

Technology companies, in particular, begin to play a leading role in the design and delivery of infrastructure, and control data pools and interfaces. This leads to not only a diversity of new services, but also to an increasingly dominant position for technology companies in the infrastructure industry. Technology players integrate planning, design, construction, and maintenance to control the data and systems used on their projects. Firms outside the emerging common data systems are disadvantaged, because they cannot process data from upstream activities, and the data they produce is less valuable for downstream activities.

Independent contractors and pure operations-and-maintenance companies are most at risk because much of their work is now automated, and they increasingly depend on data from partnerships with design and engineering firms. They are forced to increase integration and collaboration across the value chain, or risk failure.

The dominance of the technology companies has displaced the traditional financial industry. Investment shifts away from physical assets and toward technology that supports step changes in asset productivity, for example the building of advanced traffic management systems that receive much greater throughput on existing transport networks. The industry becomes less capital intensive, there is a surplus of available capital and the role of independent capital providers becomes less important. Large investment houses reduce in size and the investment industry becomes more fragmented with large firms competing with the family offices of the inventors, patent-holders, and founders of the fundamental technology architecture to fund the next technology innovation. Infrastructure investments have become routine corporate functions, rather than a niche asset class in the private markets.

2. Infrastructure asset demand shifts, lowering physical asset needs significantly, while boosting demand for telecommunication-linked assets

In this technology-dominated scenario, the physical world is complemented by a rich virtual world offering immersive, productive and affordable platforms to optimise physical systems. As a result, people can travel further, more easily. The value of proximity to major economic centres reduces, leading to fundamental changes in land markets, urban design, transport networks and telecommunications requirements.

Demand is now intensely local, reshaping transport markets with significant reductions in the capacity and coverage of road networks and retrenchment of rail capacity. These traditional transport modes are replaced by affordable autonomous, shareable and electric vehicles providing last-mile intra-urban solutions.

Energy requirements in The Digital Planet scenario are significant. However, technological breakthroughs in renewable power generation, smart grid management and storage enable countries to meet the demands of consumers and industry sustainably. Improvements in the efficiency with which industrial and consumer machines use power has also improved, lowering total energy demand systematically. Global cooperation leads to the diffusion of these energy-producing and efficiency-enhancing

technologies across countries, including between emerging and mature markets.

With the rapid pace of technology development and economic reliance on data, this scenario sees significant evolution in telecommunications and data infrastructure. There is large-scale investment in global networks to underpin global communications. Data centres are critical nodes in commercial infrastructure networks. Their physical security becomes a more acute issue given the disruptive impact of any data breaches.

3. Infrastructure value chains are dominated by InfraTech

InfraTech becomes the dominant theme, with firms looking to replace manual activity with data-driven solutions at all steps of the infrastructure value chain. Technology products replace traditional manual jobs and trades (see next section for labour market implications). The human element is, however, not fully replaced as highly skilled technical experts in data science, robotics, AI, and materials science oversee the sophisticated InfraTech networks.

The advanced data and analytics capabilities within the InfraTech ecosystem enable agile and highly detailed real-time mapping, analysing and predicting of network performance. Advanced AI-based systems are used to forecast network demand in the development and planning of every infrastructure asset. Predictive modelling is used to forecast potential consumer interactions across the asset, based on detailed datasets tracking consumer purchases, movements and habits, and enabling firms to maximise opportunities to cross-sell products (or to monetise the insight from the predictive model). These models, additionally, inform future network investments whose design, construction and operation are governed by sophisticated eight-dimensional (8D) building information models (BIM).

In this scenario, the way assets are built is fundamentally different, resulting in productivity gains, ability to deliver on-budget, and speed. These 8D BIM are the nervous system of the construction phase by fully integrating data across the full asset life cycle: object data (3D); scheduling (4D); operating and capital expenditures (5D); sustainability (6D); social inclusiveness (7D); and operation and maintenance (8D). While the core construction activities are handled by autonomous robots and equipment, human workers supervise projects and manage the real-time building materials inventory systems.

Technology also boosts transparency during the procurement process, with bid models automatically predicting outturn prices using vast datasets of final prices from previous procurements (or asset deliveries). The universality and accuracy of the systems encourage firms to continually innovate and deliver quickly, below budget and on-spec since the blockchain-powered procurement systems are ubiquitous. Moreover, the transparency afforded by these advanced technologies promote scrutiny by stakeholders.

The operations and maintenance (O&M) functions of assets – be they economic, social or civic assets – are largely commoditised. Sensors built into an asset during construction stream information into the asset's BIM to guide facility management activities. While the 8D models have internalised most O&M functions, specialised firms exist to create and manage digital twins that optimise asset operations and predict potential maintenance activities ahead of the 8D BIM. Moreover, industrial robotics firms maintain onsite robots.

4. Concentrated economic and political influence leads to workforce dislocation with minimal efforts to address systematic imbalances

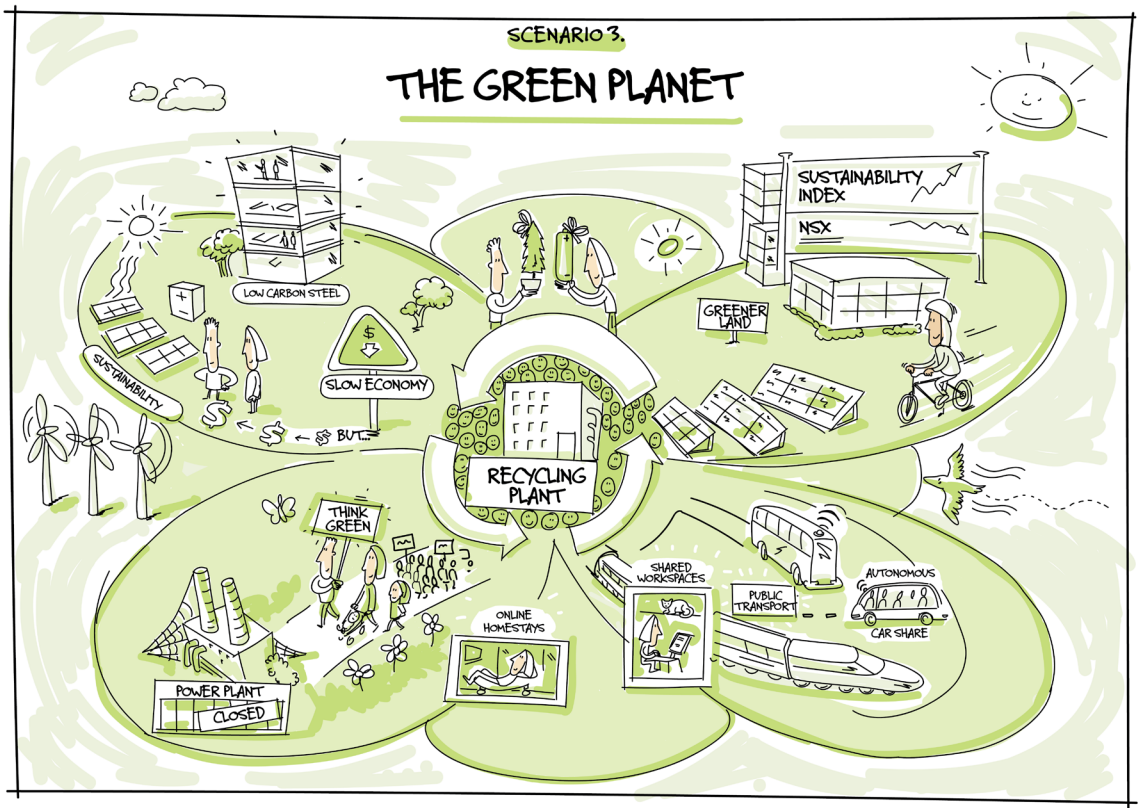
In The Digital Planet scenario, technology permeates every aspect of life. The impact is felt acutely in the labour markets servicing the infrastructure industry where labour is, largely, displaced by InfraTech, which aligns with current projections that by 2050 more than 40% of today's jobs could be obsolete,[12] and hundreds of millions of jobs lost to automation.

While the role of government is reduced in The Digital Planet scenario, public policy initiatives capable of re-skilling labour forces are paramount. This is essential to ensuring that with seismic gains in productivity, speed, consumerisation and quality, the infrastructure industries support more than just an elite workforce. The workers requiring support from the state do not have a universal background, but are rather impacted differentially based on market (emerging versus mature), sector, age group, gender, educational level, and socio-economic background.[13]

The interactions between labour, private firms and government are particularly fractious in emerging markets. In nations with less entrenched norms toward equitable distribution of opportunity, decision-making and wealth, the interactions lead to extractive institutional structures, largely favouring foreign technology firms and their corporate tributaries in offshore markets. Where such norms are more established, the relationship may be less extractive as the incumbent firms will be required to support local employment.

The political and market dominance of the private sector raises the prospect of base erosion and profit shifting (BEPS)[14] in this scenario, especially in emerging markets. Governments are not able to enforce taxation legislation (or restrain private lobbies from influencing sympathetic legislative amendments) enabling the dominant firms to privatise value creation in the economy. This situation is likely to be exacerbated in emerging nations.

4.3 Scenario 3 – The Green Planet



4.3.1 Scenario description

Imagine a world where the health of the environment and wellbeing of citizens are paramount in economic, social and political decision-making. The infrastructure industry revolutionises, following the principles of the circular economy.

Using the three scenario determinants as a prism, The Green Planet scenario is defined by:

- **Geopolitical context (multilateral)**—Comprehensive cooperation ensures geopolitical alignment on global public goods, such as climate change and income equity, and manages an ever-deepening system of economic, financial and social integration. The infrastructure industry is global, with private firms working in partnership with a strong state.
- **Pace of climate change (managed)**—Mitigating further climate impact outweighs other decision metrics. A combination of global cooperation and technological progress revolutionises the infrastructure industry with a focus on prioritising the 'greenest' technology possible.
- **Technological progress (incremental)**—Technological innovation is focused on enhancing the circular economy and lowering environmental impact of economic activity. The infrastructure industry sacrifices productivity gains for a lighter environmental footprint despite clear potential from less 'green' technology.

In The Green Planet scenario, environmental caretaking becomes the primary determinant of social and economic value, driving policy decisions for governments around the world. Safeguarding the world's environmental and climatic systems is a powerful coordination mechanism that drives sustained global collective action. The impact of global cooperation is considerable, with significant advancements in the climate mitigation agenda as advanced technologies are deliberately commoditised to enable emerging world economies' use. Additionally, consumers take up the challenge of reorienting the demand for goods to more sustainable products and production processes (such as the 'sharing economy') that reshapes global food production and processing.

Global trade has slowed as consumer demand shifts to domestically produced goods and services. Productivity gains run at a lower rate as public funding concentrates on the development of climate-smart technologies, processes and materials. Moreover, governments broaden sustainability principles to include wealth equity, which is achieved through stronger enforcement of taxation policies (of corporates and individuals) and clamping down on any form of BEPS.[15]

In this scenario, the role of the state is paramount. Economic incentives are recast in many economies by more agile (and globally harmonised) taxation systems and the focus on improving economic, environmental and social equity. These three principles become the rallying point for a system of international cooperation and, in particular, for international organisations that, despite dampened economic prospects in many countries, pursue developmental programs around the world.

Global governance embraces the notion of creating an equal, sustainable and vibrant international community. Global governance architecture is critical as not all regions of the world are fully able to mitigate the impacts of a changing climate, especially across emerging markets. Adaptation strategies are needed to safeguard the livelihoods of people living in the most climate-affected regions, particularly the small states with constrained fiscal and technological resources. Global assistance is required to construct resilient infrastructure, such as sea walls, and for programmatic support, such as long-term supplies of potable water. This support is viewed as a globally emblematic program for social equity between emerging and mature markets.

The Green Planet scenario evolves from stigmatising the infrastructure (and mobility) industry to championing its transition to environmental neutrality. Heavy public investment in the research and development of climate-responsive building materials, low- to no-emitting construction machinery, electrified transportation (linked to renewable generation sources), and iron-clad efficiency regulations have transformed the industry. Profit pools shift to the building materials sector, which continues to develop innovative building materials that are climate-smart, environmentally sustainable and legally mandated for use.

4.3.2 Implications for the infrastructure industry

1. Circular economic policy fosters new business models focusing on environmental services, the sharing economy, and recycling of local materials

In this scenario, infrastructure business models are designed to adhere to the regulatory regimes underpinning the circular economy. The shift in social values and in government regulation promotes opportunities for service-oriented businesses, such as environmental planning for decommissioning and environmental impact auditing. Significant opportunities also emerge in sharing platforms (transport, housing, and equipment, for example) and in recycling building materials. Fiscal policy promotes the use of locally-sourced recycled materials and serves as the basis for new, local enterprises created to recycle building materials.

Design and engineering firms provide experience and capabilities in up-front comprehensive analyses of an asset's environmental impact over the course of its lifetime. Environmental auditing is now a legal requirement for every asset, not only in major mature markets but also in emerging economies, and assessing opportunities to reuse an asset at the end of its life cycle becomes a lucrative business.

2. The focus on sustainability reduces demand for built assets and infrastructure, while promoting renewable energy assets and recycling

Demand for infrastructure changes through a combination of shifts in consumer preferences and regulations. Consumers live intensely local lifestyles with the lowest possible carbon footprint. They avoid private transportation, preferring shared and electric options, while regulations have outlawed any form of transportation or energy generation driven by fossil fuels. Network industries have, therefore, changed with mass reductions in the capacity within the inter-city road network and the power sector is dominated by green technology companies capable of both developing utility-scale renewable projects, as well as installing micro-grids (and off-grid solutions) for specific communities.

Cities use sophisticated technology to overcome intra-city congestion by deploying real-time traffic optimisation software and comprehensive infrastructure asset pricing models that charge consumers dynamically fotr use of transportation networks, be they public or private.[16] Many cities have passed regulation banning vehicles from the urban core, encouraging citizens to use other mobility options from electrified bicycles to scooters and mopeds. Urban planners prioritise green spaces, often constructed on or around decommissioned assets in order to revitalise previously unused portions of the city.

3. The infrastructure industry shifts to sustainable technologies, inclusive practices and methodologies across the full asset life cycle

Energy demand continues to grow, as does the demand for recycling infrastructure. Renewable sources dominate energy generation, such as solar, wind, and wave energy, and investments in these assets rise. Extensive networks of 'prosumers' (consumers who are also involved in producing goods) generate their own energy and sell it back to the grid at scale; similarly, they recycle their water and sell the excess. This generates competition across infrastructure markets, which were previously dominated by natural monopoly providers and also creates scale for innovative technologies. Waste policy is shaped by the circular economy and compulsory waste separation is in force across the world. Infrastructure assets, such as wastewater treatment plants and waste-to-energy plants, are ubiquitous.

The Green Planet scenario sees the infrastructure development process evolve significantly around the principle of how to plan, design, build, operate and decommission assets in the cleanest, greenest and most socially responsible manner. InfraTech is deployed to limit negative environmental impact, rather than to boost productivity, which has become a secondary requirement. Productivity losses are exacerbated by labour policies enshrining a 'right to work'.

At the asset planning and design stages, regulation requires developers to run complex simulations that estimate an asset's potential environmental impact over its lifetime. These simulations take into account the construction impact of the asset, and the carbon-intensity of its operations and decommissioning. This estimate is audited by government against strict qualifying criteria before an environmental licence to build or operate is issued. Additionally, adaptive capacity for infrastructure assets must be incorporated at the design stage. Designs must be submitted for climate-robustness assessments to gauge longevity, and prioritise resilience and adaptability. Furthermore, developers are also legally required to conduct thorough stakeholder engagement activities to ensure that disadvantaged groups can have their say and that there is a more equal distribution of the benefits.

During the construction phase, technologies are employed onsite to reduce the environmental impact of the construction process. For example, AI-powered 3D printing creates building elements onsite to minimise transportation impacts and the chance of offsite contamination. Breakthroughs in material science focus on regenerative materials[17] to increase an asset's durability and reduce maintenance costs—for instance, asphalt that resets itself through induction heating, concrete mixed with living bacterial aggregates that can patch up cracks, and new alloys with self-healing properties.

Once operations commence, the regulatory role of the state is significant. Data and analytics from the real-time operations of the asset are fed to environmental enforcement agencies that ensure the asset's environmental impact remains within acceptable limits. Sustainability agencies verify that each asset's environmental impact during and after construction matches projections created by design-stage simulations. Penalties and reputational damage are severe, turning asset management into a highly specialised field.

4. Government policy discourages greenfield projects, and regulates brownfield projects heavily

The Green Planet scenario is, in part, a product of the state's strength to incentivise private investment and consumption into goods and services that are environmentally sustainable. Supported by broad-based global cooperation, governments implement policies that encourage asset optimisation and preservation over new builds.

Existing assets are kept operating as long as possible, requiring significant retrofits and maintenance work to extend useful lives. Governments provide ring-fenced funding and tax incentives to investors to encourage a focus on existing assets in what is termed 'smart growth policy'. As part of this, land use policies focus on increasing densification to reduce carbon footprint. Governments assume the risk of obsolescence by subsidising investment to prolong the useful life of assets that face potential disruption from technological advances (for assets that still meet stringent environmental conditions).

Greenfield projects are rare, especially in mature economies. Proposals for greenfield projects must pass stringent environmental criteria as well as lengthy stakeholder engagement processes that, in part, must prove the asset's contribution to the national strategy for climate mitigation or resilience. Global coordination enables emerging markets to invest in the new assets required to mature the domestic infrastructure stock to meet industrial and consumer demand.