February 2026

Technologies Shaping the Future

Civilisational Transition, Strategic Competition, and the New Architecture of Power

The Institute for Strategic Intelligence and Intervention
Strategic intelligence for consequential decisions
at the intersection of geopolitics, technology, and capital
The Institute for Strategic Intelligence and Intervention is an initiative of the F4G Group

Technology as a Force for Good, 2026 Report

Technologies Shaping the Future

Civilisational Transition, Strategic Competition, and the New Architecture of Power

The citation for the report is: Institute for Strategic Intelligence and Intervention. (2026, February). *Technologies shaping the future: Civilisational transition, strategic competition, and the new architecture of power*

ISII/001

An Institute for Strategic Intelligence and Intervention publication
978-1-918214-08-6
978-1-918214-09-3 (e-pub)
978-1-918214-10-9 (pdf)

CONTEXT

Let’s be in no doubt. Our world is more dangerous and contested now than it has been for decades. I want to talk about human agency. We all have choices to make about how we deal with the undercurrents shaping our world. About how, in our new, faster, more dangerous and technology-mediated world, it will be our rediscovery of our shared humanity, our ability to listen, and our courage that will determine how our future unfolds. Conflict is not inevitable.
Blaise Metreweli, Chief of the Secret Intelligence Service, UK, 15 December 2025

Fusion - well beyond conventional limits
Researchers working on China's fully superconducting Experimental Advanced Superconducting Tokamak (EAST) have experimentally accessed a theorized "density-free regime" for fusion plasmas, achieving stable operation at densities well beyond conventional limits.
Chinese Academy of Sciences, EAST Tokamak Experiments Exceed Plasma Density Limit, Offering New Approach to Fusion Ignition, 7 January 2026

Stay ahead of the curve in the increasingly fierce international competition
The world today is undergoing accelerated transformation unseen in a century … a new crossroads - solidarity, cooperation and mutual benefit or return of hegemonism and the law of the jungle … Breakthroughs are being made one after another in AI, quantum technologies, humanoids, new-energy vehicles, and biomedicine … whoever establishes a solid presence in the Chinese market will stay ahead of the curve in the increasingly fierce international competition.
President Xi Jinping, China, 31 October 2025

US National Security … America First
We want to ensure that U.S. technology and U.S. standards - particularly in AI, biotech, and quantum computing - drive the world forward … The world’s most advanced, most innovative, and most profitable technology sector, which undergirds our economy, provides a qualitative edge to our military, and strengthens our global influence.
National Security Strategy of the United States of America, November 2025

A Crack in Creation
The power to control our species' genetic future is awesome and terrifying. Deciding how to handle it may be the biggest challenge we have ever faced.
Jennifer Doudna, Nobel Laureate in Chemistry, led discovery of CRISPR-Cas9

Humans … limited by slow biological evolution … would be superseded
The development of full artificial intelligence could spell the end of the human race … It would take off on its own, and re-design itself at an ever-increasing rate. Humans, who are limited by slow biological evolution, couldn’t compete, and would be superseded.
Stephen Hawking, Scientist, BBC, 2 December 2014

FOREWORD

Technology is altering the fabric of reality, redefining the limits of power, unlocking vast wealth, and reshaping human agency and national sovereignty in the process. We are at the beginning of a time in which no system will remain unchanged, and no limit will go unchallenged.

This civilisational transition is already underway. The Information Age is not merely augmenting existing systems, it is increasingly replacing them. Economic organisation, political authority, and social coordination are being restructured at the same time as digital systems take over functions once performed by institutions, markets, and human judgement. These systems determine what information is visible, which behaviours are rewarded, and how decisions are made at scale. Technology now functions as the infrastructure through which reality and power are organised.

Nineteen core technologies spanning computation, energy, materials, biology, manufacturing, and networks are driving this shift. Individually they reshape sectors. Together they reshape civilisation. A small subset, most notably artificial intelligence, quantum technologies, and advanced biotechnology, followed by fusion, nanotechnology, and augmented reality, function as systemic technologies. They are often framed as productivity tools. In practice, they reconfigure entire systems and alter the foundations of economic value, institutional power, and strategic advantage.

This civilisational transition is already underway. The Information Age is not augmenting existing systems; it is replacing them

Power therefore lies not with those who use technology to deliver better services, but with those who use it to change the system itself. Leadership now depends on the ability to scale and integrate technology across energy, industry, supply chains, platforms, standards, governance, and security. Control concentrates around a small number of choke points, compute, data, platforms, energy, materials, and infrastructure, where advantage compounds. These control points shape markets and geopolitics more decisively than production scale or territory. Markets have misread this shift, overvaluing digital products and undervaluing systems of control.

This dynamic is clearest in the rivalry between the United States and China. They represent competing system models, not just competing economies. The United States leads in frontier innovation, capital markets, and global platforms. China leads in energy, manufacturing, materials, and coordinated deployment. A third axis may yet emerge through strategic collaboration between the European Union, the United Kingdom, and India, combining regulation, industry, talent, and scale. The outcome will define the structure of global power.

As power concentrates, the boundary between state authority and corporate power dissolves. As in earlier imperial eras, commercial actors move first, creating markets, dependencies, and infrastructure. Political authority follows. Today this occurs through digital systems and cognition rather than territory. States depend on corporate platforms to govern and compete. Corporations depend on states for protection and reach. Together they form hybrid power systems whose influence extends deep into economic life and the mind.

The decisive shift occurs as these technologies cease to develop in parallel and begin to unify. Artificial intelligence amplifies quantum discovery, drives advances in microbiology, and demands new energy frontiers such as fusion to sustain its scale. Energy abundance removes scaling constraints. Interfaces connect human cognition directly into system operation. As unification advances, technology moves through three broad phases: first enhancing human performance, then organising society at supra-human scale, and finally operating near the limits of human governance. Across these phases, authority migrates steadily from individuals and institutions toward systems that structure choice itself.

At the frontier, empires are no longer built on land, using labour and through force. They are built on attention, belief, and behaviour

At the frontier, empires are no longer built on land, using labour and through force. They are built on attention, belief, and behaviour. Militaries can support that but not supplant it without great cost. Power is exercised through systems that shape what populations see and know while preserving the experience of autonomy. As these systems embed, technology becomes invisible infrastructure. Decision-making exceeds human pace and comprehension, because systems function at a speed and scope far beyond human capabilities, allowing the system to organise how our world works.

This report sets out the case for a fundamental shift in how leaders think about technology, power, wealth creation, agency and governance. It speaks to states, corporations, multilateral institutions, civil society, and individuals, arguing that the Information Age is transitioning to the Cognitive Age and thus demands new strategies for security, sovereignty, prosperity and agency.

Ketan Patel
Chairman
The Institute of Strategic Intelligence and Intervention

ACKNOWLEDGEMENTS

Many thanks to Garry Jacobs, President and CEO, World Academy of Art and Science; Glenn Gaffney, Chief Strategy Officer, Former Under Secretary General and Director of Science and Technology for the Central Intelligence Agency; Jonathan Miller, CEO of Integrated Media Co.; former Chairman and Chief Executive of News Corporation's digital media group and former Chairman and CEO of AOL Inc; Shaurya Doval, Founder, India Foundation - for their work in founding the Institute. Special thanks for challenge and support to Bridget Fawcett, Head, Sustainability & Corporate Transition Investment Banking, Citi.

Many thanks to Force for Good for the ideas and thinking it has and continues to provide and to Greater Pacific Capital for its research, knowledge and resources.

The report was led by Ketan Patel, Chairman, Force for Good, Chairman ISII; Christian Hansmeyer, Research Lead at ISII, Head Research at Force for Good; supported by Aditya Ajit, Analytic Lead at ISII, Analysis and Research Lead at Force for Good; Aman Arora, Data and Analysis Lead, ISII; Analysis and Data Lead, Force for Good.

ABOUT THE INSTITUTE

The Institute for Strategic Intelligence and Intervention's mission is to generate the strategic intelligence and foresight required to understand, anticipate, and respond to system-level transitions, major events, and points of strategic consequence shaping the future of nations, regions, global institutions and enterprises.

The Institute operates at the intersection of geopolitics, technology, and capital, where many of the most consequential decisions of this era now take shape. In a period of systemic transition, power, prosperity, and sovereignty are increasingly determined by how these domains interact, requiring integrated understanding and strategic intelligence to navigate complexity and shape future outcomes.

ISII is a not-for-profit initiative of the Force for Good Group.

The Board of Directors for the Institute for Strategic Intelligence and Intervention comprises:

Ketan Patel, Chairman and Director: Chairman, Force for Good Initiative; CEO and Founder, Greater Pacific Capital; Formerly Managing Director, Goldman Sachs, Head of Strategic Group.

Garry Jacobs, Director: President and CEO, World Academy of Art and Science; Chairman and CEO, World University Consortium; Full Member of the Club of Rome.

Jonathan Miller. Director: CEO, Integrated Media Group; Partner, Advancit Capital; Director of BBC News Worldwide; former Chairman and Chief Executive of News Corporation's digital media group and News Corporation's Chief Digital Officer; former Chairman and CEO of AOL Inc.

Glenn Gaffney, Director: Founder, Noblereach Foundation; Executive Vice President and Fellow, In-Q-Tel; former Director of Science and Technology for the Central Intelligence Agency; former Deputy Director of National Intelligence for Collection; former Associate Director of CIA for Talent.

Shaurya Doval, Director: Co-founder and Director, India Foundation; Founder and Managing Director, Torch Investments.

TABLE OF CONTENTS

FIGURES, TABLES, AND INFOGRAPHICS

ABBREVIATIONS AND NOTES

AI	Artificial intelligence
AU	African Union
AR/VR/XR	Augmented reality/virtual reality/extended reality
BERD	Business Expenditure on Research and Development.
Bn	billion
BRICS+	A political and economic coordination framework including several Global South economies
BSL-4	Biosafety Level 4
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats - a gene-editing technology
DRAM	Dynamic Random Access Memory
EUV	Extreme Ultraviolet (Lithography)
EU	European Union
EV	Electric vehicle(s)
FEC	International Atomic Energy Agency Fusion Energy Conference (FEC)
GDP	Gross domestic product
GERD	Government Expenditure on Research and Development
GPU	Graphics processing unit
HBM	high bandwidth memory
IEC	International Electrotechnical Commission
IoT	Internet of things
IP	Intellectual property
ISO	International Organization for Standardization
IT	Information technology
LLM	Large Language Model
M	million
NATO	North Atlantic Treaty Organisation
OIC	Organisation of Islamic Cooperation
PCT	Patent Cooperation Treaty
PV	Photovoltaics
R&D	Research and development
STEM	Science, technology, engineering and mathematics
UK	United Kingdom
US	United States
US$	United States dollars
VC	Venture capital

HIGHLIGHTS

The world remains focused on how technology drives wealth, productivity, and jobs; the deeper story is that it is reorganising the foundations of power, sovereignty, and human agency.

1. **A Civilisational Threshold Has Been Crossed.** Humanity is no longer approaching the Information Age but has entered it, with economic organisation, political authority, and social coordination being restructured at the same time.
2. **Nineteen Technologies Now Underpin the Global Order.** A set of nineteen core technologies spanning computation, energy, materials, biology, manufacturing, and networks has become the foundation of the global economy, with combined impacts measured in tens of trillions of dollars.
3. **A Subset of Systemic Technologies Can Rewire Civilisation.** Artificial intelligence, quantum technologies, advanced biotechnology, fusion energy, nanotechnology, and extended reality possess systemic potential to restructure entire economic and institutional systems rather than merely improve them.
4. **Artificial Intelligence Has Become the Keystone of the System.** AI uniquely accelerates every other major technology, compressing research, simulation, and deployment into continuous loops that only a handful of actors can afford to operate.
5. **Control Points Now Decide Markets and Geopolitics.** Compute, data, platforms, energy, materials, standards, and infrastructure have become chokepoints through which economic advantage and political leverage now flow.
6. **U.S.-China Lead in a Geopolitical Rivalry Between Different Approaches.** The United States and China are no longer competing economies but competing technological models with different approaches to scale, coordination, and control.
7. **Space Exists for a Europe–India Axis to Create an Alternative Tech Power.** Combining Europe's standards-setting power, scientific depth, and institutional governance capacity with India's scale, talent and IT base, a rules-based alternative to U.S.–China technological dominance is possible.
8. **States and Corporations Are Fusing into Hybrid Power Structures.** Political authority increasingly depends on corporate platforms, while platforms rely on states for protection and reach, blurring the traditional boundary between public and private power.
9. **Markets are Mispricing Current AI Models, Risking 30-50% Write-offs in a Mid Case Scenarios.** A continuity scenario implies 10-25% compression; architectural competition 30–50%; paradigm displacement 50–70%, consistent with historical falls such as Microsoft (c.35%), IBM (c.65%), and Cisco (c.70%).
10. **Technologies Are Converging into Higher-Order Systems.** Systemic technologies advancing in parallel, once unified form tightly coupled systems where intelligence, energy, matter, biology, and interfaces reinforce one another.
11. **Authority Is Migrating from Human Institutions to Machine-Scale Systems.** Technology is moving from enhancing human performance to organising society at supra-human scale, operating faster and deeper than direct human governance can follow.
12. **Empires of the Mind Are Replacing Empires of Territory.** Power is increasingly exercised through systems that shape attention, belief, and behaviour at scale, governing choice while preserving the appearance of autonomy.

Markets & Economics in the Systems Age - Highlights

A US$350 trillion worldwide transition is being driven by core technologies. If successfully navigated, the Information Age shift could more than triple global GDP to roughly US$350 trillion by mid-century, representing the largest expansion of economic value in history.

- **Six of 19 core technologies will determine systemic technology leadership.** Artificial intelligence, quantum, fusion, gene editing, nanotechnology, and extended reality function as force multipliers, shaping defence, energy, health, compute and industrial competitiveness simultaneously.
- **Two national leaders across five dimensions of tech power.** The U.S. and China dominate benchmarking across foundational innovation, ecosystems, commercialisation, scaling, and global integration, structurally separating them from all other countries assessed.
- **Leadership is divided by capability, not geography alone.** U.S. tech captures c. 20% of global equity value and leads AI commercialisation; China accounts for roughly 49% of global patent filings and produces c.80% of solar panels and batteries.
- **A third axis combining nearly 2 billion people can be formed.** A Europe-India coalition would aggregate world-class foundational scientific strength, a vast STEM talent pipeline, and leadership in standards bodies, potentially rivalling U.S.-China scale.
- **US$27 trillion concentrated in 20 companies focused on the AI ecosystem.** The world's 20 largest technology firms now exceed US$27 trillion in market capitalisation, representing roughly 20% of total global equity value clustered around AI, platforms, and compute control points.
- **34.4% of the S&P 500 is now concentrated in seven stocks.** The U.S. so called "Magnificent Seven" shows a rise in share of the S&P from 12.5% a decade ago to 34.4% in early 2026, illustrating extreme concentration of value and platform-driven capital market dominance.
- **US$690 billion has been committed to AI infrastructure in one year.** Just five firms announced US$690 billion in 2026 capex, largely for data centres, chips, and hyperscale AI infrastructure at historically unprecedented peacetime scale.
- **Chokepoints outside Big Tech are material factors requiring close cooperation.** TSMC fabricates c.90% of advanced logic chips, and Samsung/SK Hynix supply 80%+ of AI memory, exposing geopolitical fragility beneath U.S. valuation dominance.
- **Up to 14% of U.S. electricity could be consumed by data centres by 2030.** AI demand is projected to rise from c.3% today to c.14% by 2030 and c.28% by 2040, making energy a hard constraint, while China is expanding generation capacity at roughly 3x the U.S. rate, leveraging renewables at scale.
- **Massive - 10–70% - valuation risk across evolutionary scenarios.** Incremental adaptation by AI companies could imply 10–25% compression; architectural tension 30–50%; full paradigm displacement 50–70%, suggesting survival likely but dominance and valuation premiums far from secure.

Wolves, Neanderthals or dinosaurs. Today's AI companies face adaptation, displacement or collapse: wolves survived by adapting to colder climates; Neanderthals were ultimately replaced by Homo sapiens; dinosaurs' scale and resource intensity became fatal after abrupt environmental shock.

I. Executive Summary

The Age of Institutions Is giving way to the Age of Systems.

The world is in an epochal technological shift that is reshaping civilisation - one that opens extraordinary possibilities while introducing profound risks. Moving beyond innovation metrics, market performance, and geopolitical rivalry, requires asking a deeper question: how advanced technologies are redefining human agency, national sovereignty, and global order. Grounded in quantitative evidence and qualitative analysis, this report frames the coming decades as a journey across three technological ages, toward a world governed less by territory and institutions, and more technological systems that will shape human potential itself.

1. A Civilisational Transition Is Underway

In the most significant shift in history, humanity is moving from the Industrial Age to the Information Age. As in prior era shifts, economic models, political authority, and social organisation are being restructured simultaneously, producing instability as legacy systems weaken before new ones consolidate.

- **The post-war liberal order is fragmenting at an accelerating pace.** Global trade has declined from 61% of world GDP in 2008 to under 57% in 2024, the non-western BRICS+ now represent 44% of global GDP (PPP), signalling a decline of the power structures that shaped the global order.

- **The global economic centre of gravity is shifting decisively eastward.** China's share of world GDP has soared from 2% in 2000 to over 17% today, while the EU has fallen from cc.30% in 1980 to under 18%, with long-term projections suggesting China and India could surpass the U.S. and EU between 2050-2075. The U.S. is pursuing its National Security Strategy in a way that is causing friction with allies and rivals and leading them to reduce dependency and seek ways to collaborate with each other and reduce dependency.
- **Democratic freedoms have been declining and economic inequality rising.** By 2025, democracy fell for a 19th straight year - only 20% live in fully free countries, European populism rose from 12% to 32%, and inequality surged as the top 1% took 38% of new wealth since the 1990s versus 2% for the bottom half, undermining political stability.
- **Technology has become the dominant force in global capital markets.** Tech now accounts for 26-30% of global equity value, with seven U.S. mega-cap companies alone comprising one-third of the S&P 500, reflecting an unprecedented concentration of digital power and influence.

2. Technology Has Become the Organising Substrate of Civilisation

Technology is no longer a sector or tool. It increasingly functions as the operating substrate of economies, governance, security, and social life, with power and legitimacy flowing through systems rather than institutions alone.

- Technology has historically determined the rise and decline of civilizations**.** Each major technological advance has not merely improved productivity but fundamentally reconfigured economic models, social organization, and political authority, placing entire societies on new developmental trajectories ushering in new with winners and losers.
- Technology as the primary driver of human progress. During the Industrial Revolution steam power, mechanization, steel, and electrification drove productivity increases of approximately 20-fold in key economic sectors within a single lifetime, reconfiguring social hierarchies and shifting political and economic power globally.
- The Fourth Industrial Revolution is converging physical, digital, and biological realms simultaneously**.** Emerging technologies now embed intelligence into physical systems, biological processes, and environmental ecosystems, creating powerful new externalities that affect all people and the entire planet in ways previous technological revolutions could not.

3. Nineteen Core Technologies Define the Information Age

The transition is being driven by 19 distinct technologies spanning computation, energy, materials, biology, manufacturing, and networks. Today, they remain partially independent, advancing unevenly but inexorably towards a greater human capability across almost every field of endeavour.

- **Digital intelligence as connective tissue.** Digital intelligence now functions as the enabling substrate binding all 19 technologies into a single system - even deeply physical technologies like fusion energy and nanotechnology rely on data generation, computation, and networked systems, allowing breakthroughs to compound, interact, and scale across domains as innovation propagates through this digital connective tissue.

- **Four technologies alone are projected to drive over half of all economic value creation by 2030.** AI, Internet of Things, robotics, and renewables are projected to generate more than US$35 trillion of the estimated US$61 trillion in total annual economic value from the 19 core technologies, with AI contributing the largest share through automation, enhanced decision-making, and new product creation.

4. Six Technologies Can Reshape Civilisation

Among the nineteen, a subset of six functions as systemic technologies. These do not merely enhance performance; they have the potential to restructure entire economic, social. institutional, and strategic systems across the world, determining how the next civilisation will function.

- **Six Systemic Technologies have general-purpose capabilities**. AI, quantum computing, gene editing, fusion energy, nanotechnology, and extended reality each have the capacity to rewire entire economic and institutional systems. Three are technologically ready - AI, gene editing, and extended reality, and three quantum computing, fusion energy, and nanotechnology - await further engineering breakthroughs -to unlock system-wide transformation.
- **AI is unique in directly accelerating other Systemic Technologies.** Unlike steam power, electricity, or the internet which transformed single domains, AI operates directly on all other areas compressing R&D cycles and enabling leaps across material science, genomics, drug discovery, energy systems, and robotics.
- **The Systemic Technologies remain at different levels of technological and commercial readiness**. AI is the first digital-era Systemic Technologies to enter the commercial scaling phase, gene editing and extended reality are sufficiently technologically developed to scale but face regulatory or commercial challenges, and fusion, nanotechnology and quantum require further technological breakthroughs.

5. The U.S. and China Lead, Each Facing Clear Constraints

The U.S. and China now represent competing system models. The U.S. excels in rapid commercialisation and market development, leveraging capital markets to build global platforms; Chinas lead in early-stage research, development, and diffusion and scaling capacity. EU The EU forms a third axis based on standard governance leadership, which could be significantly strengthened through alliances with countries like the U.K. and Europe.

- **China has achieved a measurable lead in early-stage foundational innovation.** China produces nearly twice the total volume of research publications as the U.S., while its share of global patent applications rose from 34.6% in 2014 to 49.1% in 2024, solidifying its position as the dominant source of new patent filings worldwide despite still spending less on R&D in absolute terms than the United States.
- **The U.S. overwhelmingly leads in value capture and commercialization.** U.S. tech companies represent over 25% of global equity market value, reflecting the world's deepest venture capital ecosystem, strongest startup formation, and global platform dominance, making this the technology dimension with the largest current macroeconomic impact.
- **While the U.S. Leads on Initial Commercialisation, China has Unmatched Domestic Scale.** While both countries have strong R&D capabilities, U.S. commercialisation and market development

provides it with a first mover advantage for initial technology scaling, while China's infrastructure and industrial capacity provide it with a longer-term advantage to dominate technologies as they mature.

- **Energy is a core limiting factor for the U.S. far more than China, whose renewables mix has been critical.** U.S. data centres already consume c.3% of electricity, projected to reach up to 14% by 2030 and c.20% by 2040, straining its grid, and face a policy environment that has politically and economically disincentivised renewables. In China, renewables now account for over 60% of installed power capacity and rising, energy expansion has been aligned with technological scale, reducing the risk that growth in AI and other Systemic Technologies hits hard physical limits.

6. There is Space for a Third Axis in Systemic Technologies

U.S. and Chinese technology leadership, particularly in systemic technologies and their diffusion and commercial scaling, is built on current technological paradigms. Current technology middle powers, and particularly groups of them working together, have the foundational research capacity to achieve technological breakthroughs that could create a third axis in future leadership across key technologies.

- **The race to general AI is dominated today by the U.S. and China, and a small handful of companies.** The progress and value concentration in the two leaders is one that can be challenged given the foundational research capability that the U.K. and E.U. prosses if leveraged to either take their place within the race or lure one of the global minded firms based in the US (with much of their development in the UK) into a different geopolitical relationship and residency.
- **Middle powers can rival superpowers through strategic coalition.** EU-India and U.K.-India combinations outperform both the U.S. and China on foundational innovation indicators, suggesting coordinated blocs could rival leading individual systems, though they continue to underperform significantly on venture capital, corporate leadership, and globally dominant companies.

Third Axis Tech Powers Would Outperform the Leaders on Critical Fronts. An alliance between the EU, the U.K. and India would be a global tech leader in terms of foundational research based on scientific strength and the size of its STEM talent pool as well as a global standard setter and driver of open-source technologies.

7. Private Sector Competition Is Focused on Control Points of the Tech Stack

The world's largest and most successful technology companies are focused on (an increasingly narrow set of) critical control points, with advantage accruing to those that command not only entire layers of the tech stack, with but also the upstream inputs, critical components, and infrastructural choke points that those layers depend upon, from rare earths and advanced semiconductors in the hardware foundation, to platforms that sit astride identity, distribution, and user access at the application layer.

- **Six platform companies generate over half of the top 20 global tech companies' total revenue.** These companies dominate strategically significant layers of the global technology stack, with four U.S. platforms (Amazon, Apple, Alphabet, Meta) and two Chinese platforms (Alibaba, Tencent) dominating through network effects that create monopolies of ecosystems rather than individual services.
- **U.S. corporation currently account for roughly half of the global top 20 technology companies**, reflecting a model built on rapid commercialisation, early platform formation, and deep capital-

market integration. Market-capitalisation dominance is further amplified by U.S. financial-market structure, while regulatory and geopolitical risks suppress Chinese valuations, likely overstating U.S. durability and understating China's strategic capacity.

- **Leadership in the devices layer is overwhelmingly concentrated in Asia**, with top firms based in China, Taiwan, Japan, and South Korea. Devices reward manufacturing scale, process engineering, and supply-chain coordination over frontier innovation. These characteristics align with East Asian industrial models, driving leadership toward economies best equipped to industrialise, standardise, and diffuse technology at global scale.
- **AI compute power is globally spread, with critical chokepoints beyond U.S. control**, with Asia and Europe capturing system-level but key control points remain outside U.S. control**.** TSMC fabricates nearly 90% of the world's advanced logic chips, while Samsung and SK Hynix supply over 80% of global advanced memory (HBM and DRAM) used in AI accelerators, and the EU's ASML is the sole global supplier of EUV lithography critical for advanced chipmaking.

8. Markets Are Mispricing a Transitional AI Paradigm and Risk Severe Correction

Capital markets are valuing early-stage, energy-intensive AI architectures as if they represent the mature and enduring form of the technology. If this were a species, it would not survive given the food it needs to consume to perform. The risk factors against the current paradigm - LLM systems that are statistically driven and energy-inefficient - suggest structural valuation risk as architectural discontinuities emerge.

- **Current AI is statistical, not cognitive.** LLMs rely on pattern prediction rather than grounded reasoning, memory, or causal understanding; neuroscience shows the human brain performs complex cognition on just 12-20 watts, orders of magnitude more efficiently than today's models.
- **Energy and capex are diverging from returns.** Hyperscaler AI capex has accelerated into the hundreds of billions globally, while monetisation lags; valuations imply profit outcomes well beyond consensus forecasts, embedding assumptions of architectural continuity.
- **Leading companies have failed or lost dominance after paradigm shifts.** Historical transitions saw companies lose substantial value - IBM (c.65%), AT&T (c.60%), and Cisco (c.70%) - during architectural change; current AI valuations do not reflect comparable discontinuity risk.
- **Three valuation correction scenarios with a mid-scenario of a 30-50% fall are plausible.** A continuity scenario implies 10-25% compression; architectural tension 30-50%; paradigm displacement 50-70% - consistent with historical collapses in company values during discontinuity.
- **Wolves, Neanderthals or dinosaurs - markets have not discerned which species today's AI most resemble.** The absence of an estimation of industry evolution and its drivers is leading the markets to value today's AI as if it were the survivor species.

9. States and Corporations Are Converging as a Power Structure

Competition in the Information Age is increasingly shaped by the convergence of state authority and corporate platforms. As in earlier imperial patterns, merchants, today's mega corporations, create the markets, followed by political consolidation, now across digital infrastructure rather than territory.

- **Technology is shifting from tool to governing infrastructure.**
  Digital platforms and AI systems introduced to improve efficiency now coordinate activity at population scale, mediating communication, attention, and access to opportunity. As these systems become embedded in daily life, they begin to perform governance functions, reorganising how societies operate and where durable power accumulates.
- **Commercial systems increasingly precede and merge with state authority.**
  As in earlier colonial eras where commercial networks preceded the establishment of state control, today's platforms establish economic dependencies, standards, and behavioural norms ahead of regulation. Governments increasingly rely on these systems for growth, security, and mobilisation, while platforms depend on state tolerance and geopolitical alignment.
- **The central risk is invisible governance without individual or democratic consent.**
  Control now operates through system design rather than force, shaping choice, belief, and behaviour at scale. As governance migrates into code, contracts, and algorithms, accountability becomes diffuse. The defining challenge is whether democratic agency can function inside systems that govern through architecture rather than explicit authority.

10. Unification of Technologies Creates a Higher-Order Technological System

The epoch-defining decisive technological shift occurs Systemic Technologies converge into a unified system. Intelligence, energy, matter, biology, and interfaces reinforce one another, producing capabilities far exceeding those of individual technologies, setting the stage for a profound systemic shift in how power is exercised.

- **Key technologies converging into a unified system with multiplicative effects.** AI, quantum computing, gene editing, fusion, nanotechnology, and extended reality interfaces with each other such that outputs from one become inputs to others, creating feedback loops that collapse discovery, testing, and deployment into continuous processes compressing decades of innovation into years, and create hybrid applications.
- **Convergence produces new hybrid systems and applications.** Unification of technologies creates new classes of application - autonomous biological engineering, accelerated materials and drug discovery, energy-abundant compute and fabrication loops, embodied AI-driven physical systems, and reality-scale simulations systems that generate direct biological, physical, and societal outcomes - whose impact is multiplicative rather and impossible to achieve within any single domain.
- **Unification challenges human capabilities and authority across civilization.** When intelligence, energy, matter, biology, and perception integrate within a single technological framework, power initially shifts to those controlling the interfaces and infrastructures, extending influence beyond markets to societal organization and planetary systems at scales that exceed humanity's ability to fully understand, govern, or meaningfully contest.

11. Empires of the Mind Replace Empires of Territory

In the maturation of the corporate state propelled digital age, power is exercised through the organisation of attention, behaviour, and belief at scale. Authority migrates from visible institutions to invisible architectures that organise attention and behaviour at scale - shaping outcomes while preserving the illusion of choice.

- **Platforms govern cognition, not territory.** Digital platforms penetrate directly into human attention and decision-making, shaping commercial, ideological, and political behaviour through continuous AI-enabled optimisation. Dependence becomes psychological and structural, autonomy is illusionary, and influence operates without overt coercion.
- **Loss of individual agency scales to loss of national sovereignty.** Platforms, data, cloud systems, and AI creates borderless systems of power that states struggle to regulate or counter. Individually, this erodes agency, collectively, it represents a loss of sovereignty as governance functions migrate to systems and system owners.
- **Technologies that subjugate dominate until ones that liberate emerge.** Such systems obscure their own authority, making subjugation difficult to perceive and harder to contest. Yet the same technologies can expand awareness, coordination, and autonomy if deliberately redirected. The decisive question is whether digital power continues to extract and condition or is utilised to augment human agency and self-determination.

12. Three Ages Mark a Shift from Technology for Performance to Technological Authority

As unified systems mature, technology moves from enhancing human performance, to organising society at supra-human scale, to operating near the limits of human governance, progressively reshaping where authority resides.

- **Age I - Super-Performing Systems.** In the first, and current phase, the 19 core technologies are enhancing productivity and accelerating R&D while value accrues to those who integrate these augmentative tools most effectively into decision-making. They have the potential to generate over US$60 trillion annually by 2030 - mechanizing cognition and coordination through a shared digital substrate.
- **Age II - Supra-Human Systems.** In the next and near term age, infrastructures organize activity at scales beyond individual comprehension - platforms that already mediate information for billions simultaneously move to shaping and pre-empting individual needs, financial systems execute at machine speed in peer-to-peer systems while monetising ideas for users, and cyber-physical systems govern grids, supply chains, transport, production and security in real time, creating structural dependence where participation requires engaging with systems that shape choice through opaque optimization.
- **Age III - Post-Human Systems.** The third age sees unified systems operating at planetary scale - integrating AI, sensors, supra-human systems, and infrastructures to monitor and manage climate, ecosystems, physical world assets, and populations as interconnected variables. These systems exceed human scope in depth and breadth, raising whether human civilization can remain the primary locus of authority when systems exercise control beyond human comprehension.

The journey ahead may be the most consequential humanity has faced, offering unprecedented possibility alongside systemic risk.

This report does not predict outcomes; it diagnoses the forces reshaping the world and maps the paths now unfolding. As technology evolves from tool to system to authority, power shifts away from invention toward a new system-based order. Leadership will not belong to those who dominate individual technologies, but to those who can intervene at the intersection of technology and human agency. The choices made across the three Ages of Systems will determine whether the emerging world order diminishes autonomy or unlocks a higher trajectory for human civilisation.

II. Disruption in the Civilisational Transition

The world's rising levels geopolitical conflict, economic fragmentation, technological rivalry, inequality, and climate stress are becoming increasingly interlinked, with failures in one domain propagating rapidly across others. This self-reinforcing dynamic has given rise to a metacrisis, a systemic breakdown in the mechanisms intended to manage volatility, enforce rules, and stabilise outcomes. Beneath this disorder sits a deeper structural force: a civilisational transition from the Industrial Age to the Information Age, in which the foundations of economic organisation, political authority, and power projection are being reconfigured. As legacy institutions struggle to govern systems that now operate at digital speed and planetary scale, authority increasingly shifts toward actors that control scalable technologies, networks, capital, energy, and information flows. Economic value concentrates, political legitimacy weakens, and competition intensifies over control points rather than territory alone. This transition is critical because it is redefining how power is generated, exercised, and contested across markets and states.

1. Rising Global Disorder: From Polycrisis to Metacrisis

The world is in a period of escalating turbulence, where familiar shocks - conflicts, inflation, migration, supply chain disruptions and political polarisation - are symptoms of a deeper systemic shift underway. The post-war order, once anchored in the belief that liberal democracy and open markets would expand indefinitely, has weakened significantly. Optimism that followed the fall of the Berlin Wall in 1989 and the belief in an "end of history" moment dissolved with the shocks of 9/11, the 2008 financial crisis, and successive global disruptions that revealed structural vulnerabilities in the international system.

Since then, the global risk landscape has deteriorated sharply. Environmental, geopolitical, economic, technological and societal risks are increasingly interlinked. After decades of slow erosion, the past several years have brought a dramatic intensification of disorder. Global cooperation has weakened, ideological divides have sharpened and the capacity of multilateral institutions to respond has declined. The result is a more fragmented, conflict-prone world.

I. **Asymmetric Might Extracts Through Technology, Capital, and Force.** The global system is dividing between states able to project military, economic, and technological power, and those exposed to shocks they did not create. Influence is now exercised not only through territory, but through sanctions, capital access, energy control, and digital infrastructure. As leverage becomes more overt, protection turns conditional, international law uneven, and fragmentation accelerates.

II. **An Assertive U.S. Strategy has Put the World's Assets into Play.** America remains the world's pre-eminent economic, military and technological power, and is increasingly pursuing a neo-mercantile vision to secure what it sees as strategic assets including territories across the world. Its traditional global leadership model grounded in broadly free trade and open markets has given way to using tariffs to redistribute economics, bilateral bargaining, and punitive measures against allies and perceived rivals.

III. **Alliances are Fracturing from Differences in Ideology and Geopolitical Positioning.** Longstanding alliances are under strain as the U.S. assets itself with tariffs of up to 200%, targeting land acquisition in Europe, and the willingness to intervene in European politics to influence a shift to the far-right in elections. Majorities of EU citizens see the U.S. as a negative for security and the economy, [1] with higher disapproval from citizens of NATO members, and a noticeable shift in positive views towards China,[2] with U.S. Canada, the UK, Japan, South Korea and India deepening economic engagement with China's technology and industrial ecosystem.

IV. **The World Is Reorganising into New Blocs and Spheres of Influence.** A rules-based global structure is giving way to overlapping economic and security blocs. Russia-Iran's 20-year strategic pact, China-Russia's "no limits" partnership and the expansion of BRICS reflect the emergence of new power webs that challenge Western dominance. In response, the EU has been catalysed to internally align far more rapidly following threats from the US, and EU citizens and world opinion,[3] particularly in China, sees the EU as a positive force.[4]

V. **Wars and Conflicts Have Eroded the Rules of Engagement, Escalating Future Risk.** Russia's invasion of Ukraine has killed nearly 15,000 civilians, displaced 5.7 million refugees internationally and 3.7 million internally.[5] ,[6] In Gaza, Israel's military response has killed 60,000+ Palestinians and displaced 1.9 million - around 90% of the population[7] [8]. These wars disregard UN-agreed rules, frame victims as perpetrators, treat land as an object of acquisition, and use digital platforms to induct mass populations to confuse evidence with opinion. The peace efforts to date indicate pragmatism and commercial goals dominate rather than rights and humanitarian concern. Without accountability or reconciliation mechanisms, grievances are set to fuel future instability regionally and globally.

VI. Rising Economic Inequality Is Driving Extreme Politics. Governments across the developed world are failing to deliver growth and prosperity. Rising inequality, where the top 1% captured 38% of global wealth gains since the 1990s, has fuelled resentment and sharpened political divides. Populist and far-right parties now command around 32% of the European vote, reshaping policy and weakening liberal democratic institutions.

VII. Power Rivalry Extended to Technology Supremacy. Power rivalry increasingly runs through technological and cyber supremacy. Technology now accounts for nearly 30% of global equity value, with seven U.S. mega-cap companies comprising a third of the S&P 500, reflecting the concentration of digital power[9]. The US-China contest over AI and semiconductors defines the next geopolitical frontier. The share of all cyberattacks associated with geopolitical conflict has risen to nearly 30%, while attacks targeting critical infrastructure now account for roughly 40%, with cyber augmenting technological rivalry, military power, and foreign policy.[10]

VIII. The Rules-Based World Order Is Disintegrating at an Accelerating Pace. The geopolitical environment is more fractured today than at any point since the Cold War. The United States, while remaining the pre-eminent economic, military, and technological power, increasingly prioritises leverage over leadership, intensifying competition across trade and technology. International law is applied selectively, and multilateral frameworks are bypassed. In this new era of might makes right, power is exercised through economic pressure, information warfare, and technological control. The expansion to BRICS+ - 44% of global GDP (PPP), 56% of the world's population, and 43% of global oil production - reflects a shift toward alternative power structures.

IX. Global Crises Continue to Grow as Leadership Falls Away. Around 800 million people remain in extreme poverty, with over 1.1 billion in multidimensional poverty, much of it in climate-exposed regions. More than 2.2 billion people lack safely managed drinking water.[11] Climate risks are accelerating, with global CO_2 emissions projected at 41.6 billion tonnes in 2024, while adaptation finance remains below one-tenth of assessed need despite over US$2 trillion in annual clean-energy.[12, 13] Fewer than 20% of SDG targets are on track, placing the world on a 2.7-3.0°C warming trajectory.[14, 15]

X. A More Dangerous World at a Point of Rupture. The convergence of power fragmentation, technological militarisation, inequality, unaddressed global issues, and norm-breaking conflict is pushing the international system toward a decisive threshold. History suggests such moments resolve either through structural reform or widespread violence. Without credible leadership to realign security, development, and climate governance, the drift toward coercion and confrontation will continue - raising the risk that this decade becomes defined not by renewal, but by escalation and war.

As these crises collide, economic inequality, fragile democracies, degraded ecosystems, and ungoverned technologies increasingly reinforce one another, exposing deeper structural failures. This polycrisis is not simply the accumulation of shocks but a self-reinforcing cycle of social fragmentation, disinformation, weakened governance, and escalating risk. As trust, particularly in but not limited to institutions erodes, the capacity for collective action declines. The world therefore faces not only multiple, overlapping crises, but a metacrisis, a breakdown of the systems, institutions, and norms meant to manage risk, which now instead generate and amplify it.

2. The Nature of the Civilizational Transition

Thus, rising disorder and mounting crises are painful symptoms of a series of deeper structural forces, represented by four simultaneous civilizational defining shifts. First, humanity is undergoing mass population expansion, growing from 6.1 billion in 2000 to a projected c.10 billion by 2050[16]. Second, mankind is nearing planetary resource exhaustion and ecosystem breach: more than half of all fossil fuels ever extracted have been burned since 1990[17] [18], while human activity has already pushed six of nine planetary boundaries beyond safe operating limits, undermining the Earth systems on which civilisation depends[19]. Third, the international system is entering a great-power cycle transition, as non-Western economies now account for over 50% of global GDP (PPP), signalling the erosion of the post-Cold War unipolar order[20]. And fourth, the focus of the global economy is shifting from physical production and energy-intensive manufacturing to one defined by data, digital networks, intellectual capital, and the control of information flows. Together, these shifts define the transition from the Industrial Age to the Information Age.

Structural Instability Is a Feature of Civilizational Transition

The international system has entered a phase in which instability is not episodic but structural. This transition is reconfiguring economic organisation, social relations, and political authority. As in previous shifts between civilizational eras, this process weakens existing institutions before new ones rise, producing extended periods of disorder. Crisis, fragmentation, and institutional strain and collapse are therefore not aberrations of the transition but expected features of it.

Digital Acceleration Compresses Time and Magnifies Disruption

Digital technologies collapse distance and compress time, destabilising existing economic, political, and social systems while accelerating new ones to scale globally. The coexistence of industrial and informational systems produces sharp dislocations in jobs, value, power, and influence, contributing to sub-optimal economic outcomes and polarised politics. Adjustment that once unfolded across generations is forced into compressed timeframes, increasing volatility and reducing the margin for error in governance and policy.

Economic Transformation Precedes Political and Social Reordering

As in earlier civilizational transitions, disruption first emerges across economic systems. Across much of industrial Europe, economic performance has stagnated, productivity growth has weakened, and states struggle to deliver rising prosperity despite historically high public spending. Financial markets and investment increasingly reward scale, speed, and network effects, concentrating wealth among asset owners, technology entrepreneurs, and hyperscaler companies and their second-tier ecosystems. Political and social systems adjust more slowly, widening gaps between economic reality and institutional response.

Power Reorders Around Control of Scalable Systems

Technological breakthroughs drive a reordering of global hierarchies. Influence accrues to enterprises, states, and institutions capable of adopting, scaling, and controlling the dominant systems of the new era. In the Information Age, this centres on data, networks, semiconductors, energy systems, and computing capacity rather than industrial production alone. Actors tied to legacy systems experience relative decline, while those able to integrate new technologies consolidate positional advantage, intensifying geopolitical competition within and across regions.

Rupture, Not Continuity, the Norm

The Information Age does not extend the logic of the Industrial Age, it displaces it. Economic coordination, political influence, and social organisation are increasingly structured through networks rather than hierarchies, and through platforms rather than institutions. Governance frameworks designed for slower, territorially bounded systems struggle to regulate algorithmic decision-making, cyber risk, and transnational platforms. This mismatch fuels mistrust, fragmentation, and coercive economic and political behaviour.

Figure 1: Transition Era Challenges[21]

Historical civilizational transitions unfolded in stages rather than all at once. The transition to the Information Age began in the mid-20th century with the invention of the semiconductor (late 1940s-1950s) and accelerated dramatically with the rise of personal computing (1970s-1980s) and the internet (1990s). The world is now entering the decisive phase of this transition, driven by AI and digital networks. This change is accelerating as technology advances and the old industrial socio-economic-power structure strains to survive, hanging onto jobs and a way of life that cannot be saved. The cumulative effect is an irreversible shift toward a new civilizational platform.

3. The Transitions to a New Civilisation

The transition to the Information Age is unfolding through a series of interlinked economic, environmental, social, geopolitical and technological sub-transitions. These shifts cascade across systems, reshaping power, value, stability and risk. Together, they illustrate how the civilizational transition is actively redrawing the global map of influence.

Figure 2: Rises and Falls of Global Transition[22]

1. Economic, Environmental and Social Transitions: Global Climate Systems. Human activity has pushed global temperatures beyond safe limits, with fossil fuels, deforestation and industrial land use driving greenhouse gases to levels unseen in millions of years.[23] In defiance of global agreements and oversimplified nationalized strategies, the world is heading toward 3°C warming, triggering fivefold increases in extreme heat, 0.6-1.1m sea-level rise displacing 800 million people, near-total coral mortality, and up to one-third of species facing extinction.[24] Global crop yields may drop 10-25%, deepening food insecurity,[25] while climate migration could reach 630 million by 2100,[26] reshaping resource competition, geopolitical alignments and state stability amid an already turbulent global transition.

2. Economic, Environmental and Social Transitions: Eco- and Human Systems. Environmental degradation now collides with vast unmet human needs, creating a dangerous feedback loop. Even after decades of global economic growth, 2.2 billion people still lack safely managed drinking water,[27] and 673 million experienced hunger in 2024.[28] Meanwhile, explicit and implicit global fossil-fuel exceed US$7.4 trillion annually, further undermining climate commitments.[29] These combined pressures fuel political instability, accelerate urban overcrowding, intensify health crises, and expose deep vulnerabilities in regions least able to adapt.

3. Economic, Environmental and Social Transitions: Social and Political Systems. Wealth inequality has surged over the past three decades: the top 1% captured 38% of new global wealth while the bottom half received just 2%, reshaping political behaviour and governance stability.[30] Democratic decline is entrenched -

only 20% of the world lives in fully free countries, and 2025 marked the 19th year of backsliding.[31] Populist parties in Europe have risen from 12% of the vote in the 1990s to 32% today.[32] Meanwhile, information integrity is collapsing: 72% see online falsehoods as a major threat.[33] As social cohesion fractures, states lose the capacity for collective action just as global crises intensify.

4. Economic, Environmental and Social Transitions: Economic Power. Economic power is undergoing a profound three-way shift. First, value is moving from industrials to technology: tech now accounts for 26-30% of global capital markets,[34] and seven U.S. mega cap companies alone make up one-third of the S&P 500.[35] Second, wealth continues to concentrate upward, weakening social cohesion and limiting broad-based growth. Third, global power is tilting eastward. China's share of world GDP has soared from 2% in 2000 to over 17% today, while the EU has fallen from ~30% in 1980 to under 18%.[36] Despite ongoing downward revisions, long-term projections continue to suggest China and India could surpass the U.S. and EU between 2050-2075,[37] reshaping global rules, institutions and the foundations of economic influence.

5. Economic, Environmental and Social Transitions: Financial Power Hubs. The geography of global finance is being redrawn as geopolitics and digital transformation shift capital flows. New York is positioned to retain dominance thanks to the depth of U.S. capital markets and technological leadership. London, by contrast, is losing ground post-Brexit as activity shifts to EU centres such as Paris, Frankfurt, and Amsterdam. Singapore and Hong Kong face structural constraints, Singapore's limited domestic scale and Hong Kong's reduced autonomy, while Shanghai and Beijing rise as China integrates capital, regulation and digital finance around its domestic core. Future shocks, from de-dollarisation and crypto adoption to tech bifurcation and regional conflicts, could scramble the hierarchy further.

6. Peace and Security Transitions: Liberal International Order. The post-WWII liberal order, anchored in the UN, WTO, IMF, and World Bank, can no longer manage the scale, speed or complexity of modern crises. Global trade has already slid from 61% of world GDP in 2008 to under 57% in 2024, reflecting fragmentation and near-shoring.[38] The average level of democracy has fallen back to 1980s levels,[39] and long-standing norms of predictability, collective security, and peaceful dispute resolution are eroding. The system built for the Industrial Age are fracturing as the realities of the Information Age manifest.

7. Peace and Security Transitions: American Power. The United States remains unmatched in innovation, defence capacity and financial clout - but its strategic posture is shifting. Withdrawals from key multilateral agreements, punitive tariff regimes, and reduced support for global institutions reflect a move toward unilateralism at a time when cooperation is most needed. History shows great powers often accelerate their decline when they disengage from institutions, prioritise extraction over partnership, underinvest in public goods, and experience internal fragmentation. America's long-term relative decline is not predetermined - but current choices risk speeding it up.

8. Peace and Security Transitions: Webs of Alliances. As the old alliance system frays, new and fluid coalitions are emerging. BRICS+ is expanding its reach through commodity-rich and emerging economies, though internal cohesion remains weak. The EU maintains deep institutional integration but struggles with demographic stagnation and political fragmentation. The Shanghai Cooperation Organisation is deepening security cooperation across Eurasia, while the OIC, AU, and Commonwealth show renewed potential despite internal divisions. The world is moving toward a polycentric landscape where alliances are increasingly pragmatic, flexible, and interest-driven rather than ideological.

9. Science and Technology Transitions: Frontier Technologies. 19 core technologies, including AI, quantum computing, robotics, synthetic biology, genomics, and advanced materials, are now driving the shift to the Information Age. These technologies blend the physical, digital, and biological realms, redefining national competitiveness and accelerating societal transformation. They unlock immense productivity but also amplify systemic risks, demanding new models of governance and coordination.

10. Science and Technology Transitions: Tech Leadership. In the Information Age, strategic advantage accrues not only to the inventors but to the actors who can deploy, scale and integrate technologies fastest and the race for technological dominance is reshaping global power. The U.S. leads in AI foundation models, cloud ecosystems, semiconductor design and globally scaled platforms. China leads in patent filings, research output and rapid deployment and is positioned itself at the centre of the clean-energy transition, building 74% of the world's solar and wind capacity under development.[40] Meanwhile, the world's top 20 tech companies generate US$3.2 trillion in revenue,[41] and spend nearly US$400 billion on R&D annually, with almost US$200 billion devoted to AI.[42]

Together, these transitions suggest a world where every domain - economics, security, technology, society and culture - is being rewritten at the same time. Across these ten transitions there are several themes emerging that will define the character of the next era and confer relative power to those that can secure their position.

The Emergent Themes of the Civilizational Transition

I. **Attention becomes a critical arena of power and value.** Political, economic, and social outcomes are increasingly shaped through attention, perception, and narrative control.

II. **Foundational technologies determine power hierarchy.** Leadership in core technologies sets the basis for share of economic growth, security, and strategic autonomy.

III. **Transition insecurity leading risk of unbounded conflict.** Losses and gains in the transition are leading to insecurity and competition, increasing likelihood of miscalculation and spreading conflict.

IV. **Networks and blocs coexist in a hybrid order.** Formal alliances endure, but influence increasingly flows through overlapping networks, platforms, and dependencies.

V. **Execution capacity separates authority from aspiration.** Institutions are judged less by intent or ideology than by their ability to deliver outcomes under stress.

VI. **Capital concentration accelerates through scalability.** Wealth and influence concentrate where capital can scale rapidly through platforms, IP, and network effects.

VII. **Resource extraction faces planetary constraints.** Competition intensifies over energy, water, materials, food, and supply chains as ecological limits are breached.

VIII. **Rules fragment as power reasserts primacy.** Shared norms weaken, and rule-setting becomes a contested instrument of advantage rather than a framework for mutually beneficial agreements.

IX. **Coercion expands beyond the battlefield.** Economic, financial, technological, and informational pressure increasingly substitute for direct force.

X. **Populism evolves under performance pressure.** Populist politics persists but divides between those that transition to delivering real benefits and those that rest on civil disorder.

XI. **Truth becomes a contested strategic domain.** Events are weaponised with truth losing its potency as post-truth dynamics erode shared reality, dehumanising people via humanised machines.

XII. **Resilience becomes a decisive differentiator.** The capacity to absorb shocks, adapt, and recover determines endurance in a polycrisis and metacrisis world, unprotected by multilateralism.

Taken together, these transitions and themes reveal not only the scale and complexity of the current moment, but also the degree to which the global system is under strain. Left unmanaged, this entangled transformation risks tipping into disorder, amplifying social fragmentation, institutional breakdown, and geopolitical instability. The challenge, then, is not simply to adapt to change, but to shape the transition in a way that is deliberate and coordinated. Without coordination, enterprises, states, and blocs pursue advantage in ways that increase systemic risk. Power in a competitive and predatory transition confers to ownership of sources of advantage such as attention, technological-military systems, scalable capital, alliance architectures, and institutional resilience.

4. The Stakes of the Transition: Managed vs. Unmanaged Paths

The world faces complex transition scenarios. At one extreme, is a long, unmanaged and haphazard transition, with the world entering an illiberal era marked by the systematic erosion of fundamental rights and freedoms. At the other extreme, is a short, managed and planned transition in which innovation spreads rapidly to every corner of the world, not only raising the value of the parts and the whole but also reinforcing rights and freedoms as access to technology, knowledge, and opportunity broadens participation and inclusion. The world is precariously poised between these trajectories. If the shift to the Information Age unfolds chaotically, existing systems could break down faster than new ones are built, increasing the risk of uncontrolled conflict.

Features of a Chaotic Transition

1. **Economic Dislocation.** Legacy industrial jobs disappear faster than new sectors can absorb workers, while concentrated tech ownership widens inequality and traps both rich and poor countries in deeper social fragmentation and low-income stagnation.
2. **Governance Failure.** Misinformation, polarisation and digital echo chambers steadily erode institutional trust, fuelling political extremism.
3. **Environmental Breakdown.** Without coordinated global transition, warming pushes past 3°C, unleashing cascading crises - crop failures, mass migration, collapsing ecosystems and rising conflict over water, land and resources.
4. **Escalating Geopolitical Risk.** US-China tech rivalry intensifies without guardrails, cyber operations and AI-driven escalation heighten the risk of conflict, and long-standing alliances fracture into unstable, transactional arrangements.
5. **Global Fragmentation.** Nations retreat into protectionism and regional spheres of influence as de-dollarisation and financial bifurcation destabilise capital flows. Competing digital, financial and political systems emerge, further splintering global order.
6. **Loss of Cognitive Agency.** As AI-enabled systems shape information and decision-making, individuals and states lose control over how choices are structured. Dependence on privately controlled platforms erodes autonomy, accountability, and strategic resilience.

This transition points to the emergence of a predatory, survival-based international system. Dominant actors impose terms of engagement, middle powers coalesce defensively to preserve autonomy, and weaker states are left to stagnate, align under pressure, or be systematically exploited.

Features of a Managed Transition

1. **Levelling Up the World.** Global stability depends on enabling lagging regions to catch up through access to education, connectivity, digital tools, infrastructure investment, frontier-market capital, and climate resilience. Levelling up is not charity, it is a prerequisite for stability and supports an investment boom by expanding demand-side participation.
2. **Investing for a Shared Global Transition.** A new global transition framework succeeds the SDGs with a global transition programme that invests in frontier technologies, leverages existing ones and rolls them out at scale across the world, protecting rights and encouraging collaboration and competition.
3. **Building a New Global Financial Architecture.** Systemic constraints are overcome to mobilise capital at scale for climate, development, and resilience, serving 'left behind' populations across income levels. A new architecture unlocks long-term finance, expands fiscal space, strengthens South-South finance, and modernises trade rules.
4. **Creating Fit-for-Purpose Global Institutions.** Global institutions, including the United Nations, World Bank, and World Trade Organization, are reformed to manage shared systemic risks such as climate change, cyber domains, biosecurity, and emerging technologies through architectures grounded in adaptability, resilience, and human security, while rebalancing the interests of major and smaller powers.
5. **Forming New Alliances and Multistakeholder Coalitions.** Progress is reinforced through flexible alliances linking states, companies, investors, and civil society around shared objectives, making cooperation more dynamic and inclusive.
6. **Recognition of Cognitive Sovereignty and Rights.** Cognitive agency is recognised as core to stability and sovereignty and protected through digital rights, data sovereignty, and algorithmic transparency, ensuring AI-enabled systems enhance rather than override national and individual autonomy.

These measures in aggregate define a managed transition in which governance is modernised fast enough to keep up with systemic changes. Rather than allowing disorder to dictate outcomes, power is channelled through renewed institutions capable of absorbing shocks, coordinating action, and sustaining cooperation at scale. In this trajectory, adaptation becomes deliberate, resilience is designed in, and the transition to the Information Age strengthens rather than fractures global order. Executed well these domains offer a pathway to a more secure, sustainable and superior future.

No transition can be as successful without peace. Rising conflict risks, geopolitical rivalry, climate shocks, resource scarcity, make progress risky. Without stability capital flows are constrained, technology cannot diffuse equitably, institutions cannot reform, and cooperation collapses. A global peace offensive, formal or informal, is required to stabilise the transition period and ultimately lay the ground for greater human security for all.

To date, the world has made little progress on the necessary elements of the transition roadmap. Leaders with the capacity to act are often unwilling; those willing lack the system-level leverage needed. Meanwhile, geopolitical fragmentation deepens. Yet the opportunity remains. The transition is inevitable, but whether it is chaotic or transformative depends on choices made now. How we emerge, as people, nations, economies, and the planet will be everything and will be determined by how we manage through the transition.

In summary

- **Polycrisis has become metacrisis.** Interlinked geopolitical, climate, economic, and technological stresses reflect systemic breakdown.
- **A civilisational shift is underway.** The move from the Industrial to the Information Age is reordering power faster than institutions can adapt.
- **Power is consolidating around systems.** Control of technology, capital, energy, and information now outweighs territory or production.
- **Instability is structural.** Digital acceleration drives disruption, inequality, and geopolitical risk ahead of governance.
- **The outcome is undecided.** Unmanaged, the transition risks conflict; managed, it enables resilience and shared prosperity.

III. Core Technologies Shaping the Future

Civilisational transitions are ultimately determined not by shocks or politics, but by the technologies that reshape how societies produce value, coordinate activity, and exercise power. In the transition from the Industrial Age to the Information Age, technology is not merely accelerating change, it is redefining the architecture of economic organisation and strategic advantage itself. A relatively small set of technologies now functions as foundational infrastructure, embedding intelligence into physical, digital, and biological systems at unprecedented speed. Understanding which technologies matter, how they interact, and where value and authority concentrate across their life cycles is therefore essential to assessing the trajectory of the Information Age and the emerging hierarchy of economic and geopolitical power.

1. Technology Catalysing Human Progress

Technology has been one of the defining forces of human progress, repeatedly reshaping cultures, economies, and political systems. Throughout history, advances in knowledge have driven corresponding leaps in tools, systems, and methods, each unlocking new forms of productivity gains that have raised incomes, reduced poverty, and increased literacy and life expectancy across the world.

At its core, technological progress is not driven by tools alone but by human nature itself. The capacity to innovate emerges from deeply rooted cognitive traits: curiosity, abstraction, symbolic reasoning, cooperation at scale, and the ability to accumulate and transmit knowledge across generations. Humans uniquely combine imagination with social coordination, allowing incremental improvements to compound over time into transformative breakthroughs. Technology is therefore an expression of accumulated human cognition, culture externalised into tools. In that sense, it has been a central driver of the rise and decline, of civilizations. It was foundational to the Agricultural Revolution, where early tools, irrigation systems generated agricultural surpluses[43]. The Industrial Age marked a second rupture: the steam power, mechanisation, steel, and electrification, drove another transformation, with productivity in key economic sectors increasing c.20-fold within a single lifetime.[44] The breakthroughs did more than raise productivity: they reconfigured social hierarchies, shifted political and economic power, and placed entire societies on new developmental trajectories.

Today, the transition to the Information Age represents a similarly consequential shift, made possible by information's new role as the primary medium of economic and social re-organisation. The 'Digital Revolution', initiated by the semiconductor and accelerated by personal computing and the internet, transformed how information is created, stored, transmitted, and acted upon. Global internet users increased from virtually zero in 1990 to more than five billion today and is set to include every human being on the planet.

The world is currently in what may be the decisive phase of this transformation, often described as the Fourth Industrial Revolution, in which the physical, digital, and biological realms are converging. Emerging technologies embed intelligence into physical systems, biological processes, and environmental ecosystems. These technologies are reshaping global natural and man-made systems, introducing powerful new externalities at the same time, just as previous technological revolutions did only this time the stakes are all people and the whole planet in ways that more limited systems in history could not impact.

The nature and reach of technology ushers in a new and exciting era of change with far reaching implications for which no one and nothing is set to remain untouched

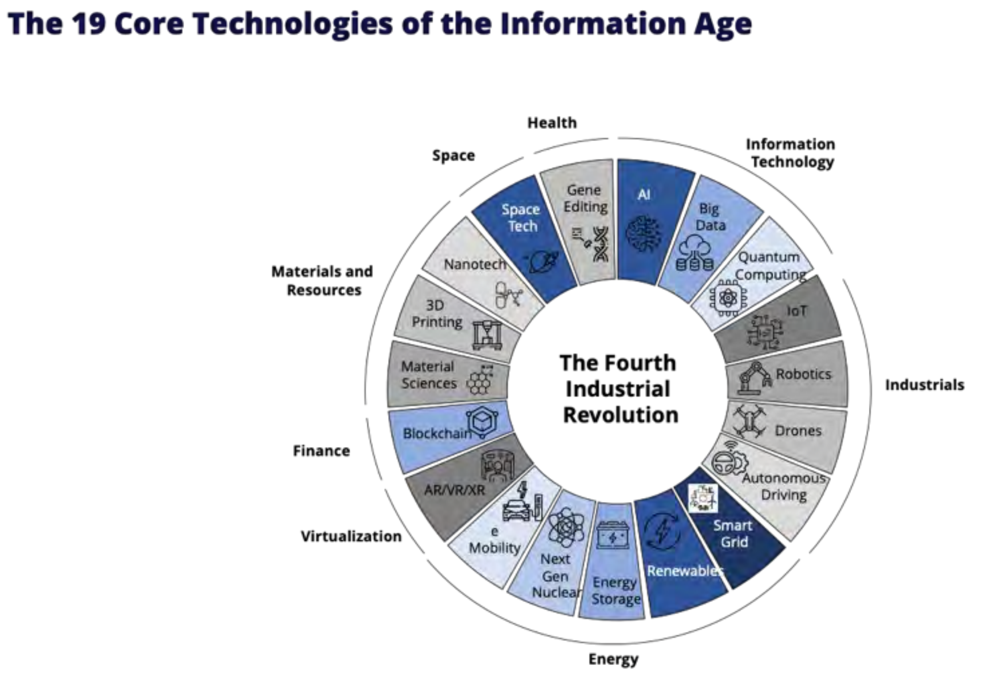
2. Technologies Defining the Information Age

Technology as the Architecture of Power

The distribution of power in the Information Age is being shaped by a small set of technologies that function as the operating systems of modern economies, security architectures, and societies. These technologies do not merely improve productivity or efficiency; they define the control points through which strategic advantage for power and wealth now flow. As in earlier civilizational transitions, leadership in the foundational technologies of the era determines long-term geopolitical position, economic performance, and resilience.

There are number of core technologies that are embedding digital intelligence into every domain of human activity. Spanning information systems, industrial innovation, energy, materials, health, space, and resource management, a total of 19 technologies form the foundational building blocks of the Fourth Industrial Revolution[45]. Together, they blur the boundaries between the physical, digital, and biological and ecological spheres, reshaping how societies create value, coordinate systems, and project power.

Figure 3: Core Technologies of Information Age[46]



Source: Force for Good, 2025

1. **Artificial Intelligence (AI).** Systems that learn, reason, and act autonomously, making AI core because it automates cognition itself and amplifies productivity across every sector.
2. **Big Data.** The ability to collect, process, and analyse massive datasets, forming the raw fuel that enables AI, prediction, and real-time decision-making.
3. **Quantum Computing.** Computing based on quantum mechanics that can solve certain problems exponentially faster, threatening current cryptography and enabling breakthroughs in materials, optimisation, and science.
4. **Internet of Things (IoT).** Networks of connected sensors and devices that digitise the physical world, turning infrastructure, cities, and industries into data-generating systems.
5. **Robotics.** Programmable machines that perform physical tasks, allowing digital intelligence to directly reshape manufacturing, logistics, healthcare, and warfare.
6. **Drones.** Autonomous or remotely operated aerial systems that collapse the cost and accessibility of surveillance, delivery, mapping, and precision strike capabilities.
7. **Autonomous Driving.** Vehicles that navigate without human input, redefining mobility, logistics, urban design, and labour structures.
8. **Smart Grids.** Digitally managed energy networks that balance supply and demand in real time, enabling large-scale renewable integration and energy security.
9. **Renewable Energy.** Solar, wind, and other low-carbon power sources that underpin the Information Age by decoupling growth from fossil fuel dependence.

10. **Energy Storage.** Technologies like advanced batteries that stabilise intermittent power, making electrification and renewable systems viable at scale.
11. **Next-Generation Nuclear (Fusion).** Advanced nuclear designs offering reliable, high-density clean power critical for energy-intensive digital economies.
12. **E-Mobility.** Electrified transportation systems that integrate energy, data, and mobility, reshaping supply chains and urban infrastructure.
13. **Extended Reality (**AR/VR/XR**).** Immersive computing interfaces that merge digital and physical environments, transforming work, education, entertainment, and training.
14. **Blockchain.** Distributed ledgers that enable trust without central authorities, reshaping finance, identity, governance, and coordination systems.
15. **Material Sciences.** The engineering of novel materials that enable faster chips, lighter structures, and more efficient energy systems across technologies.
16. **3D Printing.** Additive manufacturing that decentralises production, compresses supply chains, and enables rapid, customised fabrication.
17. **Nanotechnology.** Engineering at the atomic and molecular scale that underpins advances in medicine, electronics, energy, and materials.
18. **Space Technology.** Satellites and space-based systems that enable global connectivity, navigation, intelligence, and planetary-scale observation.
19. **Gene Editing.** Precise modification of DNA that transforms medicine, agriculture, and biosecurity, extending the Information Age into biological systems.

Digital Intelligence is Now the Connective Tissue

What unites these 19 technologies is they are digitally enabled and computationally designed. While several technologies, like fusion energy or nanotechnology, are deeply physical and engineering-led, each relies on data generation, computation, and networked systems, allowing breakthroughs to compound, interact, and scale across domains. Digital technology functions as the enabling substrate through which innovation propagates, binding together advances in industry, energy, health, materials, space, and resource management into a single, interconnected system.

Digital technologies transform systems in three fundamental ways. Firstly, they enable automation at scale, reducing error while dramatically increasing speed, precision, and efficiency. Secondly, they embed intelligence into physical and biological systems, allowing machines and infrastructure to operate and optimise in real time. Thirdly, they compress innovation cycles by enabling ideas, processes, and designs to be simulated and iterated digitally before physical deployment raising the level of the systems and activities they touch. Together, these effects accelerate change beyond the capacity of legacy institutions.

Figure 4: Digital Everything[47]

Convergence, Multiplication and Transformation

Technologies are no longer advancing along separate tracks but are increasingly impacting each other. Breakthroughs in in any one technology now improves the performance of the others through shared data, and digital control. At the core of this convergence are AI and Big Data, which provide the analytical layer across the ecosystem. They accelerate discoveries in R&D intense areas like quantum computing and gene editing, optimise the efficiency of industrial technologies like smart grid systems, and enable simulation-led design in engineering driven technologies like 3D-printing and space technology.

Importantly, this dynamic is not driven solely by the digital and computational technologies. Breakthroughs in nanotechnology, batteries, and additive manufacturing, for example, expand the physical capabilities upon which AI, data analytics, quantum computing, and autonomous systems depend. The convergence therefore runs in both directions: the digital accelerates the physical, and the physical unlocks new frontiers for the digital.

Technologies are no longer advancing along separate tracks but are increasingly impacting each other. Breakthroughs in in any one technology now improves the performance of the others

Crucially, these interactions are both multilateral and compounding: AI improves battery chemistry; better batteries accelerate EV adoption; EVs reshape grid demand; smart grids generate data that improves AI models; improved materials from nanotechnology and quantum simulation enhance batteries, vehicles, and energy infrastructure simultaneously. The significance of these technologies therefore lies not in isolated applications or paired interactions, but in a dense web of cross-reinforcing relationships. Together, they form an integrated technological architecture in which progress anywhere propagates everywhere, accelerating breakthroughs across the entire economy and defining the foundations of the emerging Information Age.

The decisive impact of the 19 core technologies lies not simply in the new capabilities they introduce, but in their potential to transform economic, institutional, and geopolitical structures, while the value they create determines the scale and speed of its adoption, and the capital flows towards then. Together, these forces explain why some technologies reshape entire systems while others remain incremental, and why competition over them increasingly defines economic leadership, strategic advantage, and long-term national power. In practise, each technology's impact depends not only on what they can do, but on how far each has progressed toward scale. Differences in technical maturity and deployment readiness now shape where economic value is already being realised and where it will accelerate over the coming decade.

3. Near Term Value Commercialisation

The 19 technologies today vary widely in technical maturity, deployment readiness, and commercial traction. A small number are already scaled globally and reshaping industries today, while a second tier is moving through critical inflection points that will drive substantial value creation over the next decade. This uneven maturity determines both the timing and the distribution of economic gains between now and 2030.

Estimates suggest that, by 2030, the 19 core technologies could collectively generate more than US$61 trillion in annual economic value.[48] This figure includes direct market revenues as well as broader productivity improvements, efficiency gains, and innovation spillovers, which in many cases exceed the value captured by technology developers themselves.

Figure 5: 2030 Macro-economic Impact of 19 Core Technologies

Four technologies alone - artificial intelligence, the Internet of Things, robotics, and renewables, account for more than US$35 trillion of this potential, reflecting their scalability and applicability across multiple sectors. Among these, artificial intelligence contributes the largest share, enabling both automation and enhanced decision-making. The Internet of Things delivers value through industrial optimisation, smart infrastructure, and data-driven services. Robotics accelerates automation across sectors like manufacturing, logistics, healthcare, agriculture, and resource extraction. Renewables generate economic gains through lower energy costs, improved energy security, and reduced environmental externalities.

Beyond this top tier, a broader group of technologies, including big data systems, gene editing, advanced materials, additive manufacturing, and electric mobility, are each on track to contribute between US$1 trillion and US$5 trillion in annual value. While smaller in direct economic terms, many of these technologies function as essential enablers, providing capabilities that allow higher-impact technologies to scale and diffuse more effectively.

Four technologies alone - artificial intelligence, the Internet of Things, robotics, and renewables, account for more than US$35 trillion of this potential, reflecting their scalability and applicability across multiple sectors

This near-term value creation demonstrates that the transition to the Information Age is already well underway., and the differences in near term value creation are as much, if not more, a function of each technology's maturity as it is a function of its total economic value. Reaching commercialisation typically requires both a fundamental scientific breakthrough and one or more engineering breakthroughs to translate that science into a viable product; yet moving from initial viability to widespread adoption demands a far broader set of capabilities in practice, including process engineering and supply-chain optimisation to drive down costs, effective product-market fit to unlock sustained demand, and, in some cases, supportive legal and regulatory frameworks.

In practice, technologies tend to progress through four broad stages.

1. **Scientific validation marks the point at which core principles are proven**, typically in laboratories or tightly controlled pilots, but commercial relevance remains uncertain and dependent on further breakthroughs.
2. **Engineering and early commercialisation follows when those principles are translated into workable products**, often through one or more engineering advances that improve reliability, performance, or usability; at this stage, costs are high, and applications are narrow.
3. **The most economically consequential phase is scaling and diffusion.** Here, the underlying technology is already viable, and value creation is driven less by invention than by execution: process engineering to reduce costs, manufacturing scale, supply-chain depth, integration into existing systems, and the identification of applications that unlock sustained demand. Legal and regulatory frameworks, as well as the quality and reach of education, particularly in the engineering disciplines, often become decisive constraints or enablers.
4. **Finally, maturity and optimisation are reached once core capabilities are widely deployed.** Incremental improvements dominate, competition shifts toward efficiency and integration, and the technology's contribution becomes embedded in the broader economy rather than a discrete source of transformational growth.

On this basis, the nineteen technologies sit at markedly different stages of development, from early scientific validation to full industrial scaling.

Figure 6: Maturity of 19 Core Technologies

Technology	Maturity Stage	Rationale
Quantum Computing	1 - Scientific Validation	Breakthroughs needed in error correction and hardware
Fusion	1 - Scientific Validation	Net energy still not commercially viable
Nanotechnology	2 - Engineering & Early Commercialisation	Many niche successes, limited general-purpose impact to date
Gene Editing	2 - Engineering & Early Commercialisation	CRISPR proven; safety, and regulation remain binding, along with cost and industrial control
XR (AR/VR/MR)	2-. Engineering & Early Commercialisation	Tech works, mass-market use cases still weak
Autonomous Driving	2 - Engineering & Early Commercialisation	Edge cases, safety, and regulation unresolved
Blockchain	2 - Engineering & Early Commercialisation	Infrastructure works; mainstream use cases uncertain
Materials Science	2 - Engineering & Early Commercialisation	Breakthroughs frequent, diffusion slow
AI*	3 - Scaling & Diffusion	Core models work; value now driven by deployment, compute, data, and integration
Smart Grid	3 - Scaling & Diffusion	Tech exists; rollout limited by infrastructure and regulation
Batteries	3 - Scaling & Diffusion	Chemistry largely known; gains via manufacturing and materials
Electric Vehicles	3 - Scaling & Diffusion	Product-market fit proven; scaling and cost curves dominate
3D Printing	3 - Scaling & Diffusion	Strong industrial niches; limited consumer penetration
Space Tech	3 - Scaling & Diffusion	Launch economics improving; downstream markets expanding
Drones	3 - Scaling & Diffusion	Tech mature; regulation constrains deployment
IoT	3 - Scaling & Diffusion	Proven tech; value in integration and security
Big Data	4 - Maturity & Optimisation	Foundational capability; gains now incremental
Renewables (solar/wind)	4 - Maturity & Optimisation	Core tech proven; value now in system integration

**refers to current state of AI based on generative LLMs*

Where a technology sits along its maturity curve shapes who captures value and where power concentrates. In early stages, value accrues to innovators and first movers, where technical scarcity and intellectual property allow leading firms to build large, often global businesses with significant pricing power.

As technologies mature and diffuse, capabilities standardise and barriers to entry fall. More firms and countries participate, competition intensifies, margins compress, and value shifts from invention toward execution, cost efficiency, manufacturing scale, and system integration. Industries at this stage tend to become more diversified, with leadership less concentrated in a small number of frontier innovators.

This dynamic is central to understanding shifts in technological leadership. Countries possess different assets, research strength, industrial capacity, supply chains, and regulatory frameworks, that align with different stages of the technology lifecycle. As technologies move from invention to diffusion, sources of advantage change, often driving geographic shifts in leadership toward those best positioned to scale and embed technologies across the broader economy.

4. Systemic Technologies Where Value Propagates

Systemic Technologies at the Core of Long-term Transformation

While all 19 core technologies will generate economic value and confer competitive, only a small subset possess the capacity to reshape entire economic systems and redefine long-term trajectories of power. These are Systemic Technologies: technologies whose impact extends far beyond any single industry, whose applications proliferate across sectors, improves continuously over time, and catalyses successive waves of complementary innovation. Systemic Technologies do not merely enhance productivity; they alter how economies function, how institutions organise, and how societies coordinate activity.

Historically, Systemic Technologies have defined technological epochs. Steam power reorganised industrial production and transportation. Electricity reshaped manufacturing, urbanisation, and domestic life. The internet transformed communication, commerce, and information flows. In each case, the decisive feature was not the initial invention, but the technology's ability to diffuse widely, compound in capability, and become foundational infrastructure for economic and social systems.

> *19 core technologies are defining the transition to the future ... a subset of six are Systemic Technologies with the ability to alter how economies function, institutions organise, and societies coordinate across the world*

Systemic Technologies share four defining characteristics. First, pervasiveness: they diffuse across most sectors rather than remaining confined to a single industry. Second, continuous improvement: their performance compounds as complementary innovations accumulate, and ecosystems form around them. Third, innovation-spawning effects: they expand the frontier of what is technically and economically feasible, accelerating progress in other technologies. And fourth, system-rewiring capacity: beyond raising efficiency, Systemic Technologies reorganise production, labour, governance, and patterns of power. Core technologies that fail to meet these characteristics function instead as Enabling Technologies or Application Technologies, each playing a distinct but more bounded role within the broader innovation ecosystem.

Enabling Technologies provide critical inputs, tools, or infrastructure that enhance the performance of other technologies but do not independently reorganise economic systems. They improve efficiency, reduce cost, or expand capability within existing structures. These technologies are indispensable and often strategically sensitive, yet their impact typically operates through the Systemic Technologies they support rather than through direct system-wide transformation.

Application Technologies, by contrast, are downstream implementations of broader technological capabilities. They apply existing scientific and engineering foundations to specific use cases, which while commercially significant and sometimes disruptive within particular sectors, do not fundamentally rewire institutional structures or redefine cross-sector economic organisation.

Identifying which 19 technologies function as genuine Systemic Technologies is essential for understanding long-term trajectories of economic power, geopolitical influence, and technological leadership. Systemic Technologies are not simply high-growth sectors; they are the architectural foundations of future eras, shaping which enterprises, countries, and institutions are positioned to lead, and which risk structural decline.

Figure 7: Systemic Nature of Core Technologies

Technology	Pervasiveness/ Cross Sector Impact	Continuous, Compounding Improvement, Self-Reinforcement	Frontier Innovation-Spawning Effects	Institutional System-Rewiring Potential	Overall Systemic Technologies Potential
Artificial Intelligence	✓✓	✓✓	✓✓	✓✓	Systemic Technologies
Gene Editing	✓✓	✓✓	✓✓	✓✓	Systemic Technologies
Extended Reality	✓	✓		✓✓	Systemic Technologies
Nanotechnology	✓	✓	✓✓	✓✓	Systemic Technologies
Fusion	✓✓	✓	✓	✓✓	Systemic Technologies
Quantum Tech	✓✓	✓✓	✓✓	✓✓	Systemic Technologies
Big Data	✓✓		✓		Enabling Tech
Material Sciences	✓	✓	✓		Enabling Tech
Internet of Things	✓				Enabling Tech
Robotics	✓				Enabling Tech
Blockchain					Application Tech
Space Technology			✓		Application Tech
Energy Storage		✓✓	✓		Enabling Tech
Smart Grids					Enabling Tech
Renewables					Enabling Tech
3D Printing					Enabling Tech
E-Mobility					Application Tech
Drones					Application Tech
Autonomous Vehicles					Application Tech

Among the 19, there are important nuances. Extended Reality's designation reflects its dual role as systemic and enabling, given its cross-sector impact on learning, perception, and cognitive processing, reshaping how individuals experience context, presence, and interaction. Quantum computing and broader quantum technologies differ in technical scope, the first enabling exponential computational breakthroughs in optimisation and simulation, and the second underpinning advances in sensing, secure communications, and precision measurement. Robotics and autonomous vehicles are best understood within the wider arc of machine autonomy: systems that increasingly sense, decide, and act independently and can be expected to shift from enabling technologies to systemic ones with profound real-world implications. This expanding autonomy represents a transformative force whose implications extend well beyond any single application category.

The table above highlights Systemic Technologies based on a current distinction between technologies that exhibit the full properties of systemic impact as currently conceived in research and execution and those whose transformative potential is more narrowly bounded today. Irrespective of technological maturity, the technologies with Systemic Technologies potential already being manifested include:

- **AI** is pervasive across nearly every sector, improves continuously through data-compute-model feedback loops, accelerates discovery across sciences and engineering, and is already reshaping how decisions, work, and organisations function through embedded intelligence.
- **Extended Reality** has the potential to become a new interface layer for work, education, and coordination, but currently lacks strong cross-technology enablement and broad institutional dependence.
- **Gene Editing** acts as a platform technology across healthcare, agriculture, food systems, and industrial biology, with steady improvement in precision and delivery methods, and the capacity to reorganise both biological production systems and overall healthcare models.
- **Nanotechnology enables** advances across materials, electronics, and medicine, and could underpin multiple industries, yet progress remains constrained by fabrication and tooling breakthroughs that limit diffusion.
- **Fusion,** although earlier stage in development, has clear system-transformative potential for energy, geopolitics, and industrial structure, and more importantly the potential to unbound progress along almost every front, but today awaits more scientific breakthroughs.
- **Quantum Computing** combines rapid research level performance improvement with the ability to unlock new science in materials, chemistry, sensing, and cryptography, positioning it as a foundational layer for future computation and national capability.

Enabling technologies such as Big Data, Materials Science, IoT, Robotics, Batteries, Smart Grids, Renewables, and 3D Printing play critical roles within the ecosystem but do not independently reconfigure economic systems as conceived today.

Application technologies, including Blockchain, Space Technology, Autonomous Vehicles, EVs, and Drones, remain largely sector-specific for now, their impact concentrated within defined domains.

> *Systemic Technologies status is not static. Technologies often begin as specialised tools before crossing thresholds where their impact becomes systemic*

Importantly however, Systemic Technologies status is not static. Technologies often begin as specialised tools before crossing thresholds where their impact becomes systemic. Electricity was initially a niche industrial technology, computing began as a specialised scientific tool, and the internet started as a military-academic network. Over time, each evolved into foundational infrastructure. A similar dynamic is now unfolding today as certain technologies move from lab to commercial scale and from sectoral relevance toward economy-wide transformation.

AI, The Cornerstone Systemic Technology

Among the systemic technologies shaping the Information Age, artificial intelligence occupies a singular position. AI is the first systemic technology to systematically accelerate progress across other technological domains by acting directly on cognition, discovery, and optimisation itself. In this sense, AI is not simply a complementary technology among many; it is the keystone technology upon which the broader technological system increasingly depends.

AI exhibits the defining characteristics of a systemic and even general-purpose systemic technology to an unparalleled degree. It is universally applicable across sectors, continuously improving through feedback loops between data, models, and compute, and capable of spawning successive waves of complementary innovation.

Unlike earlier Systemic Technologies, AI operates directly on cognition itself - automating perception, prediction, optimisation, and decision-making - thereby reshaping both economic production and institutional behaviour. While earlier Systemic Technologies such as electricity and digital computing broadly raised productivity and diffusion capacity, AI uniquely compresses the process of invention, experimentation, and system design across science and engineering. What differentiates AI even further is its role as a force multiplier for the entire technology stack of 19. AI compresses research and development cycles, accelerates scientific discovery and enables extreme optimisation of complex systems. It is already transforming material science, genomics, drug discovery, energy systems, advanced manufacturing, and robotics. No previous Systemic Technologies has combined direct cognitive automation, with large scale scientific discovery at comparable speed and breadth.

AI exhibits the defining characteristics of a general-purpose, systemic technology to an unparalleled degree. It is universally applicable across sectors

AI's impact is also self-reinforcing. Each wave of deployment generates new data, which improves the capability of future models and reduces the cost of using them. This creates powerful positive feedback loops that drive exponential performance gains and favour actors able to operate at scale. As a result, AI increasingly behaves not as a discrete product, but as an underlying infrastructure of intelligence embedded across economies, institutions, and security systems.

As AI becomes pervasive, it begins to resemble earlier infrastructural technologies such as electricity or the internet, visible in its early stages, but ultimately fading into the background as a foundational substrate. A notable exception to this would be AI that is embedded in a robot with its own cognitive ability. Such a system would be fully autonomous with the potential to replace humans in the workplace. Yet unlike those predecessors, AI evolves faster, diffuses more broadly across cognitive and physical domains, and directly shapes how decisions are made. This combination ensures that leadership in AI increasingly determines the pace, direction, and distribution of gains from the wider technological transition.

Taken together, these attributes position artificial intelligence as the central organising technology of the Information Age. It increasingly drives the other core technologies and defines the frontier of innovation, shaping economic competitiveness, national security, and institutional power. Other systemic technologies, such as quantum technologies, may in time become co-evolutionary partners with AI; however, at present their development trajectories are themselves increasingly shaped by AI-enabled discovery and optimisation. Understanding the Information Age therefore requires treating AI not as a sector, but as the core infrastructure through which the next era is being built.

Unlike predecessors such as electricity, AI evolves faster, diffuses more broadly across cognitive and physical domains, and directly shapes how decisions are made … meaning that leadership in AI increasingly determines the pace, direction, and distribution of gains from the wider technological transition

Stepping back, it is important not to regard the current state of AI systems, focused on large language models (LLMs) as more than the initial mass use form of artificial intelligence. While they demonstrate impressive linguistic and analytical capabilities, the evidence for their capability exceeding to statistical prediction rather than true contextual comprehension or grounded reasoning is limited. These systems represent an early stage in a broader developmental trajectory that is likely to include more cognitively capable, context-aware, and adaptively intelligent architectures. Assuming today's models are the endpoint risks obscuring both the potential and the challenges of future AI developments.

Conclusion

Taken together, these dynamics place artificial intelligence at the centre of the emerging technological order. Because AI functions as an enabling layer across nearly all other systemic technologies, leadership in AI increasingly confers leverage far beyond the technology itself - shaping the pace of innovation, the structure of value creation, and the distribution of economic and strategic power. It is therefore unsurprising that AI has become one of the most intensely contested domains of competition, not only among firms, but between states seeking to secure durable advantage in the Information Age.

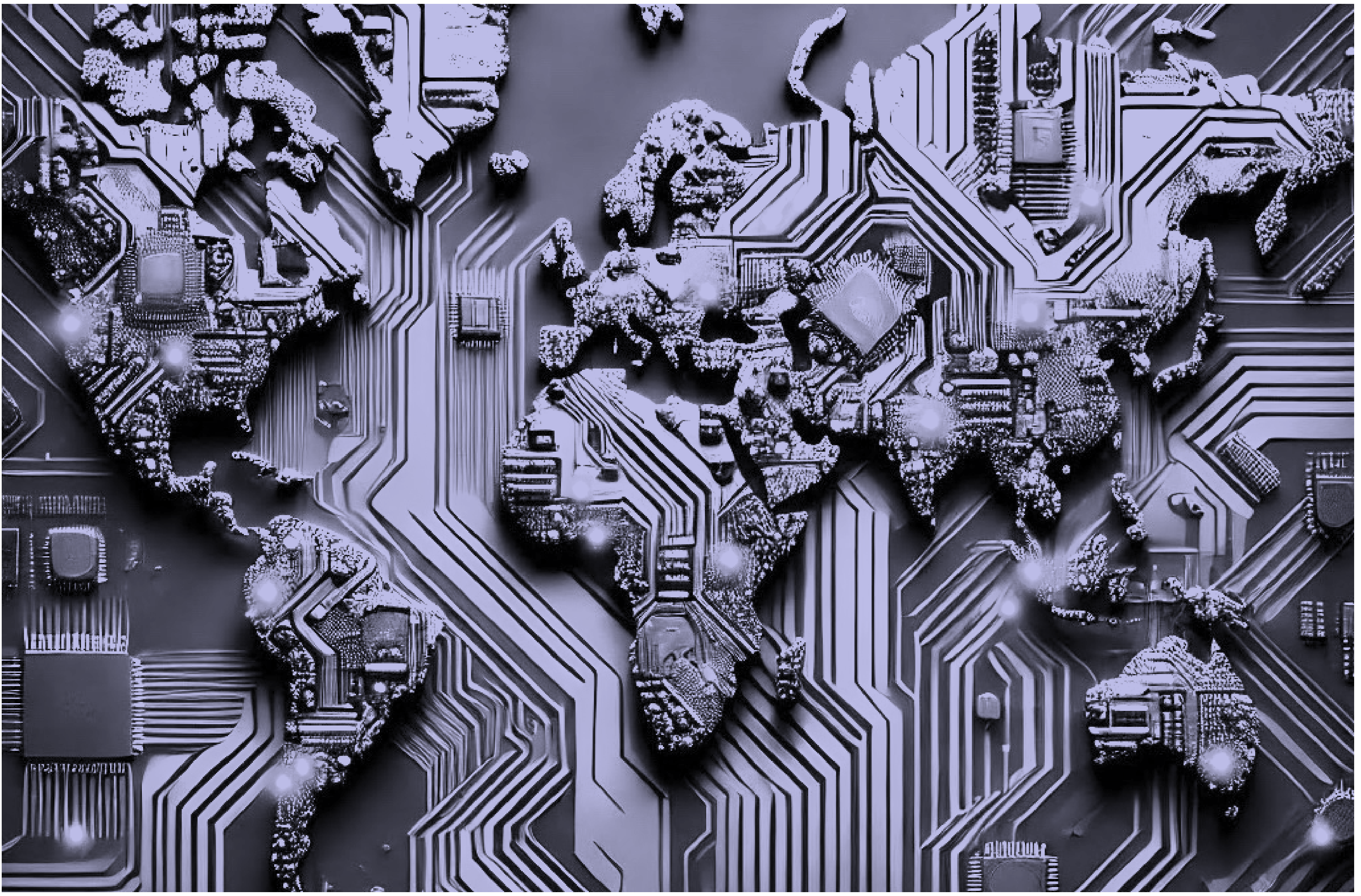
Yet while AI occupies a uniquely central role, it is not the only technology that matters. The broader set of systemic technologies, from energy systems and advanced materials to quantum computing, remain critical battlegrounds in their own right. Countries and companies differ markedly in how they position themselves across these technologies, reflecting divergent endowments, institutional strengths, and strategic priorities. Some focus on frontier innovation, others on scale and diffusion; some compete through platforms and standards, others through industrial capacity and supply chains.

The sections that follow benchmark these differences in technological power and capability. They assess how countries and leading technology firms are positioned across AI and the wider set of systemic technologies, and how their strategies are shaping the evolving geography of technological leadership.

In Summary

- **Technology now determines civilisational outcomes.** A small set of foundational technologies is reshaping how value is created, systems are coordinated, and power is exercised in the Information Age.
- **Nineteen core technologies form the new infrastructure.** Spanning digital, physical, and biological domains, they embed intelligence across economies, security systems, and societies.
- **Convergence drives systemic transformation.** These technologies increasingly operate as a single, interlinked system where progress in one propagates across all others.
- **Value follows maturity and control points.** Near-term gains concentrate where technologies scale fastest, while long-term power accrues to those controlling infrastructure, platforms, and standards.
- **Only a few technologies are truly systemic.** AI, alongside quantum, advanced biology, materials, and energy, reshapes entire systems, making leadership in them decisive for economic and geopolitical power.

IV. Tech Competition of Nations



As technology becomes the organising substrate of the Information Age, the critical question is no longer who innovates first, but who can build enduring technological capacity: converting research into scalable companies, deploying infrastructure, controlling supply chains, and shaping standards that lock in advantage. This recasts technology from a growth driver into a source of sovereignty. The tech rivalry between the U.S. and China illustrates two divergent system models, one optimised for rapid commercialisation and platform dominance, the other for coordinated scaling and industrial depth, while Europe and other middle powers retain influence through regulation, standards, and coalition-building. At the corporate level, power concentrates around a narrowing set of control points across the technology stack, where capital intensity, lock-in, and network effects create defensible positions and strategic gatekeeping.

Technology as the New Basis of a Nation's Power

Rising Contest for Tech Supremacy

Technological capability is increasingly emerging as a primary determinant of national power. Beyond its role as a driver of productivity and economic growth, technology now underpins military capability, intelligence advantage, industrial resilience, and strategic autonomy and sovereignty. As digital systems become embedded across infrastructure, finance, defence, healthcare, energy, and information ecosystems, leadership in the 19 core technologies of the future not only determines who prospers economically, but who sets standards, controls dependencies, and exercises influence in the global system.

This shift is already visible in capital markets. The so-called Magnificent Seven, Apple, Microsoft, Alphabet, Amazon, Nvidia, Meta, and Tesla, in early 2026 account for approximately 34.4% of the S&P 500's total market capitalisation, up from roughly 12.5% a decade earlier, reflecting a dramatic concentration of value in a small set of technology companies.[49] This trend points to market's recognition that technological platforms increasingly occupy the highest-leverage positions in the global economy. Companies that control critical digital infrastructure, advanced semiconductors, hyperscale compute, and foundational software systems are no longer simply industry leaders. They are becoming systemic actors whose capabilities shape the functioning of entire sectors and, in some cases, national strategies.

Nowhere is this more evident than in the intensifying U.S.-China competition over advanced semiconductors and artificial intelligence (AI). Export controls on advanced chips, restrictions on equipment sales, investment screening mechanisms, and aggressive industrial strategy on both sides transcend trade disputes as strategic efforts to shape the technological balance of power. The underlying logic is increasingly explicit: leadership in key technologies confers economic advantage, security resilience, and geopolitical leverage, while technological dependence creates vulnerability. Whether in compute capacity, chip production, critical minerals, or elite talent, states are positioning their technological ecosystems as strategic assets.

> *"The United States is in a race to achieve global dominance in artificial intelligence. Whoever has the largest AI ecosystem will set the global standards and reap broad economic and security benefits"*
> *America's AI Action Plan, July 2025*

As a result, technological supremacy is becoming an increasingly important factor underpinning national strength. The countries that dominate the foundational technologies of the Information Age will disproportionately shape global standards, capture high-value economic activities, and exercise geopolitical influence. Conversely, those that fall behind risk becoming structurally dependent on external platforms, infrastructure, and intellectual property. In the transactional world 'order' implied by America First the structurally dependent rule takers risk economic exploitation by the stronger rule makers, mirroring in some respects the dynamics of the pre-war imperial colonial order.

Historical Continuity: The Return of Techno-Nationalism

While the current intensity of technological competition between nations may appear novel, the underlying dynamic is historically familiar. Technology has long been a central arena of geopolitical rivalry. During the Industrial Revolution, Britain's early leadership in mechanised manufacturing, by 1870 responsible for nearly one-third of global industrial output,[50] underpinned its 19th-century imperial dominance and vast export networks.

Control over electrification, chemicals, and industrial production shaped economic power in the early 20th century, with Germany producing more electrical machinery and synthetic chemicals than any other nation on the eve of the First World War, capabilities that translated directly into military advantages. Nuclear technology and missile systems defined strategic hierarchy during the Cold War, with the United States and the Soviet Union investing heavily in atomic research, aerospace, and rocketry; by the 1960s, each was spending more than 5% of GDP on defence-related R&D, [51] locking in technological lead in critical military and space systems. And in the late 20th century, leadership in semiconductors and computing underwrote U.S. dominance in global technology ecosystems: by 1990, American corporations accounted for over 70% of global semiconductor design revenues,[52] anchoring U.S. leverage over global digital infrastructure and value chains.

In each case, technological leadership translated into economic strength, military advantage, and institutional influence. What distinguishes the present era is not that technology has become geopolitical, but the breadth and depth of its reach. Earlier technological revolutions primarily transformed production and military capability. The technologies now emerging extend far beyond industry into the core informational and cognitive systems of states and societies. AI shapes how knowledge is produced, and decisions are made; digital platforms structure communication and economic coordination; biotechnology alters the foundations of health and agriculture; and quantum and advanced computation promise to reshape scientific discovery. These systems increasingly sit at the intersection of economic systems, security systems, and societal organisation.

> *A renewed and explicit techno-nationalism is now embedded not merely in rhetoric, technology policy is increasingly being written into national security strategies, industrial policy frameworks, and long-term economic planning*

The result is a renewed and explicit techno-nationalism, now embedded not merely in rhetoric but in institutional design. Technology policy is increasingly being written into national security strategies, industrial policy frameworks, and long-term economic planning. Governments are reorganising bureaucracies, funding mechanisms, and regulatory regimes around the assumption that technological leadership must be deliberately cultivated rather than passively assumed. China has operated under an evolving national artificial intelligence strategy since 2017, explicitly framing AI as a strategic technology central to economic transformation and national power. And the United States published a formal national AI action plan in 2025, supported by no fewer than six executive orders on artificial intelligence issued by President Trump in his second term. In keeping with America's historical laissez-faire posture toward industrial policy (with exceptions for issuing government contracts to companies), relying on private markets to drive innovation, the action plan prioritises infrastructure, competitiveness, and security, and narrows federal oversight. In effect, the plan reinforces the model in which hyperscale firms retained operational control, with sovereignty-like influence over core AI infrastructure.

What is emerging is therefore not episodic intervention but a durable structural shift: a world in which states increasingly view technological ecosystems as strategic assets to be actively shaped, defended, and contested. This reorientation is likely to persist across political cycles and to define the character of technological competition in the decades ahead.

5. Strategic Tech Competition Among Nations

Benchmarking Overall Technology Power

As technology becomes more central to national power, the nature of competition between states is also evolving. Where previous eras focused primarily on control of territory, industrial capacity, or physical resources, contemporary strategic competition increasingly centres on access to and control of the critical technologies of the future. Technology leadership increasingly depends not only on breakthroughs, but on the broader national environment that sustains innovation over time. Tech power is therefore not simply about invention. It is the capacity to generate knowledge, translate it into globally competitive companies, scale it through infrastructure and capital, and project influence across borders. Frontier science depends on strong research institutions and deep talent pipelines. Scaling depends on capital formation, entrepreneurial ecosystems, and industrial depth. Global influence depends on the ability to shape standards, embed platforms internationally, and participate credibly in governance regimes.

On this basis, a technology's competitiveness can be broken down into three structural dimensions, which follow the development cycle of research, development and commercialisation:

1. **Foundational Innovation Capacity** captures the ability to generate frontier knowledge. Indicators such as scientific output, citation impact, research investment, and the depth of the STEM talent pool reflect the long-term intellectual base from which technological leadership emerges.
2. **Innovation Ecosystem** reflects whether scientific potential is converted into sustained technological momentum. R&D intensity, the density of technology clusters, institutional quality, and the strength of intellectual property frameworks determine whether innovation remains episodic or becomes structurally embedded.
3. **Commercialisation and Market Development** is the capacity to translate technological capability into globally competitive companies. Venture capital activity, startup formation, corporate leadership in global markets, and the presence of dominant technology companies reveal whether innovation is being successfully scaled.

While the three dimensions above capture a country's ability to generate commercialise technologies, long-term technological power depends on broader, cross-cutting capabilities beyond any single innovation cycle, which determine whether success becomes economy-wide. Two additional dimensions capture a country's capacity to diffuse technology domestically and to shape the global standards that govern future value creation.

4. **Global Integration** reflects a country's ability not only to participate in the global technological system but to shape it. Leadership in standards-setting bodies, influence within governance frameworks, and the global diffusion of national technologies indicate whether a country is setting the rules of the emerging order rather than merely operating within them.
5. **Technology Adoption and Scaling** determines whether technological capabilities diffuse broadly through the economy rather than remaining confined to isolated centres of excellence. Digital infrastructure, education infrastructure, industrial digitisation, manufacturing sophistication, and supply-chain depth determine whether technology becomes a systemic national advantage.

Taken together, these dimensions provide a structured framework for assessing which countries are best positioned to compete across the 19 technologies as whole over the long term, and which risk becoming structurally dependent on external technological ecosystems. The table below scores a set of leading tech powers across these five dimensions of general tech power on a scale of 1-10, based on a set of key indicators and sub-indicators.

Figure 8: Overall Country Tech Power

Domain of Tech Competition	U.S.	China	EU	U.K.	Japan	India	South Korea	Russia
Foundational Innovation	**5.0**	**5.5**	**4.8**	**1.8**	**1.5**	**2.5**	**1.5**	**0.9**
Scientific Strength	**4.5**	**6.0**	**6.3**	**3.4**	**2.2**	**2.9**	**2.9**	**1.4**
Scholarly Output	4.4	6.7	7.0	1.5	0.8	1.9	0.6	0.7
Field Weighted Citation Impact	4.5	5.3	5.6	5.4	3.6	3.8	5.2	2.1
R&D Infrastructure (GERD)	**7.5**	**3.9**	**3.9**	**0.9**	**1.2**	**0.2**	**0.9**	**0.2**
Talent Pool	**3.1**	**6.7**	**4.2**	**0.9**	**1.1**	**4.2**	**0.8**	**1.0**
Researchers	4.6	7.3	5.8	0.9	1.8	1.1	1.2	1.1
STEM Graduates	1.5	6.1	2.6	0.8	0.4	7.3	0.4	0.8
Innovation Ecosystem	**4.7**	**6.4**	**2.9**	**1.2**	**2.2**	**0.7**	**2.0**	**0.8**
R&D Intensity (BERD)	**7.6**	**3.6**	**3.0**	**0.8**	**0.9**	**0.1**	**0.6**	**0.1**
Clusters and Hubs	**2.7**	**7.4**	**4.8**	**0.6**	**0.9**	**0.9**	**1.1**	**0.4**
Tech Exports	1.7	7.4	4.6	0.3	1.0	0.1	1.5	0.0
Scientific/Technical Journal Articles	3.8	7.4	5.0	0.9	0.9	1.7	0.6	0.7
Policy & IP	**3.7**	**8.4**	**1.1**	**2.3**	**4.7**	**1.2**	**4.3**	**1.8**
Patent Family Count	0.8	7.7	0.5	0.1	0.9	0.0	0.8	0.0
Tech Advanced Innovative Score	7.8	9.2	1.8	5.5	10.0	2.8	9.3	4.4
Commercial /Market Development	**5.7**	**3.5**	**3.1**	**0.8**	**0.5**	**0.4**	**0.8**	**0.2**
Entrepreneurial Activity	**6.3**	**1.5**	**3.1**	**2.0**	**0.2**	**0.7**	**0.4**	**0.5**
VC Investment	7.8	1.5	1.3	0.7	0.2	0.5	0.2	0.0
New LLCs	2.7	1.4	7.4	4.9	0.2	1.1	0.7	1.5
Corporate Leadership	**7.8**	**1.8**	**0.4**	**0.0**	**0.4**	**0.0**	**0.5**	**0.0**
Share in Top 100 firms Market Cap	7.8	0.9	0.3	0.0	0.2	0.0	0.2	0.0
Share in Top 100 firms Revenue	7.7	2.8	0.5	0.0	0.6	0.0	0.8	0.0
Market Share (Tech Trade)	**3.1**	**7.2**	**5.7**	**0.5**	**1.1**	**0.4**	**1.4**	**0.2**
Tech Adoption and Scaling	**6.3**	**7.1**	**4.7**	**4.2**	**4.9**	**2.6**	**4.7**	**1.7**
Digital Capacity	**6.8**	**7.0**	**4.3**	**4.2**	**3.9**	**3.0**	**4.2**	**3.1**
Fixed Broadband Users	1.6	7.8	2.1	0.3	0.6	0.5	0.3	0.5
Digital Competitiveness	9.9	8.8	7.3	8.8	7.5	5.7	8.7	6.0
Network Readiness Index	7.9	6.9	6.3	7.4	7.1	5.4	7.5	5.6
Data Centre Capacity	7.6	4.5	1.7	0.4	0.3	0.5	0.3	0.5
Industrial Capacity	**5.9**	**7.1**	**5.0**	**4.2**	**5.9**	**2.2**	**5.2**	**0.2**
Economic Complexity Index	7.0	6.9	5.8	8.0	10.0	3.6	9.4	0.0
Med-Hi-tech Manu. Value Added	4.9	7.3	4.1	0.4	1.8	0.8	1.0	0.4
Global Integration	**3.8**	**3.9**	**5.8**	**3.0**	**3.0**	**3.0**	**1.8**	**3.0**
Standards and Governance	**1.5**	**1.5**	**7.6**	**1.3**	**1.4**	**0.4**	**0.6**	**0.4**
ISO Secretariats at TC and SC levels	2.3	2.1	7.3	1.9	2.1	0.3	0.6	0.2
Permanent Members of IEC	0.8	0.8	7.8	0.7	0.8	0.6	0.7	0.6
Open Platforms and IP	**1.3**	**3.1**	**3.1**	**0.2**	**0.8**	**0.2**	**0.5**	**0.1**
PCT Applications	2.8	7.7	0.5	0.1	1.4	0.4	1.1	0.1
Open-Source Contributions	0.5	0.4	7.8	0.5	0.7	0.3	0.3	0.2
Digital Diplomacy Index	**8.6**	**7.1**	**6.7**	**7.2**	**6.7**	**8.2**	**4.2**	**8.4**

The results of the benchmarking points to a split global landscape:

- **The United States and China occupy a distinct system top tier** across nearly all dimensions, with a scale of technological capacity that is structurally different from all other countries assessed, albeit with very different relative strengths.
- **The European Union emerges as third, materially ahead of other advanced nation states** but lags not on the broad-based capability level of the two system leaders, other than in Global Integration where it leads due to its market size, and power in standards setting, governance, and regulatory domains.
- **The United Kingdom, Japan and South Korea function as technological middle powers,** home to competitive companies across selected domains and strong research bases, but lacking the scale, ecosystem breadth, and systemic influence required to compete with the U.S. and China across the set of power dimensions.
- **India presents a profile of latent potential rather than current power**, possessing large-scale human capital in the form of STEM graduates, strong performance in specific niches such as IT services exports, and pockets of excellence, but not yet a fully formed technological ecosystem capable of competing across domains.
- **Russia's rank at the bottom of the list reflects structural weaknesses** including limited commercialisation capacity, constrained access to global ecosystems, declining research competitiveness, and international isolation that increasingly restricts its ability to scale or project technological influence.

This indicates a global technology system that increasingly resembles a two-power structure with a middle player and a long tail of secondary and emerging players.

US-China Competing with Different Systems and Innovation Models

An important implication of the framework is that determining overall leadership between the United States and China difficult. This is not a weakness of the model, but a reflection of the deeper reality. The two countries are not simply competitors within the same system; they represent distinct innovation models shaped by different histories, institutions, and stages of development. This also explains why media narratives and analyst commentary frequently oscillate between declaring either the U.S. or China as "winning" the overall technology race:[53] Conclusions vary depending on whether emphasis is placed on frontier research, commercial success, diffusion, geopolitical influence, or global market share. The key dimensions of the comparison that are critical are:

1. **Early-Stage Innovation: China's Emerging Lead.** China now exhibits a small but meaningful lead in Foundational Innovation Capacity, driven by, high volumes of early-stage research output, a vast and rapidly expanding talent pool, and strong performance in scholarly output and scientific and technical publications, producing nearly twice the total volume of research publications as the US.[54] Notably, this has been achieved despite China still spending less on R&D in absolute terms than the United States, increasingly converting demographic and institutional scale into frontier scientific production.
2. **Innovation Ecosystem: China Building Momentum.** China's early-stage advantage is now increasingly extending into the Innovation Ecosystem dimension. High patent volumes,[I] dense clusters of activity, growing centres of excellence, and institutional alignment between research, industry, and state policy have allowed early-stage strength to begin compounding structurally, with e.g. its share of global patent

---

[I] Despite the reliability of patent filings as an indicator of innovation being questioned given different national strategic and defensive filing practices, they have been included (with a measured 16% weighting) as a standardised and internationally comparable signal of codified inventive activity and technological direction.

applications rose from about 34.6% in 2014 to roughly 49.1% in 2024, solidifying its position as the dominant source of new patent filings worldwide.[55]

3. **Commercialisation and Market Development**: **Clear U.S. Dominance.** Clear U.S. commercial leadership reflects the world's deepest venture capital ecosystem, strong startup formation and entrepreneurial attraction, the global dominance of its technology companies Besides being the most visible part of the technology value chain, the products, and platforms that shape everyday consumer and enterprise experience, it is also the dimension with the largest current macroeconomic impact, explaining why the U.S. continues to capture a disproportionate share of global technology value creation. U.S. tech companies today represent c.20% of global equity market value.[56]
4. **Technology Adoption and Scaling**: **China Demonstrating Material Scale.** China's original tech advantage has rested on adoption and scale. Its large, integrated industrial ecosystem, deep manufacturing base, and large domestic market enable rapid movement from prototype to mass deployment. These capabilities are a critical stepping stone toward leadership in strategic technology domains, particularly in hardware and manufacturing related technologies, as China has demonstrated in renewable energy: Chinese companies today produce roughly 80% of the world's solar panels, wind turbines, and energy storage batteries.[57]
5. **Global Integration: Competitive Parity with Different Strengths.** In Global Integration, the two powers are broadly neck-and-neck, though with different profiles. The United States retains an edge in digital diplomacy, institutional influence, and governance credibility within existing multilateral frameworks, shaping many of the rules of the current system. However, China is increasingly effective at building parallel ecosystems that attract adoption beyond its borders, integrating its technologies through infrastructure export and digital cooperation with initiatives like the US$79 billion China's Digital Silk Road project.[58] It is notable though that both trail significantly behind the EU in this area for the reasons laid out above.

The result of these dynamics is that despite China leading in research and development across most metrics, The U.S. and American companies capture the lion's share of early markets and value during the initial scaling of technologies due to their lead in 3. Commercialisation and Market Development capabilities. However, as technologies mature, the competitive advantage appears to shift back towards China, with its deep domestic market, unparalleled manufacturing scale, dense and adaptive supply chains, and proven ability to drive rapid cost reduction and mass adoption once technologies reach industrial maturity.

Wider Considerations Driving Technology Leadership

The short- vs. longer-term - shifts to China. Current global technology leadership, particularly in AI, which is in its mass scaling phase, appears to lie primarily with the United States. It dominates the commercialisation phase of technological development: companies, platforms, capital markets, and monetisation. All other things being equal, the longer-term trajectory of the system, however, appears increasingly tilted toward China, and not just because of its ability to scale mature technologies. Leadership in early-stage innovation, ecosystem density, and scaling capacity via speed of diffusion creates strong conditions for future market capture and technological influence.

Longer term advantage from scientific and research leadership favours China. All other things being equal, sustained advantages in these areas tend to compound over time into commercial and geopolitical power. Britain leveraged its sustained innovations in steam power and mechanization into a 32% share of global manufacturing capacity by 1870,[59] Germany's pioneering chemical-science ecosystem in the 19th century helped it capture about 90% of the international chemical market by 1914,[60] and the U.S., having invented the core technologies of the semiconductor industry led it global R&D spending, still sees U.S. companies control roughly half of global semiconductor sales more than seventy years later.[61] On current trends therefore, the trajectory of science and research in foundational technology points towards future leadership for China.

Geopolitical leadership plays an important role, and one which America has weakened, and China does not yet have. Critically however, leadership outcomes are shaped by far more than technological capability alone. They reflect the interaction of politics, economics, institutions, and social models, and the choices governments make across these domains. These factors require considerations of how the U.S. and China are currently pursuing their national interests vis-à-vis their allies and other states. The indications from recent international politics and interventions, particularly in Europe regarding U.S. territorial ambitions and globally in terms of tariffs levied on almost all nations, would suggest the current U.S. administration's more coercive approach to foreign affairs and economics is driving its allies including Canada and the U.K. towards China.

Implications for Middle Powers: Collaboration is Critical

Strategic technological alliances are critical to defending and progressing their positions. This reality has critical implications not only for the United States and China, but for the rest of the world as well. For most countries, particularly technological larger powers such as the EU and other middle powers unlikely at this state of competing head-to-head with either system leader across the full technology stack, the strategic challenge is not how to "win" the technology race, but how to position themselves within the twin-superpower global system. Strategic technology alliances and coordination scan reduce dependency on external ecosystems, preserve strategic autonomy, defend key control points, and shape outcomes in selected technology domains.

Europe and India have highly complementary skills that fill critical gaps in position. For most of the advanced industrialised world, this strategic positioning increasingly means forming partnerships with India**,** which while niche in absolute technological output compared with the United States and China today, possesses the demographic scale and future market potential to replicate aspects of the tech strategy that drove China's rise to (co-)leadership. The West has long viewed India as a security counterweight to China**,** particularly in the Indo-Pacific, and as a future hedge in trade and investment networks**.** The 2025 UK-India and the recently finalised India-EU free trade agreements reflect deepening economic ties, while initiatives like the India-U.K. 10-year Defence Industrial Roadmap are explicitly framed as both a security and an industrial partnership**.**[62] What is now increasingly required is the addition of structured technology partnerships, with the potential to fundamentally rebalance long-term global tech power

Figure 9: Potential Tech Power Blocs

Domain of Tech Competition	U.S.	China	India + Japan	EU + India	EU + U.K. + India
Foundational Innovation	**5.0**	**5.5**	**4.0**	**7.3**	**9.0**
Scientific Strength	**4.5**	**6.0**	**5.1**	**9.2**	**12.6**
Scholarly Output	4.4	6.7	**2.8**	8.9	10.4
Field Weighted Citation Impact	4.5	5.3	**7.5**	9.5	14.9
R&D Infrastructure (GERD)	**7.5**	**3.9**	**1.4**	**4.1**	**5.1**
Talent Pool	**3.1**	**6.7**	**5.3**	**8.4**	**9.2**
Researchers	4.6	7.3	**2.9**	6.9	7.7
STEM Graduates	1.5	6.1	**7.7**	9.9	10.7
Innovation Ecosystem	**4.7**	**6.4**	**2.0**	**3.3**	**4.0**
R&D Intensity (BERD)	**7.6**	**3.6**	**1.0**	**3.1**	**3.9**
Clusters and Hubs	**2.7**	**7.4**	**1.8**	**5.7**	**6.3**
Tech Exports	1.7	7.4	**1.1**	4.8	5.0
Scientific and Technical Journal Articles	3.8	7.4	**2.6**	6.7	7.6
Policy & IP	**3.7**	**8.4**	**3.2**	**1.3**	**1.7**
Patent Family Count	0.8	7.7	**0.9**	0.5	0.6
Tech Advanced Innovative Score	7.8	9.2	6.4	2.3	3.4
Commercial and Market Development	**5.7**	**3.5**	**0.9**	**3.4**	**4.2**
Entrepreneurial Activity	**6.3**	**1.5**	**0.9**	**3.8**	**5.8**
VC Investment	7.8	1.5	**0.7**	1.8	2.5
New LLCs	2.7	1.4	**1.3**	8.5	13.4
Corporate Leadership	**7.8**	**1.8**	**0.4**	**0.4**	**0.4**
Share in Top 100 firms Market Cap	7.8	0.9	**0.2**	0.3	0.3
Share in Top 100 firms Revenue	7.7	2.8	**0.6**	0.5	0.5
Market Share (Tech Trade)	**3.1**	**7.2**	**1.4**	**6.0**	**6.5**
Tech Adoption and Scaling	**6.3**	**7.1**	**4.2**	**4.5**	**5.2**
Digital Capacity	**6.8**	**7.0**	**3.7**	**4.3**	**4.8**
Fixed Broadband Users	1.6	7.8	**1.1**	2.6	3.0
Digital Competitiveness	9.9	8.8	6.6	6.5	7.3
Network Readiness Index	7.9	6.9	6.2	5.8	6.3
Data Centre Capacity	7.6	4.5	**0.8**	2.2	2.6
Industrial Capacity	**5.9**	**7.1**	**4.7**	**4.8**	**5.6**
Economic Complexity Index	7.0	6.9	6.8	4.7	5.8
Medium and High Tech Manufacturing Value Added	4.9	7.3	**2.6**	4.9	5.4
Global Integration	**3.8**	**3.9**	**3.5**	**6.3**	**6.8**
Standards and Governance	**1.5**	**1.5**	**1.9**	**8.0**	**9.3**
ISO Secretariats at TC and SC levels	2.3	2.1	**2.3**	7.6	9.5
Permanent Members of IEC	0.8	0.8	**1.4**	8.4	9.1
Open Platforms and IP	**1.3**	**3.1**	**1.0**	**3.4**	**3.6**
PCT Applications	2.8	7.7	**1.7**	0.8	0.9
Open Source Contributions	0.5	0.4	**1.0**	8.1	8.6
Digital Diplomacy Index	**8.6**	**7.1**	7.4	7.4	7.4

The numbers paint a clear picture for a potential third systemic technology axis to form around a ‘Europe-India Strategic Alliance’:

1. **A Europe-India Strategic Alliance comprising the EU, the U.K., and India would lead in foundational innovation and global integration**. In foundational innovation, it would lead the U.S. in both scientific strength and the size of the talent pool, while still trailing in R&D infrastructure. In global integration, its strong leads in standards and governance and open platforms would more than overcome America’s continued (perhaps now historic) slight lead in digital diplomacy.
2. **A Europe-India Strategic Alliance would not lead in innovation ecosystems, commercial and market development, or tech adoption and scaling.** Specifically, in market development it would continue to trail the U.S. in entrepreneurial activity and corporate leadership, despite capturing a larger share of the global tech market overall. In innovation ecosystems, the alliance would lead the world in terms of clusters and hubs but still trail the U.S. and China overall, and while its tech adoption capability would continue to lag both America and China’s in terms of digital and industrial capacity.

Several strategic collaborations can close the gap and position the rest of the world as tier one players:

- **Partnerships with India meaningfully rebalance the innovation.** The EU and India and EU, U.K. and India combinations outperform both the U.S. and China on foundational innovation and global integration, exceed the U.S. on innovation ecosystem and technological adaptation and scaling and also surpass China in commercialisation and market development. This suggests that coordinated blocs could rival or exceed the leading individual systems by working together. However, India and Japan do not close that gap, leaving Japan to join one of the others if it is to be a meaningful player.
- **The EU and U.K. bring critical strengths to India that it cannot easily bridge alone.** India remains at the early stages of building tech power, and it not yet managed to scale its innovation ecosystem and tech commercialisation capabilities, to the level seen in more mature technology powers such as the EU and U.K., particularly in areas like advanced research translation and globally integrated industrial platforms.
- **India’s contribution is primarily a force multiplier for talent and scale.** Across the combined groupings, the largest gains appear in talent pool, STEM graduates, and adoption-related indicators, indicating that India’s human capital is potentially highly impactful when integrated with more mature research and institutional systems.
- **Commercial and market constraints remain.** Even the strongest coalition continues to meaningfully underperform the U.S. on venture capital, corporate leadership, and presence of globally dominant companies, indicating that partnerships can rebalance capability but are insufficient on their own to rebalance platform-level economic power in the absence of innovation that attracts capital at scale.
- **Coalitions further strengthen influence in system-level domains that shape long-term power.** The combined blocs perform strongly in areas such as standards, global integration, industrial capacity, and technology trade, implying that cooperation could shift global technology leadership toward a more balanced, multipolar structure.

Early positive signs between Europe and India. There are early indicators of such bi- and multi-lateral partnerships being put into practise. The EU and India for example are cooperating on developing a globally interoperable standard for 5G, on cybersecurity and on the promotion of technical and regulatory work on the development of technologies like AI and Blockchain.[63] The U.K. and India in 2024 launched the Technology Security Initiative to promote collaboration across semiconductors, AI, quantum, and advanced materials.[64] And Japan and India have recently entered into the ‘India-Japan Digital Partnership 2.0**’** to collaborate in in sectors including semiconductors, AI, digital public infrastructure, and R&D.[65]

There is far to go to make a Europe-India relationship strategic and functional. Of course, while such initiatives signal intent and strategic direction, they remain a long way from a dense, self-reinforcing technology ecosystem that would allow coalitions of middle powers to compete structurally with either the United States or China. Achieving this would require moving beyond marginal cooperation toward sustained joint investment in R&D and infrastructure, partial alignment of industrial policy, interoperable standards, coordinated supply-chains and joint export control policies, a profound political and strategic undertaking on par with the introduction of the Euro. An important component is the U.K. and E.U. agreeing that their strategic alliance is a necessity and putting the post-Brexit friction aside.

In terms of the geopolitics of technology, and sovereignty, a third axis has strategic relevance to the rest of the world too. The would then have a three-option game to decide between: falling in line with an assertive and America First approach (at least for now), a China First approach (which has been a constant), or a slower but more rules-based approach with Europe and India (one a long standing promoter of rules and standards, and the other a bureaucracy in transition).

Strategic Positioning for the Six Systemic Technologies

Technological competition in practice does not occur at the level of abstract “overall leadership,” but plays out across specific technologies, sectors, and applications. It is within these domains that governments target policy, where companies invest capital, where supply chains are built, and where partnerships take shape. This is true not only for the system leaders, the U.S. and China, but also for the potential coalitions of middle powers seeking to strengthen their collective position.

As explored earlier, not all technologies carry equal systemic weight. The 19 core technologies identified in this report are not equivalent in their strategic importance, nor in the extent to which leadership within them translates into durable geopolitical power. A small subset, notably artificial intelligence, quantum technologies, gene editing, fusion, nanotechnology and extended reality, function as true systemic technologies, with the potential to reshape the underlying structure of economic and strategic power itself.

> *Artificial intelligence, quantum technologies, gene editing, fusion, nanotechnology and extended reality, function as true systemic technologies, with the potential to reshape the underlying structure of economic and strategic power itself*

The tables below outline the country-by-country performance across these key Systemic Technologies, identifying where countries are positioned. These technologies are benchmarked against a subset of the dimensions of overall tech competition, focusing on (i) Foundational Innovation, (ii) Innovation Ecosystem, and (iii) Commercialisation and Market Development. Factors including Tech Adoption and Scaling and Global Integration are excluded given the analysis’ focus on who is leading the upstream intellectual, scientific, and commercial engines of these technologies, rather than on who has system-level technological power across the whole economy. However, it is important to note that two of the six technologies, quantum and fusion, remain at the scientific validation stage, and three technologies, Extended Reality, nanotech and gene-editing are still in the very early days of commercialisation, with only AI currently scaling rapidly. For these earlier stage technologies, the current level commercialisation. For these earlier-stage technologies, the current level of commercialisation is a less meaningful indicator of long-term competitive position, as it reflects patterns of entrepreneurial activity and venture funding more than realised commercial potential; in this context, the U.S. will almost inevitably lead given a technology model optimised for rapid experimentation, capital deployment, and speed to market rather than near-term industrial scale.

The analysis below therefore provides a snapshot of how a countries assets and capabilities in each technology are currently distributed, rather than serving as a prediction of who will ultimately lead in each technology.

Figure 10: Countries Benchmarked by Systemic Technologies

Across the six systemic technologies, a clear pattern emerges because of countries' different technology strategies:

- **AI.** The U.S. leads decisively across foundational innovation, ecosystem depth, and commercialisation, with the largest margin in market development. China and the EU demonstrate meaningful scientific capability, but much weaker ecosystem and commercial translation, underscoring how far ahead the U.S. is in converting capability into platforms and markets in a technology that is currently scaling rapidly.
- **Quantum.** Leadership is more distributed across the three dimensions. The U.S. retains an edge in foundational innovation, the EU leads on ecosystem and commercialisation indicators, and China remains scientifically competitive but weaker in market formation. Quantum is the only Systemic Technologies where leadership is not clearly concentrated in one country.
- **Gene editing and nanotechnology.** China and the EU (respectively) match or exceed the U.S. in foundational research, but the U.S. dominates overwhelmingly in ecosystem formation and commercial presence. The gap in creating clusters, companies, and markets is particularly stark here, yet given how early both technologies remain in the commercialisation cycle, this advantage reflects early ecosystem formation rather than a settled long-term leadership position, with a substantial share of value creation

still dependent on future scaling and diffusion, with China enjoying significant scale in bio manufacturing and bio foundry infrastructure.

- **Fusion and Extended Reality.** The EU and China show credible scientific strength, with the EU leading in extended reality foundational innovation, yet the U.S. is again far ahead in ecosystem density and commercial development, reinforcing the pattern seen across the other technologies.

A more detailed analysis of national capabilities across the six technologies is included below.

Artificial Intelligence

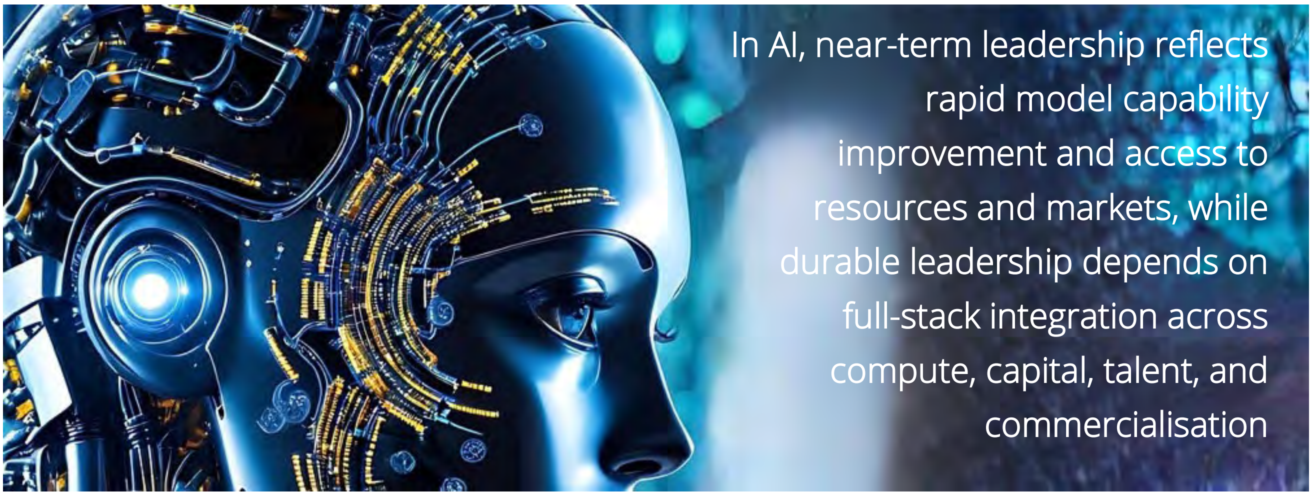

In AI, near-term leadership reflects rapid model capability improvement and access to resources and markets, while durable leadership depends on full-stack integration across compute, capital, talent, and commercialisation

Figure 11: AI Benchmarking by Country (Unweighted)

AI	U.S.	China	EU	U.K.	Japan	India	South Korea	Russia
Foundational Innovation	**5.7**	**3.6**	**4.1**	**2.0**	**1.4**	**1.8**	**1.7**	**0.6**
Scientific Strength	**3.8**	**5.7**	**4.1**	**3.6**	**1.5**	**3.5**	**3.0**	**1.0**
Scholarly Output	2.7	7.2	3.9	0.9	0.7	3.8	0.5	0.3
Field Weighted Citation Impact	4.9	4.1	4.4	6.3	2.4	3.1	5.5	1.7
R&D Infrastructure	**7.6**	**1.5**	**4.1**	**0.3**	**1.3**	**0.1**	**0.4**	**0.2**
Supercomputers	7.4	2.7	5.2	0.6	1.5	0.3	0.6	0.3
Compute Capacity	7.8	0.4	3.0	0.1	1.1	0.0	0.3	0.1
Innovation Ecosystem	**6.4**	**2.3**	**3.3**	**0.9**	**0.5**	**2.7**	**0.4**	**0.3**
R&D Intensity	**7.7**	**0.7**	**2.5**	**0.8**	**0.3**	**0.3**	**0.1**	**0.2**
VC Investment	7.8	0.6	0.7	0.8	0.1	0.1	0.1	0.0
Number of Data Centres	7.6	0.7	4.4	0.9	0.4	0.5	0.2	0.3
Clusters and Hubs	**5.0**	**3.9**	**4.0**	**1.0**	**0.7**	**5.0**	**0.6**	**0.4**
AI Github Projects	7.3	0.6	4.0	1.1	0.7	6.2	0.8	0.5
Scientific and Technical Journal Articles	2.7	7.2	3.9	0.9	0.7	3.8	0.5	0.3
Commercialisation and Market Development	**7.8**	**1.5**	**1.1**	**0.6**	**0.1**	**0.2**	**0.2**	**0.0**
Entrepreneurial Activity (VC Investment)	**7.8**	**0.6**	**0.7**	**0.8**	**0.1**	**0.1**	**0.1**	**0.0**
Market Share (High Tech Exports)	**7.7**	**2.5**	**1.4**	**0.5**	**0.2**	**0.3**	**0.3**	**0.0**
Notable AI Models	7.6	4.2	0.8	0.2	0.0	0.0	0.2	0.0
Newly Funded AI Companies	7.8	0.7	2.0	0.8	0.3	0.5	0.4	0.0

In AI, near-term leadership reflects rapid model capability improvement and access to resources and markets, while durable leadership depends on full-stack integration across compute, capital, talent, and commercialisation.

- **The U.S. is a full-spectrum AI superpower across infrastructure, ecosystem, and commercialisation.** It leads decisively in compute capacity, supercomputers, VC investment, data centres, notable models, and newly funded companies, showing overwhelming strength in translating capability into market power.
- **China dominates research output, apparent parity on models, appears to underperform on infrastructure and commercials.** It leads on scholarly output and scientific strength, while weaker scores on VC, new companies, and open ecosystem indicators, which may not reflect its huge domestic market well.
- **The EU is consistently mid-strong but lacks leadership in key areas.** It performs solidly across most dimensions (science, infrastructure, ecosystem), but weak commercialisation and low presence in notable models suggest structural difficulty in turning capability into globally dominant companies.
- **The U.K. and India both show strengths while lagging in ecosystem and commercial scale. T**he U.K. excels in research quality but lacks the infrastructure and capital dept, while India demonstrates strong human capital but limited compute, funding, and institutional strength.

The AI results further illustrate the different strategies adopted by China and the U.S. to tech power and innovation. The U.S. industry model is optimised for speed, openness, capital formation, and market dominance, with overwhelming strength in infrastructure, platforms, and commercial outcomes. China's model, by contrast, emphasises scientific depth, national coordination, and strategic sovereignty, which means its real capabilities are only partially captured by commercial indicators. Recent developments in large language models illustrate this divergence: While U.S. continues to dominate the frontier scaling race with 12x the private investment as China overall,[66] including US$320 billion of capital expenditure in 2025 by just four companies,[67] Chinese models such as Deep Seek have achieved near-par performance while operating under U.S. chip export restrictions, forcing a focus on architectural efficiency and "doing more with less" rather than brute-force scaling.

It is important to note that energy availability is emerging as a critical bottleneck for advanced AI deployment. U.S. data centres already consume roughly 3% of national electricity demand, a figure projected to rise to up 14% by 2030 and potentially 28% by 2040, driven primarily by AI workloads.[68]

Meeting projected AI-related demand in the U.S. would require between 400 and 1,000 TWh of additional generation capacity, an expansion far beyond current grid planning assumptions and investment levels.[69] China, by contrast, is expanding power generation capacity at roughly three times the U.S. annual rate,[70] integrating energy planning directly with industrial and digital strategy. Without comparable energy-technology integration, U.S. technological leadership risks being constrained not by innovation, but by infrastructure.

Quantum

In quantum technologies, leadership depends on sustained advances in underlying physics and systems engineering, supported by long-horizon institutional backing, rather than rapid commercial scaling

Figure 12: Quantum Benchmarking by Country (Unweighted)

Quantum	**U.S.**	**China**	**EU**	**U.K.**	**Japan**	**India**	**South Korea**	**Russia**
Foundational Innovation	**7.2**	**3.6**	**5.0**	**1.0**	**1.0**	**0.9**	**0.4**	**0.5**
Scientific Strength (Quantum Research)	**6.6**	**6.9**	**6.6**	**1.2**	**1.2**	**1.5**	**0.6**	**0.9**
R&D Infrastructure	**7.7**	**0.4**	**3.4**	**0.7**	**0.9**	**0.2**	**0.2**	**0.1**
Compute Capacity	7.8	0.4	3.0	0.1	1.1	0.0	0.3	0.1
Universities with Quantum Research Groups	7.7	0.4	3.8	1.3	0.7	0.4	0.1	0.2
Innovation Ecosystem	**5.2**	**3.7**	**5.4**	**2.4**	**2.1**	**1.3**	**0.5**	**0.4**
R&D Intensity (Investment in Quantum Initiatives)	**3.4**	**6.7**	**5.1**	**2.4**	**3.5**	**0.3**	**0.9**	**0.8**
Clusters and Hubs (No. of Companies)	**7.0**	**0.6**	**5.8**	**2.4**	**0.7**	**2.4**	**0.0**	**0.0**
Commercialisation and Market Development	**5.2**	**3.7**	**5.4**	**2.4**	**2.1**	**1.3**	**0.5**	**0.4**
Entrepreneurial Activity (Investment in Quantum Initiatives)	**3.4**	**6.7**	**5.1**	**2.4**	**3.5**	**0.3**	**0.9**	**0.8**
Market Share (No. of Companies)	**7.0**	**0.6**	**5.8**	**2.4**	**0.7**	**2.4**	**0.0**	**0.0**

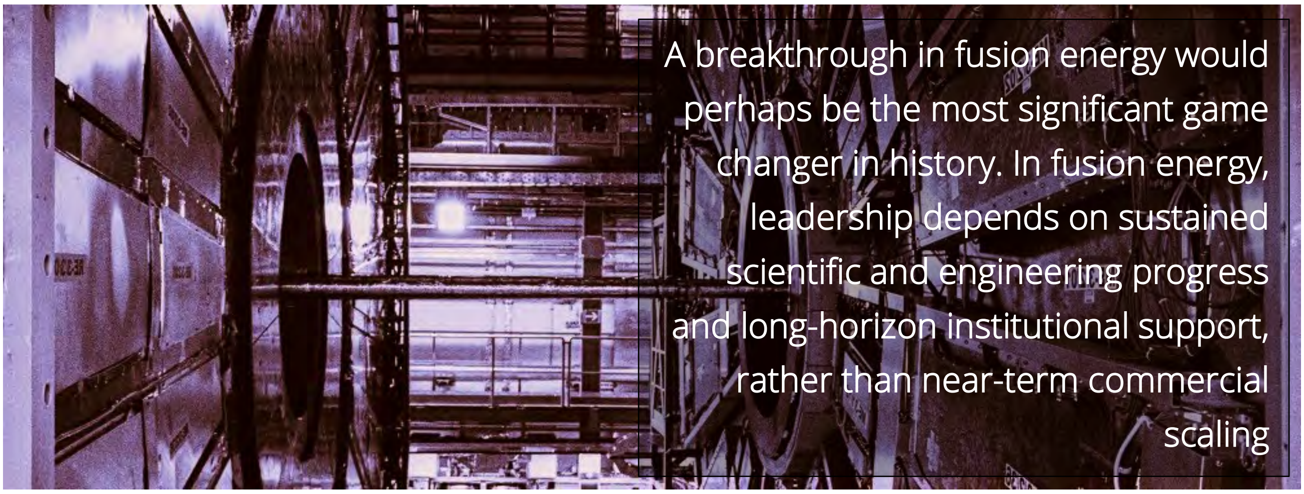
In quantum technologies, leadership depends on sustained advances in underlying physics and systems engineering, supported by long-horizon institutional backing, rather than rapid commercial scaling.

- **The U.S. is the only country with dominant strength across science, infrastructure.** It leads in foundational innovation, R&D infrastructure, compute, universities, clusters. It has also built private sector interest, whose value is unclear at this stage.
- **China has world-class scientific strength, innovation ecosystem and funding intensity.** It matches or exceeds the U.S. on scientific strength and R&D intensity; without clusters of companies.
- **The EU is a balanced challenger but lacks U.S.-level concentration of scale.** It performs consistently well across foundational innovation, ecosystem, and commercialisation, but does not dominate any category, implying breadth without decisive platform leadership.

- **U.K. and Japan are credible scientific contributors but structurally mid-tier.** Their reasonable science scores are not matched by ecosystem depth or market presence, indicating strong academic bases but insufficient industrial scaling and cluster density.
- **India, Russia, and South Korea remain peripheral in quantum.** Their low scores across infrastructure, ecosystem, and market metrics suggest participation at the margins rather than competition for platform-level leadership.

Quantum leadership is being shaped not just by raw scientific capability but by institutional models of risk, patience, and coordination. The U.S. venture capitalist system rewards speed, and ecosystem capture, leading to its dominance in market formation, but also exposes it to a key vulnerability by prioritising expansion before stability is fully mastered. Quantum systems are extraordinarily sensitive to their surroundings. Stray heat, electromagnetic interference, vibration, or tiny imperfections in materials can disrupt the delicate states on which quantum computation depends. This loss of stability, known as decoherence, is the central engineering challenge in the field.[71] The U.S. approach often assumes that breakthroughs in error correction will catch up with the pace of deployment. China's profile reflects the opposite trade-off: it backs strong science and funding with limited ecosystem emergence, tolerates delay in exchange for stability. The EU occupies a third position: scientifically strong and coherence-focused but constrained by fragmentation and slow coordination. The emerging implication is that quantum is unlikely to produce a single winner. instead, leadership will fragment by use case and architecture, with coherence discipline, not ecosystem size alone, determining who ultimately wins what.

Fusion



A breakthrough in fusion energy would perhaps be the most significant game changer in history. In fusion energy, leadership depends on sustained scientific and engineering progress and long-horizon institutional support, rather than near-term commercial scaling

Figure 13: Fusion Benchmarking by Country (Unweighted)

Fusion	U.S.	China	EU	U.K.	Japan	India	South Korea	Russia
Foundational Innovation	**5.8**	**4.2**	**4.0**	**1.2**	**2.3**	**0.7**	**0.8**	**1.5**
Scientific Strength (First Authorship FEC Papers)	**3.9**	**7.2**	**4.9**	**1.3**	**3.2**	**1.0**	**1.3**	**1.7**
R&D Infrastructure (Under Construction + Planned Fusion Devices)	**7.6**	**1.1**	**3.1**	**1.1**	**1.3**	**0.4**	**0.2**	**1.3**
Innovation Ecosystem	**7.2**	**3.1**	**2.3**	**1.0**	**2.0**	**0.4**	**0.1**	**1.1**
R&D Intensity (Fusion Funding)	**7.5**	**4.8**	**0.8**	**0.5**	**0.3**	**0.0**	**0.0**	**0.0**
Clusters and Hubs	**6.8**	**1.3**	**3.7**	**1.5**	**3.7**	**0.8**	**0.3**	**2.3**
Operating Fusion Devices	6.0	2.3	4.0	0.9	6.3	0.6	0.6	4.6
Number of Fusion Companies	7.6	0.3	3.4	2.1	1.0	1.0	0.0	0.0
Commercialisation and Market Development	**7.5**	**2.6**	**2.1**	**1.3**	**0.6**	**0.5**	**0.0**	**0.0**
Entrepreneurial Activity (Fusion Funding)	**7.5**	**4.8**	**0.8**	**0.5**	**0.3**	**0.0**	**0.0**	**0.0**
Market Share (Number of Fusion Companies)	**7.6**	**0.3**	**3.4**	**2.1**	**1.0**	**1.0**	**0.0**	**0.0**

A breakthrough in fusion energy would perhaps be the most significant game changer in history. In fusion energy, leadership depends on sustained scientific and engineering progress and long-horizon institutional support, rather than near-term commercial scaling.

- **China leads globally in fusion scientific output, deprioritising commercial development activity.** Its scientific strength, driven by large, state-funded research programmes, illustrated by its share of nearly 30% of all paper submitted to the 30th IAEA Fusion Energy Conference,[72] contrasts with a much smaller infrastructure of reactors and companies, suggesting strength in scientific academic leadership, reflecting a model oriented toward state deployment rather than venture-led innovation.

- **The U.S. has the current leading emerging ecosystem in fusion.** It has advantages in R&D infrastructure and funding intensity; its early volume in clusters of private sector venture-backed fusion companies is indeterminant in future success for such a strategic sector.
- **The EU exhibits balanced mid-tier capability but limited scaling momentum.** Solid scores across foundational innovation, science, infrastructure, and operating devices indicate breadth, yet lower funding intensity, limiting its potential to be a leading player.
- **Japan punches above its weight in operational fusion capability.** It leads globally in the number of operating fusion devices,[73] despite relatively modest ecosystem scores, indicating a technically strong with commercially conservative approach.
- **Most other countries remain peripheral to the commercial fusion race.** The UK, India, Russia, and South Korea show isolated strengths but low scores in funding and ecosystem density, indicating participation currently concentrated in research, where innovations may create future positions.

Ultimate leadership in fusion will depend on a breakthrough in the science. Of value is the ability to construct an integrated system that supports that effort with funding, infrastructure, talent, and technological ecosystem. While the U.S. stands out as the only country building a full-stack fusion ecosystem, with dense clusters, strong capital mobilisation, and a growing population of private companies translating research into commercial pathways, China’s science and ability to scale through its more government led model, places it as a strong player much as it is in AI. Emphasizing the value of market-development may not be the right approach to evaluating an early-stage technology like fusion, particularly given the breakthroughs required in the science. Other countries are slower to generate a broad commercial ecosystem despite strong technical and institutional capabilities. The overall picture points to a competition around turning frontier science into scalable industrial platforms.

Gene Editing

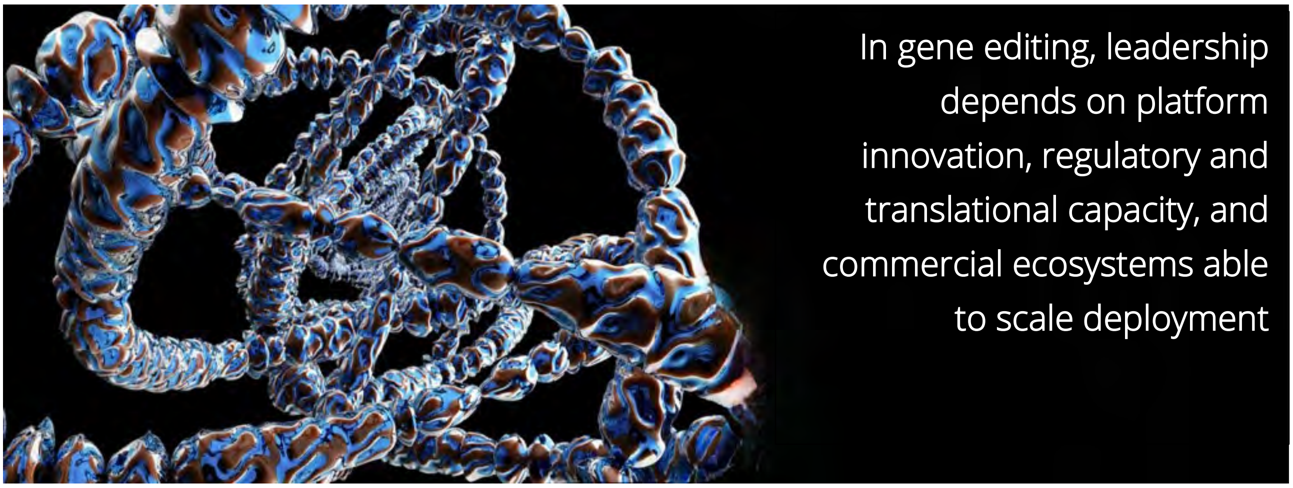

In gene editing, leadership depends on platform innovation, regulatory and translational capacity, and commercial ecosystems able to scale deployment

Figure 14: Gene Editing Benchmarking by Country (Unweighted)

Gene Editing	U.S.	China	EU	U.K.	Japan	India	South Korea	Russia
Foundational Innovation	4.8	4.9	3.8	1.9	1.0	1.3	0.5	0.7
Scientific Strength (CRISPR Priority Filings)	5.3	7.5	0.4	0.2	0.2	0.1	0.5	0.1
R&D Infrastructure (BSL 4 Labs)	4.3	2.4	7.3	3.6	1.8	2.4	0.6	1.2
Innovation Ecosystem	7.8	1.4	0.9	0.3	0.0	0.0	0.1	0.0
R&D Intensity (Gene Editing Funding)	7.9	1.6	0.2	0.0	0.0	0.0	0.0	0.0
Clusters and Hubs (No. of Companies)	7.8	1.1	1.7	0.6	0.1	0.1	0.1	0.0
Commercialisation and Market Development	7.8	1.4	0.9	0.3	0.0	0.0	0.1	0.0
Entrepreneurial Activity (Gene Editing Funding)	7.9	1.6	0.2	0.0	0.0	0.0	0.0	0.0
Market Share (No. of Companies)	7.8	1.1	1.7	0.6	0.1	0.1	0.1	0.0

In gene editing, leadership depends on platform innovation, regulatory and translational capacity, and commercial ecosystems able to scale deployment.

- **The U.S. is the dominant system leader in gene editing.** It leads overwhelmingly in funding intensity, clusters, company formation, and market share, indicating the only country with a dense, scalable pipeline from science to venture creation to commercial presence.
- **China is the scientific leader but structurally weak in ecosystem and market formation.** It tops scientific strength (CRISPR priority filings) and slightly exceeds the U.S. in foundational innovation, yet scores far lower on funding intensity, clusters, and company counts, highlighting a gap between research leadership and commercial system-building.
- **The E.U.'s strong formal biosafety and institutional infrastructure are not translating into innovation yet.** Its leadership in BSL-4 lab capacity suggests strong regulatory and research foundations, yet weak ecosystem and commercial scores indicate difficulty converting infrastructure into globally competitive companies.

- **The U.K. has foundational capability, but not ecosystem depth.** Reasonable scores in foundational innovation and infrastructure contrast with very low funding and company formation, suggesting strong academic participation without sustained industrial mobilisation.
- **Other countries remain marginal in gene-editing.** India, Japan, Russia, and South Korea show isolated infrastructure or research capacity but negligible ecosystem or commercial activity, indicating participation in science rather than leadership in platform formation.

The analysis results point to a familiar structural pattern across systemic frontier technologies: leadership requires ecosystems capable of mobilising capital, companies, and regulatory pathways at scale. In gene editing, the U.S. currently exhibits the most integrated end-to-end ecosystem, spanning foundational research, venture formation, clinical translation, regulatory approval, and commercialization. Other countries, including the United Kingdom and China, possess world-class scientific capabilities, but have not yet matched the breadth, depth, and capital intensity of the U.S. translational and commercial infrastructure. Similarly to fusion though, ultimate leadership will not stem from the current industry market share in an industry, which, while growing rapidly, is still only projected to reach around US$40 billion globally over the next decade,[74] but from the scale of its downstream externalities. Advances in gene editing have the potential to materially improve population health, extend healthy life expectancy, reduce lifetime disease burden, and raise long-term productivity. A single additional year of life expectancy can be worth up to US$1 trillion per year to the U.S. economy alone,[75] implying that even modest biomedical breakthroughs can generate social and economic value orders of magnitude larger than the revenues captured by the companies developing them.

Nanotechnology

In nanotechnology, leadership depends on materials and fabrication capability and on industrial and commercial ecosystems able to integrate nanoscale advances into scalable products

Figure 15: Nanotechnology Benchmarking by Country (Unweighted)

Nanotechnology	U.S.	China	EU	U.K.	Japan	India	South Korea	Russia
Foundational Innovation	4.7	4.1	4.7	1.0	0.7	1.0	0.7	0.4
Scientific Strength (Nanotech Patents)	3.0	7.7	2.1	0.7	1.1	1.7	1.1	0.6
R&D Infrastructure (Top Ranked Nanotech Universities)	6.4	0.6	7.3	1.2	0.3	0.4	0.3	0.2
Innovation Ecosystem	7.7	0.8	1.9	1.2	0.2	0.6	0.2	0.1
R&D Intensity (Funding)	7.8	0.7	0.9	1.0	0.1	0.0	0.0	0.0
Clusters and Hubs (No. of Companies)	7.7	0.8	2.9	1.4	0.2	1.1	0.5	0.2
Commercialisation and Market Development	7.7	0.8	1.9	1.2	0.2	0.6	0.2	0.1
Entrepreneurial Activity (Funding)	7.8	0.7	0.9	1.0	0.1	0.0	0.0	0.0
Market Share (No. of Companies)	7.7	0.8	2.9	1.4	0.2	1.1	0.5	0.2

In nanotechnology, leadership depends on materials and fabrication capability and on industrial and commercial ecosystems able to integrate nanoscale advances into scalable products.

- **The U.S. has currently the leading position in nanotechnology.** It dominates funding intensity, clusters, entrepreneurial activity, and company market share, making it the most advanced country in translating nanoscience into a large-scale commercial innovation system.
- **The E.U.'s foundational capability matches the U.S.'s, but lags in ecosystem scaling.** It ranks highest in top-ranked nanotech universities and performs well in foundational innovation, but weaker ecosystem and commercialisation scores highlight ongoing challenges in scaling companies and capital around these strengths.
- **China leads globally in nanotechnology patenting and scientific output, with weaker commercial scaling and ecosystem depth.** It's very high scientific strength score contrasts with lower funding intensity, fewer clusters, and limited company market share, indicating focus on upstream research rather than downstream industrialisation.

- **The U.K. occupies a narrow but credible niche in foundational and early ecosystem activity.** Its moderate performance on clusters and foundational innovation is not matched by funding intensity or market share, indicating participation in science rather than leadership in platform building.
- **All other countries remain marginal in nanotechnology.** India, Japan, Russia, and South Korea show limited activity across funding, companies, and commercial presence.

Nanotechnology illustrates well why leadership in Systemic Technologies depends on a strong ecosystem and not just research strength, but on the capacity to translate knowledge into scalable production, platforms, and downstream value capture. Unlike discrete technologies, nanotech creates value only when it is absorbed into other sectors, like manufacturing, semiconductor fabrication, pharmaceuticals, advanced materials, or energy systems. Nano-enabled products could contribute US$3-6 trillion annually to global economic output by the end of the decade[76]**.** At present, the U.S. remains the only system exhibiting a continuously operating, market-driven nanotechnology ecosystem spanning science, venture formation, and commercial deployment, while China retains the capacity to scale rapidly through state mobilisation should nanotechnology be elevated to strategic priority, suggesting that leadership is contingent rather than fixed.

Extended Reality

In extended reality, leadership depends on platform adoption, content and developer ecosystems, and commercially viable use cases

Figure 16: Extended Reality (AR/VR) Benchmarking by Country (Unweighted)

Extended Reality	U.S.	China	EU	U.K.	Japan	India	South Korea	Russia
Foundational Innovation	6.3	4.2	6.7	0.4	1.1	0.5	2.1	0.0
Scientific Strength (XR Patents)	5.7	4.4	7.0	0.2	1.0	0.7	2.1	0.0
R&D Infrastructure (XR R&D Centres)	6.9	3.9	6.3	0.6	1.2	0.4	2.1	0.0
Innovation Ecosystem	7.6	0.7	2.4	1.2	0.2	1.2	0.2	0.2
R&D Intensity (Funding)	7.8	0.4	0.4	0.5	0.1	0.1	0.1	0.0
Clusters and Hubs (No. of Companies)	7.4	1.1	4.4	1.8	0.3	2.2	0.3	0.5
Commercialisation and Market Development	7.6	0.7	2.4	1.2	0.2	1.2	0.2	0.2
Entrepreneurial Activity (Funding)	7.8	0.4	0.4	0.5	0.1	0.1	0.1	0.0
Market Share (No. of Companies)	7.4	1.1	4.4	1.8	0.3	2.2	0.3	0.5

In extended reality, leadership depends on platform adoption, content and developer ecosystems, and commercially viable use cases.

- **The U.S. is dominant in extended reality.** It leads decisively in funding intensity, company clusters, entrepreneurial activity, and market presence, indicating the only country with a mature pipeline from R&D into scalable consumer and enterprise platforms.
- **The EU is a scientific and foundational (co-)leader but structurally weaker in commercial translation.** It matches or exceeds the U.S. on foundational innovation and Extended Reality patents, yet its ecosystem and commercialisation scores lag, implying strong technical capabilities without comparable platform or market dominance.
- **China lags the EU, with similar strengths and weaknesses.** Solid scores on foundational innovation, patents, and infrastructure contrast sharply with weak funding, clusters, and company presence, implying that activity may be occurring within large incumbents rather than a broad, venture-driven ecosystem.

- **India's profile indicates emerging (early stage) participation.** Moderate scores on clusters and ecosystem indicators point to growing developer and company activity, but low funding and commercialisation indicate limited ability to scale globally competitive Extended Reality companies.
- **All other countries remain peripheral in extended reality system-building.** The U.K., Japan, South Korea, and Russia show pockets of foundational or infrastructure activity, but negligible ecosystem density and commercial outcomes, reinforcing how concentrated Extended Reality platform power remains.

The global extended reality market (including AR/VR) is already sizeable and growing, estimated at roughly US$60-70 billion in 2024 and projected to expand toward US$300-450 billion by the early 2030s.[77] Over the longer term, the technology is widely expected to enable persistent virtual environments for work, education, simulation, commerce, and social interaction, effectively creating a new interface layer for the digital economy. This makes extended reality fundamentally a platform game, where economic and strategic value accrues primarily to those who control operating systems, hardware platforms, app stores, identity layers, and distribution channels rather than to those generating patents or prototypes. In this context, U.S. companies such as Meta, Apple, Microsoft, and Nvidia are investing tens of billions of dollars into building end-to-end Extended Reality platforms, positioning themselves as potential gatekeepers of the next major interface layer of the internet.[78]

Conclusion

Leadership in the most critical technologies of the Information Age is a critical prize that will accrue to countries that can build strength across the full set of technological power dimensions, spanning foundational research, innovation ecosystems, commercialisation capacity, adoption and scaling, and global integration, rather than to those that excel in any single dimension in isolation. The six systemic technology benchmarks reveal a consistent structural pattern in this regard. Across AI, quantum, fusion, gene editing, nanotechnology, and extended reality, the U.S. tech model positions to best translate frontier capability into early-stage commercial activity, while other major powers tend to specialise more narrowly across the development cycle.

Full spectrum capability is not a good measure of leadership. If foundational innovation, innovation ecosystems, and commercial and market development were equally important, at all times and across all technologies, the United States would emerge as the clear leader across all six Systemic Technologies. However, such a weighting implicitly assumes that early commercialisation carries the same significance at all stages of technological maturity. In practice, the relevance of private-sector density, startup formation, and venture capital activity depends critically on how close a technology is to large-scale deployment. Nor do standard leadership metrics adequately capture structural weaknesses in diffusion. The U.S. model remains heavily oriented toward frontier discovery and venture creation - an institutional configuration shaped by the experience of the last industrial revolution from which future technologies may well diverge from.

Stage of science determines the weighting of importance. For less mature, pre-rollout technologies, such as quantum, fusion, nanotechnology, and gene editing, early commercial signals are a weak proxy for long-term leadership. At this stage, observed commercial activity reflects entrepreneurial experimentation and capital availability more than realised deployment potential. While the U.S. model is structurally well suited to capturing first-mover advantage as technologies reach initial market readiness, these are systemic technologies whose ultimate economic impact will be realised at a scale that is orders of magnitude larger than today’s startup ecosystems. As a result, the current configuration of early commercial infrastructure is a poor indicator of where durable leadership will ultimately reside.

As technologies mature, the balance of advantage shifts to scale, where the U.S. has demonstrated first mover advantages. Leadership becomes increasingly determined by the capacity to scale deployment, reduce costs, embed technologies across the economy, and project them globally. In this phase, strengths in adoption, industrial depth, and integration matter more than early market entry. This dynamic suggests that while the U.S. is likely to lead in early commercialisation across many Systemic Technologies, long-term technological leadership will be shaped by which countries are best positioned to drive mass diffusion once these technologies move beyond initial rollout.

While the U.S. values early commercial presence, China’s second-mover advantage has counted. China’s more state-coordinated model, however, has repeatedly demonstrated an ability to scale rapidly as a second mover. This pattern is visible in cleantech, batteries, and advanced manufacturing, where China leveraged low costs, industrial depth, and integrated supply chains to capture global market share.

China’s history of scaling and global integration has established its leadership before. Crucially, China enjoys parity with or an advantage over the U.S. in two broader dimensions of technological power: technology adoption and scaling, and global integration. China has repeatedly leveraged both. In electric vehicles, massive domestic adoption created industrial scale, supplier depth, and cost leadership that translated into global exports, with Chines manufacturers accounting for more than 70 % of global electric vehicle production in 2024.79 In digital technologies, China has demonstrated how participation in international standards bodies can be used to secure industry leadership, most visibly in 5G telecommunications, where companies such as Huawei combined standards influence with large-scale global infrastructure deployment, which alone commands roughly 31% of the global telecom equipment market by revenue.[80]

The ability of corporations to turn national advantages into market ones is a critical success factor. This country-level picture has a direct corporate counterpart. The ability to convert research strength, ecosystem depth, and scaling capacity into durable technological power ultimately depends on companies that operate at the critical layers of the technology stack. It is companies, not abstract national capabilities, that industrialise breakthroughs, build platforms, deploy infrastructure, and embed technologies into everyday economic and social life. Examining the top global technology companies reveals how the competition for technological leadership is increasingly concentrated in these corporate actors.

In Summary

- **Technology is now sovereignty.** Power flows not from invention alone but from the ability to scale infrastructure, control supply chains, and lock in standards.
- **The U.S. and China are now two global techno-power leadership systems.** The U.S. leads in commercialisation, platforms, VC, and hyperscale compute; China leads in scientific output, manufacturing depth, and coordinated scaling.
- **Value is highly concentrated in the U.S.** The “Magnificent Seven” account for c.34% of S&P 500 market cap, up from c.12% a decade ago, reflecting platform dominance and control-point economics, as well as the U.S. culture of markets-centricity.
- **However, U.S. commercial capture does not indicate U.S. long-term dominance.** U.S. firms hold c.20% of global equity value, while China produces c.50% of global patents and dominates industrial diffusion in mature technologies.
- **Manufacturing and energy are decisive constraints where China has control points.** China controls c.80-95% of solar PV, c.75- 80% of batteries, and c.60-90% of rare-earth processing, enabling second-mover dominance.
- **AI power rests on global chokepoints.** U.S. model leadership depends on Taiwan (TSMC), East Asian memory (>80% HBM), and Europe’s lithography stack (ASML-controlled).
- **Energy limits future tech power, particularly for the U.S. especially without renewables.** U.S. data centres already consume c.3% of electricity, projected to reach up to 14% by 2030; China is expanding power capacity c.3× faster.
- **Europe-India has capabilities to develop a third global level player in collaboration.** No single actor can rival the U.S. or China alone; EU-UK-India blocs can rebalance standards, talent, and diffusion but still lag in platforms and capital scale.

V. Private Sector Tech and Markets

In addition to fundamental technology capacity, national tech power is increasingly determined by control over the digital technology stack and the firms that dominate its critical layers. Today's AI-driven expansion has concentrated capital, valuation, and strategic influence in a small group of global technology leaders, particularly those controlling platforms, advanced compute, and hyperscale infrastructure. Equity markets have amplified this concentration, pricing current AI architectures as if they represent the durable foundation of the next technological era. Yet history suggests caution. Early architectures in systemic technologies rarely define their endpoint, and leadership often shifts as underlying scientific paradigms evolve. The current AI cycle may prove transitional rather than terminal, with future breakthroughs in cognitive, neuromorphic, or energy-efficient systems potentially reshaping competitive advantage.

1. Big Tech Strategic Competition

The Top 20 Global Tech Leaders Concentration of Value and Power

The private sector naturally concentrates capital and effort on technologies that are closest to large-scale commercial deployment. In the current cycle, this has produced a disproportionate focus on artificial intelligence. Viewed more broadly however, however, competitive advantage is increasingly determined not by participation in individual technologies alone, but by control over a narrowing set of critical control points. The largest and most systemically important technology companies are therefore competing over a limited number of these control points distributed across the digital technology stack.

The world’s 20 largest technology companies have diversified portfolios that often span multiple layers of the technology stack, their core strategic advantage and competitive focus are clustered in essentially four areas: devices, AI and compute enablers, platforms, and enterprise systems.

Figure 17: Control Points of the Technology Stack

Most layers of the stack are necessary but not sufficient for durable value capture. Control concentrates in a limited number of sublayers where scale, lock-in, and capital intensity create structural advantage. Devices control the physical interface between users and digital systems; AI and compute enablers determine how much computation can be built and at what cost; platforms mediate access, distribution, identity, and data flows; and enterprise systems embed technology into organisational processes. These layers act as gateways through which value flows, allowing firms that control them to capture economic rents even as specific applications and services change.

Crucially, these control points are characterised by scale economies, high capital intensity, and strong forms of lock-in. Leadership requires sustained investment, ecosystem coordination, and, in many cases, global reach. As a result, the technology stack filters where durable firms can emerge: most applications remain replaceable, while value and power accumulate in the layers that shape access, integration, and scale. The clustering of the 20 largest technology companies around these four areas therefore reflects the underlying structure of the stack, rather than cyclical investment preferences or short-term technological trends.

Figure 18: Top 20 Global Tech Companies

	Company	Country / HQ	Layer*	Key products	Revenue TTM (US$bn)	Market Cap (US$bn)
1	**Amazon**	USA	Platform	*AWS cloud, marketplace, logistics network, AI infrastructure*	691	2,597
2	**Apple**	USA	Platform/ Device	*iPhone, Mac, iOS, App Store, services ecosystem*	416	3,968
3	**Alphabet**	USA	Platform	*Search, YouTube, Android, Google Cloud, AI models*	386	4,163
4	**Microsoft**	USA	Enterprise Systems	*Azure, Windows, Office, enterprise AI, cloud platform*	282	3,143
5	**Foxconn**	Taiwan	Devices	*Electronics manufacturing, iPhone assembly, servers, PCs*	258	96
6	**Samsung Electronics**	S. Korea	Devices	*Smartphones, displays, memory chips, consumer electronics*	234	745
7	**Meta**	USA	Platform	*Social networks, AI models, Extended Reality hardware, ad platform*	201	1,867
8	**Alibaba**	China	Platform	*E-commerce, Alibaba Cloud, payments, AI services*	137	416
9	**Nvidia**	USA	AI & Compute Enabler	*AI GPUs, CUDA software stack, data-centre accelerators*	131	4,687
10	**TSMC**	Taiwan	AI & Compute Enabler	*Advanced semiconductor foundry, leading-edge nodes*	122	1,761
11	**Dell**	USA	Enterprise Systems	*Servers, storage, enterprise PCs, data-centre hardware*	96	79
12	**Tencent**	China	Platform	*WeChat, gaming, Tencent Cloud, AI investment*	90	716
13	**Sony**	Japan	Devices	*PlayStation, image sensors, consumer electronics*	86	134
14	**Lenovo**	China	Devices	*PCs, laptops, enterprise hardware, servers*	69	14
15	**IBM**	USA	Enterprise Systems	*Hybrid cloud, consulting, quantum research, AI tools*	68	289
16	**SK hynix**	S. Korea	AI & Compute Enabler	*Memory (HBM/DRAM/NAND) for AI and data centres*	68	435
17	**Hitachi**	Japan	Enterprise Systems	*Industrial systems, digital infrastructure*	65	154
18	**Broadcom**	USA	AI & Compute Enabler	*Networking chips, custom silicon, infrastructure software*	63	1,568
19	**LG**	S. Korea	Devices	*Displays, components, home electronics*	62	12
20	**Oracle**	USA	Enterprise Systems	*Databases, enterprise software, Oracle Cloud*	57	459

** Companies are assigned to a single category for analytical clarity, although many operate across multiple layers of the technology stack and have diversified product portfolios spanning more than one group.*

Five critical observations arise from the list above:

1. **Platforms Dominate the Current Global Tech Landscape**

Among the top 20 technology companies, platforms are both the most valuable and among the most strategically significant layers of the stack. Six of the top 20 corporations fall into this category, and they together generate well over half of the group's total revenue. This concentration reflects platform companies unique positioning and their ability to capture value in the Information Age.

Platforms sit closest to end users, capturing continuous streams of data and attention that allow them to improve services and attract more participants. As users, developers, and merchants concentrate inside these ecosystems, network effects strengthen and activities become embedded, creating powerful lock-in. This dynamic allows platforms to extract value not only from their own products, but from the economic activity of others who rely on them for distribution and visibility. In effect, they become monopolies of ecosystems rather than individual services.

American tech leadership is concentrated in such platforms, representing four out of ten U.S. companies on the list. The other two platform companies are Chinese, underscoring how control of user ecosystems has become a central axis of technological and economic power. U.S. firms have been the most active in expanding these ecosystems across international markets, while Chinese firms have to date focused primarily on domestic scale, consistent with a national strategy that prioritised building platform strength at home before pushing outward.

AI-related tech leadership is most visibly concentrated in platforms c. with the U.S. having four out of ten companies and China two - underscoring how control of user ecosystems has become a central axis of technological and economic power

2. **U.S. Dominance Reflects Development Model and Capital Market Structure as Much as Technology Leadership**

The U.S. stands out for the sheer number of companies represented among the global technology leaders, accounting for half of the top 20 firms. This concentration is not surprising given the U.S. technology development model, which emphasises rapid commercialisation, early platform formation, and deep integration between venture capital, public equity markets, and large technology incumbents. The current acceleration of AI has further reinforced this advantage, favouring firms with access to hyperscale compute, proprietary data, and the capital required to sustain multi-billion-dollar R&D programmes, capabilities that are most readily assembled within the U.S. ecosystem.

Measured by market capitalisation, U.S. dominance appears even more pronounced. However, this reflects not only corporate performance or technological strength, but also the structural characteristics of U.S. capital markets. Deep liquidity, global benchmark dominance, strong investor protections, and regulatory stability generate a persistent valuation premium for U.S. equities relative to peers.

U.S. model leadership depends on Taiwan, East Asian memory, and Europe's lithography stack –c. these are chokepoints that require cooperation and collaboration across boundaries

By contrast, Chinese technology companies trade at substantial discounts, often approaching 50%,[81] driven by regulatory uncertainty, geopolitical risk, and constraints associated with a more politicised and partially closed capital market system. These valuation effects suppress market capitalisation independently of operational scale or technological capability. As a result, current market pricing likely overstates the durability of U.S. leadership while understating China's capacity to mobilise capital, coordinate investment, and pursue long-term strategic objectives outside the logic of public equity markets.

3. Devices Favour Scale-Driven Industrial Models Concentrated in Asia

The devices layer stands out as the only segment of the global technology landscape in which leadership is overwhelmingly concentrated in Asia. All leading device companies in the top 20, spanning smartphones, consumer electronics, displays, and systems assembly, are headquartered in China, Taiwan, Japan, or South Korea. This pattern reflects the economic characteristics of the devices layer itself. Devices are mass-market products that typically rely on relatively mature technologies, or on the large-scale deployment of advanced components whose competitive differentiation depends less on frontier innovation than on manufacturing efficiency, yield optimisation, supply-chain coordination, and relentless cost reduction.

These requirements align closely with the industrial and technological models of East Asian economies, particularly China, Taiwan, Japan, and South Korea, which have prioritised scale, process engineering, and export-oriented manufacturing over early-stage commercial experimentation.

Corporate leadership in the devices layer demonstrates how leadership tends to migrate toward countries best equipped to industrialise, standardise, and deliver technology at global scale rather than those that dominate initial invention or platform formation.

4. AI and Compute Are Contested at the Surface, but with Upstream Chokepoints outside of Big Tech Control

The AI and compute layer has emerged as the most strategically contested domain in the global technology system, reflecting its role as a binding constraint on progress across AI and many adjacent systemic technologies. Unlike platforms or devices, leadership in this layer is not geographically concentrated in a single country or region, with the top AI and compute enablers evenly split between U.S. and Asian firms, with American Big Tech companies leading in accelerator design and software ecosystems, and Asian firms dominating advanced manufacturing and memory.

U.S. model leadership depends on Taiwan, East Asian memory, and Europe's lithography stack c. these are chokepoints that require cooperation and collaboration across boundaries

This balance highlights an important distinction between visible scale and structural control. While U.S. firms have been highly successful in capturing value at the system level, the physical ability to produce advanced compute remains concentrated in a small number of non-U.S. supply-chain chokepoints. Taiwan Semiconductor Manufacturing Company (TSMC) fabricates nearly 90% of the world's advanced logic chips, while South Korea's Samsung Electronics and SK Hynix together supply over 80% of global advanced memory (High Bandwidth Memory (HBM) and Dynamic Random-Access Memory (DRAM)) used in AI accelerators[82].

Further, there are several European companies further up the value chain while too small in absolute terms to make the list above, are even more structurally irreplaceable. ASML, headquartered in the Netherlands, is the sole global supplier of extreme ultraviolet (EUV) lithography machines, with each system costing over US$150 million and incorporating thousands of precision components that are sourced from single specialised European companies such as Zeiss and Trumpf.[83]

> While market capitalisation within the top cohort remains overwhelmingly U.S.-weighted, this dominance depends on the U.S. maintaining global supply chains that function smoothly in a time of political and economic risk[84].

2. The Role of Tech Leaders in a Nation’s Power

Additionally, the company-level view reveals something larger than who is leading in what part of the technology stack. Companies are not simply market participants; they are a critical component and ultimately the last mile of technological leadership for their home countries, with the most powerful corporations increasingly resembling sovereign actors in their own right. Private sector corporations are the vehicles through which foundational R&D, innovation, capital investment, and manufacturing scale are translated into deployed technologies that create value at scale. In some economic models, most visibly in the United States, private companies play the dominant role in driving this translation from invention to market uptake. In others, particularly China, the state plays a more direct coordinating role, but still relies on firms to industrialise, deploy, and scale technology in practice.

The limitations and caveats outlined above notwithstanding, U.S. companies today clearly occupy the leading position, with Chinese companies forming a second tier alongside other East Asian economies that control critical manufacturing and compute chokepoints. Europe’s companies, despite its strength in upstream science and specialised components, is largely absent from the layers where the bulk of value is captured and entire ecosystems are controlled, most noticeably in platforms.

Platforms are not only the primary sites of value capture (as evidenced by their concentration of both revenue and market capitalisation), but also the layer through which digital sovereignty and strategic agency are exercised. As technologies diffuse downstream into everyday economic and social life, it is platforms that determine how they are accessed (and monetised.) For countries seeking to maintain long-term technological power, control of these platform layers will ultimately be essential.

3. The AI Boom – A Transitional Paradigm, Mispriced by Markets

AI Driving Global Technology Spending and Valuations

The structure of today’s global technology landscape is inseparable from AI, which has emerged as the primary driver of technology spending, whose annual growth rate has doubled since the beginning of the generative AI era at the end of 2022. The 20 largest technology companies in the world collectively represent US$3.6 trillion dollars in annual revenue. Yet despite their diversity across layers of the technology stack, a growing share of their incremental growth is tied directly or indirectly to AI.

Figure 19: AI Driving Global Tech Spending Growth

AI has become the central growth vector across nearly all parts of the technology stack together. Platforms are embedding AI into user ecosystems and monetising enhanced services; enterprise software leaders are re-architecting products around AI copilots; semiconductor firms and foundries are scaling advanced logic and memory to meet model-training demand; hyperscalers are expanding data-centre footprints at unprecedented rates. Even device manufacturers increasingly position hardware as AI-enabled endpoints. Across layers, the marginal dollar of investment and the marginal dollar of expected growth are being pulled toward AI. The capex spending for the coming year announced in early 2026 by just five companies has reached US$690 billion

This concentration is visible not only in revenue trajectories, but even more so in equity markets and the value they ascribe to AI. The 20 Big Tech companies enjoy a current cumulative market capitalization of over US$27 trillion. Over the past two years the group's valuation has risen by 40% annually, against the annual growth of the MSCI World Index of 17%,[85] and the top 20 tech companies now represent roughly 20% of global equity value. Moreover, within this group of 20, the corporations perceived to control the critical nodes of the current AI architecture, semiconductors, hyperscale cloud infrastructure, and large platform ecosystems, absorb a disproportionate share of value, with AI & Compute Enablers and Platform companies enjoying 88% and 34% annual growth. These figures indicate that AI is not simply another product cycle; it has become the organising narrative through which technological leadership and future value are being priced.

Figure 20: AI Driving Global Tech Valuations

Yet this dominance rests on a specific architectural assumption: that the current generation of AI, based on large, statistical, compute-intensive models represents the durable foundation of the AI era. History suggests caution. Early architectures in systemic technologies rarely define the endpoint. The current AI boom has reshaped the distribution of power within the technology stack, but the scientific trajectory indicates that the present paradigm may be transitional rather than terminal. As with past technological eras, early leadership does not guarantee long-term advantage.

AI's Current Path and the Potential Future

The scientific perspective highlights the constraints of today's architectures and the potential directions for future breakthroughs:

- **Current models are statistical, not cognitive**. Today's LLMs rely on pattern prediction, search-lineage concepts, and associative pattern-forming rather than comprehension, grounded reasoning, or cognitively structured processing.
- **Contextual comprehension has not yet emerged.** True understanding requires memory, causality, mechanisms for learning, networking, and structures appropriate for different decision types—capabilities that are largely missing or only weakly approximated in current systems.
- **Future systems are likely to be fundamentally different.** Next-generation AI may involve cognitive architectures with grounding, causal reasoning, adaptive learning, and reflective processes that represent a clear departure from the LLM paradigm.
- **Neuro-biological and meta-cognitive architectures may redefine AI.** Adaptive architectures informed by neuroscience have the potential to complement or replace today's data-centre-scale models, while longer-term trajectories point to potential architectures capable of self-modification, meta-learning, and constructing unified causal world models.

- **Energy requirements may change radically for distributed, networked intelligence.** Cognitive systems like brains processes vast volumes of information with orders-of-magnitude less energy than LLMs require today, indicating that future AI architectures may have radically different energy requirements.

Markets Implications for Investors, Countries, and Companies

The scientific perspective reveals significant implications for investors, countries, and companies operating within an uncertain and discontinuous technological landscape:

- **Current valuations rest on static architectural assumptions**. Markets are pricing today's AI companies as if current architectures will endure and scale, despite the high likelihood that current generative AI systems are transitional rather than destination technologies.
- **U.S. and Chinese dominance is far from guaranteed**. Both countries' ecosystems are deeply committed to the generative AI-centric paradigm, which is vulnerable to further breakthroughs (particularly if these are cognitive, energy-efficient, or biologically inspired architectures), and particularly if the countries and institutions leading these arise elsewhere.
- **Dominant firms face structural inertia**. Major technology companies are locked into vast investments in infrastructures such as data centres, cloud platforms, fixed architectures, global supply chains, and specialised talent pipelines. This creates high switching costs and reduces their ability to pivot when architectural discontinuities emerge.
- **Energy planning is being built on an unsustainable assumption**. The world is rapidly expanding energy supply, grid connections, and cooling infrastructure for extremely energy-intensive models, without considering how new AI architectures could radically reduce future energy footprints.
- **History indicates that leadership shifts across paradigm shifts**. Britain dominated steam and coal yet ceded power in the eras of oil, gas, and nuclear to America. Similarly, today's AI leaders may not dominate the innovative AI architectures that follow today's AI systems.
- **Strategic space exists for other regions**. The EU, UK, and Japan have strong foundational science capabilities and can gain advantage by investing in non-LLM paradigms rather than competing within the capital-intensive, energy-hungry constraints of the current U.S.-China race as a follower.

Markets are treating an early, statistically driven AI paradigm as if it were the mature form of the technology. They underestimate the likelihood of architectural discontinuities that could reset global leadership. Fundamental science, not scaled LLMs, will determine the trajectory of the next phase of AI. Investors and policymakers should therefore treat current leadership positions and valuations as only provisional.

Structural Value and Valuation Risks

Given the likelihood to technological discontinuity, the current valuation landscape for AI reveals deep risks arising from financial dynamics, architectural uncertainty, and energy constraints that markets have not yet fully priced:

- **Valuations embed profit expectations far beyond plausible forecasts.** Achieving historical returns would require profits more than double consensus expectations, indicating valuations priced for breakthroughs, for which the current paradigm is likely to appear to deliver while remaining vulnerable to breakthrough paradigms.

- **Capex growth has decoupled from earnings growth.** Hyperscalers' AI investment continues to grow rapidly, at 60-70% annually,[86] while monetisation lags, widening the gap between spending and returns, with investors differentiating sharply between effective and ineffective spending.
- **Debt-funded AI infrastructure raises systemic fragility.** Financing capex with leverage heightens vulnerability to delays, revenue shortfalls, and architectural discontinuities.
- **Global infrastructure may become stranded capital.** Data centres, cooling systems, and specialised hardware pipelines risk premature obsolescence if future AI architectures shift toward scientific models that are fundamentally more energy efficient.
- **Current valuations assume an untenable energy trajectory.** Today's AI models scale compute and energy consumption exponentially; markets have not priced the energy-driven limits of the current paradigm, and implicitly support climate and environment destroying policies.

Given the above, today's global tech leaders, particularly those at the forefront of generative AI investments and valuations, face a distinct set of risks stemming from technological lock-in, energy economics, and architectural inertia and obsolescence, with potentially significant implications for their long-term market positioning and shareholder value creation when the inevitable further breakthroughs in AI are made.

Reflections on Valuation – Wolves, Neanderthals and Dinosaurs

Historical precedent shows that even under severe technological displacement, megacap incumbents typically experience major valuation declines, but not extinction. For example, IBM lost approximately 65% of its market value during the PC and client-server transitions, AT&T fell by over 60% as telecom architectures shifted, and Intel has experienced drawdowns of similar magnitude during the mobile and related chip transitions. While individual outcomes vary, these cases illustrate that large incumbents generally retain substantial residual value even after losing architectural leadership.

Technological paradigm shifts resemble biological selection regimes. The magnitude of valuation impact of the next AI paradigm on current tech leaders likely depends on whether the architectural changes it brings represents incremental trait adaptation, competitive displacement, or environmental discontinuity. In evolutionary systems, these regimes determine not only whether current dominant species survive, but how much of their ecological share they retain. Three scenarios of future AI innovation illustrate the different potential long-term valuation impacts for current tech leaders

1. Continuity-with-Adaptation (Low Impact: 10–25% Valuation Compression)

Description. AI breakthroughs emerge gradually, and the current LLM-centric paradigm would remain broadly viable. Hyperscalers can adapt by improving efficiency, integrating incremental cognitive enhancements, and repurposing existing infrastructure. Energy intensity could moderate at the margin, allowing capex to be digested rather than stranded. Competitive leadership would be reshuffled but not overturned.

Evolutionary Analogy. In biological terms, this resembles trait substitution within a species. Environmental conditions shift, but not abruptly enough to cause extinction. Over many generations, natural selection favours traits that improve survival under new conditions. For example, grey wolf populations across Eurasia show long-term adaptations to colder climates - such as dense winter underfur and compact body proportions - that evolved over tens of thousands of years during the Ice Ages.[87] The species as a whole to thrive but its dominant traits adjusted to the new environment.

Valuation Impact.[II] Under this regime, valuation impact would likely be contained to the 10–25% range. Such compression would be consistent with historical digestion cycles rather than structural displacement, Amazon's 2019–2020 capex digestion (c.15% decline), Microsoft's early cloud-transition revaluation (c.20%), or Apple's 2015–2016 iPhone plateau correction (c.25%). Expectations reset, growth moderates, but incumbents remain ecologically dominant.

2. Architectural Tension Scenario (Medium Impact: 30–50% Valuation Compression)

Description. Cognitive, neuromorphic, or biologically inspired architectures begin to demonstrate material advantages in reasoning capability or energy efficiency. The LLM stack no longer represent the performance frontier, and incumbents would face retooling pressure; capital intensity would rise before falling; returns on incremental compute investment would decline. Infrastructure would not be immediately stranded, but its long-term productivity assumptions would weaken.

> *Markets have not established whether today's AI companies are wolves that adapt, Neanderthals that will be replaced by Homo Sapiens or dinosaurs that are too large and resource hungry to survive*

Evolutionary Analogy. This scenario corresponds to competitive displacement by a better-adapted species. The replacement of Neanderthals by Homo sapiens offers a useful analogy. As modern humans developed more complex social networks, advanced tools, and flexible hunting strategies, they expanded across Europe and Asia into territories long occupied by Neanderthals. The genus survives, but in terms specific species, Neanderthals persisted for a time and ultimately disappeared when Homo sapiens became globally dominant.[88]

Valuation Impact. Valuations in this regime could compress materially, on the order of 30–50%. That range mirrors historical mid-cycle technological dislocations: Microsoft's mobile-era repricing (c.35%), Alphabet's revaluation during early generative-AI competitive pressure (c.40%), and the 30–45% declines experienced by enterprise software incumbents during cloud transitions. Survival remains likely, but dominance and multiple expansion assumptions are impaired.

3. Paradigm Displacement Scenario (High Impact: 50–70% Valuation Compression)

Description. A fundamentally superior architecture - cognitive, neuromorphic, or radically energy-efficient - achieving an order-of-magnitude advantage in performance per unit of energy or capital. Under such conditions, compute-heavy hyperscaler models face structural impairment. Data-centre-scale investments could become largely stranded and leadership would reassign more rapidly than markets currently assume.

Evolutionary Analogy. This third regime reflects environmental discontinuity resulting in fitness inversion. The extinction of dinosaurs following sudden environmental disruption shows how scale and energy intensity can shift from strength to vulnerability. Large, resource-demanding organisms that thrived under stable and abundant conditions became disadvantaged when ecosystems collapsed. In contrast, smaller and more

---

[II] *All valuation decline estimates referenced in these scenarios are derived from publicly accessible historical price data available through Google Finance, Yahoo Finance, Macrotrends, and TradingView, which provide long-term open-access stock-price histories enabling independent verification.*

adaptable species were better able to endure the disruption and went on to shape the next ecological balance.[89, 90]

Valuation Impact. Valuation compression in this scenario could reach 50–70%, consistent with major paradigm-displacement events: Cisco's post-dot-com structural repricing (c.70%), IBM's loss of PC-era dominance (c,65%), and AT&T's decline following telecom deregulation and mobile disruption (c.60%). Even here, extinction is unlikely; incumbents typically retain substantial residual value. But their ecological share - and their valuation premium - would contract sharply.

Collectively, these scenarios underscore a central point: the value of today's AI incumbents is highly sensitive to architectural evolution. While sophisticated large investors may be positioned to weather all scenarios, the consequences under Scenarios 2 and 3 would be severe for most other investors and for global markets, on a scale comparable to prior major technology and market corrections. History shows that paradigm shifts can compress valuations sharply, destabilise broader indices, and reassign industry leadership. As AI advances toward more cognitive, biologically inspired, or energy-efficient forms, investors and policymakers should treat today's valuations as contingent rather than definitive, ensuring that strategic planning remains adaptive to scientific and technological discontinuity.

The lesson applies to all systemic technologies, early architectures rarely define the endpoint, and markets consistently underestimate the discontinuities that ultimately determine leadership and value creation.

In Summary

- **Current AI leadership rests on a fragile paradigm**. LLMs are energy-intensive and statistically driven; future cognitive or biological architectures may overturn today's advantage.
- **Markets are pricing in paradigm longevity.** Valuations assume the LLM stack endures, despite historical evidence that architectural shifts reassign value and leadership.
- **The energy economics of current AI models are untenable.** LLM scaling requires exponentially rising energy and capex commitments; future architectures built on energy efficient AI models would write off today's multi-billion-dollar data centre and infrastructure investments.
- **Leadership positions are far less secure than markets assume.** U.S.-China dominance is built on LLM-centric infrastructure that may not survive architectural discontinuity; breakthroughs could reorder global leadership as dramatically as the previous transitions that reduced IBM, AT&T, and Intel valuations by 60% or more.
- **A third pole of leadership can still emerge.** The EU, UK, Japan, and India and their companies could gain ground by backing fundamental science and alternative architectures not yet dominated by the U.S. or China.
- **Global markets face systemic downside under discontinuity scenarios.** Scenario analysis based on tech industry precedents imply valuation impairments of 10-25% (adaptation), 30-50% (architectural tension), and 50-70% (paradigm displacement). Scenarios 2 and 3 could generate market shocks comparable to major historical technology and global corrections.

VI. Completing the Transition

The transition to the Information Age has a discernible end-state: one defined by clean energy abundance, automated production, intelligence embedded across economic and social systems, and the decoupling of prosperity from material scarcity. Yet reaching that end-state is neither linear nor benign. Progress is driven by the convergence of systemic technologies, transforming isolated advances into unified systems with multiplicative effects. This convergence propels the world through successive phases, from super-performing systems that augment human capability, to supra-human systems that organise activity at scale, and ultimately toward systems that shape perception, behaviour, and belief. As this transition unfolds, power increasingly migrates from institutions to infrastructures, and from territorial control to cognitive influence. The culmination of the transition is not simply abundance, but the emergence of "empires of the mind", systems that govern societies through attention, optimisation, and design rather than force.

1. Technology Enabled Functionality at the End of the Transition

The world is already deep into a civilizational transition from the Industrial Age to the Information Age. This transition is generating systemic disruption across economics, politics, security, technology, and society. But periods of upheaval are much easier to diagnose than the structural end-states that they eventually. The Agricultural Revolution produced sedentary societies, land-based hierarchies, and agrarian empires. The Industrial Revolution produced fossil-fuel economies, mass urbanisation, nation-states, and industrial capitalism. The Information Age is no less transformative, not merely adding to existing systems, but reshaping the foundations of value creation, governance, social organisation, power, and security, and ultimately challenging our vision of what it means to be human.

The End of the Transition

At the end of the current transition, the world would be characterised by a fundamentally different set of constraints, incentives, and power structures across multiple dimensions:

1. **Resources: Abundant, Clean Energy as the Foundation.** Energy abundance, at near-zero marginal cost (most plausibly through commercially viable fusion) removes a fundamental constraint on economic activity, enabling mass automation, large-scale computation, advanced manufacturing, and scaled processes such as desalination and carbon removal that are currently uneconomic.
2. **Industrial Structure: From Manufacturing to Information.** Economic value creation centres on data, knowledge, design, and intelligence rather than physical output, with manufacturing highly automated and commoditised. Competitive advantage lies in control of data, algorithms, and system architectures, with corporations increasingly operating as information platforms rather than industrial producers
3. **Economics: Hyper-Abundance and the Erosion of Scarcity.** Automation compresses labour costs and abundant energy relaxes resource constraints, pushing many essential goods toward post-scarcity conditions. Sharply reduced costs of food, housing, mobility, healthcare, and education, make universal basic services or income economically viable rather than merely aspirational.

The post transition world promises abundant clean energy and embedded intelligence enable post-scarcity growth, information-based power, decentralised development, and system-level governance beyond territory

4. **Politics: More Participatory, More Data-Driven Governance.** Political systems shift from periodic representation toward continuous participation enabled by digital identity, infrastructure, and real-time feedback, while policy becomes evidence driven. These tools enable more responsive governance but also introduce risks of surveillance, manipulation, and algorithmic control, making outcomes dependent on institutional design
5. **Social Organisation: Hyper-Personalisation and Decentralised Interaction.** Social life is shaped by deep personalisation of services, media, education, healthcare, and consumption through AI systems. Communication, transactions, and coordination increasingly occur via decentralised digital networks, reducing reliance on institutional intermediaries and increasing individual autonomy.
6. **Development: Leapfrogging Without Industrialisation.** The Global South bypasses traditional industrialisation pathways as low-cost energy, computation, education, and infrastructure become

digitally deliverable. Development no longer depends on heavy industry or natural resource endowments, allowing faster catch-up and reduced global inequality, (provided access to infrastructure and governance remains inclusive.)

7. **Environment: Closed-Loop Systems and Net-Zero Resource Use.** Advanced automation, materials science, and abundant clean energy enable closed-loop production systems in which waste is designed out and materials are continuously recycled. Net resource extraction and greenhouse gas emissions fall sharply, allowing climate stabilisation to be achieved through system design rather than ongoing economic sacrifice.
8. **Security: From Territorial Control to System Control.** Security centres less on territorial control and more on control of critical systems: energy infrastructure, data networks, compute resources, biological platforms, and algorithmic governance. Power shifts toward actors controlling foundational infrastructures, redefining sovereignty, strategic assets, and political authority away from geography toward system ownership.

Thematic Fault-Lines of the Transition

While the information age holds the promise of abundance and peace, managing the actual transition will be a significant challenge, and high stakes one too. As is common in revolutions, legacy systems are losing coherence faster than new ones are being fully established, producing heightened instability across multiple dimensions. Several structural fault-lines are already visible.

The fault lines of the transition run across security, economics, energy, politics, society, development, the environment and global governance … the underpinnings of the current world order

Security: From Rules to Might. The demise of the post-Cold War security order has created a more transactional and fragmented world. Escalation capability has replaced shared norms as the primary source of security, as collective security frays. States are increasingly forced to underwrite their own security through new alliances, increased investment, and technological superiority, raising unresolved questions about who maintains stability in flashpoints once managed by global order, whether on the Korean Peninsula, in the Middle East, or across contested digital and cyber domains.

Economics: From Integration to Extraction. Economic competition is shifting away from positive-sum globalisation toward zero-sum thinking. Industrial policy, subsidies, trade restrictions, and weaponised interdependence are replacing free trade. While the Information Age ultimately enables abundance through automation, energy, and intelligence, the transition phase is marked by a doubling down on extractive behaviour and the spiralling concentration of value. Without new mechanisms for distribution, taxation, and access, the benefits of technological progress risk accruing narrowly, deepening inequality within and between countries.

Energy: Competing Pathways to Power. Energy sits at the core of the transition. Over the long term, the path points to clean, abundant energy, most plausibly fusion, capable of underpinning mass automation and computation. In the interim, however, energy competition reflects divergent strategies: the United States leveraging hydrocarbons for geopolitical resilience and price stability, and China accelerating dominance in renewables, batteries, and electrified infrastructure. This dual system introduces both strategic redundancy and new dependencies for much of the rest of the world during the transition period.

Industrial Transition: Softening the Blow. Industrial systems built around fossil fuels, labour-intensive manufacturing, and legacy supply chains face structural decline. Governments are caught between softening the blow, protecting jobs, corporations, and regions, and allowing creative destruction to proceed. Preserving existing systems can smooth social impacts in the short term, but risk creating drag that slows adaptation and weakens long-run competitiveness.

Politics: Substituting Growth with Conflict. As economic growth becomes harder to deliver or distribute equitably political incentives shift. When prosperity stalls, mobilisation increasingly occurs through identity politics, grievances, and external conflict rather than shared economic expansion. This dynamic is fuelling populism, domestic polarisation and increasingly international confrontation too, and promises to get worse as technological change increasingly outpaces institutional capacity to manage its consequences.

Society: Autonomy, Fragmentation, and Control. The Information Age expands individual agency through knowledge access but also increases fragmentation. Algorithmic echo chambers, and the breakdown of shared narratives is straining social cohesion. At the same time, the same technologies also enable unprecedented surveillance and behavioural control, creating tension between empowerment and authoritarian drift, and the dehumanization of those who represent any countering opinion, idea, or ideal.

These domains collapse faster than new ones can replace them … with conditions negotiated through force and coercion

Development: Leapfrogging or New Dependence. For the Global South, the transition presents both opportunity and risk. Digital infrastructure, AI-enabled education, and low-cost energy could allow countries to bypass traditional industrialisation, yet dependence on external platforms and standards could reproduce the very asymmetric power relations development meant to address. Development outcomes will hinge on access, sovereignty, and the ability to retain value locally rather than merely consuming imported technological systems.

Environment: Design Versus Collapse. The technologies of the Information Age make closed-loop production, precision agriculture, and net zero energy technically feasible. Whether these capabilities can stabilise the climate and the environment depends on speed and coordination. Delays risk locking in irreversible ecological damage, while well-designed systems could allow prosperity to decouple from resource depletion for the first time in human history.

Multilateralism: From Universalism to Coalitions. Global governance is shifting from universal norms and institutions towards more flexible, issue-specific coalitions. Existing multilateral institutions are struggling to govern AI, biotechnology, cyber conflict, and climate risk at the required pace, while being hollowed out by internal and external pressures. The emerging model is likely to be more plural: overlapping alliances, standards clubs, and public-private governance arrangements. Whether the emergence of new coalitions produces stability or fragmentation remains to be seen.

Taken together, these fault-lines explain why the transition to the Information Age is not a smooth ascent toward abundance, but a contested and unstable period in which power, value, and governance are being renegotiated simultaneously.

2. The Economics at the End of Transition

The accumulation of knowledge has been the fundamental driver of long-run economic progress, making technological advance structurally inevitable as successive eras are reshaped by new ways of generating energy, coordinating activity, and transforming information into productive capacity. History also shows that transitions between eras are often fraught, marked by instability, inequality, geopolitical rivalry, and, in adverse scenarios, large-scale conflict and economic devastation as institutions struggle to adapt. While such outcomes remain plausible, the analysis that follows focuses on a managed transition in which technological change is successfully navigated, leading to a substantially higher - though unevenly distributed - level of global prosperity than any previous economic era.

Beyond the Transition: An Information-Centric Economy

On the far side of the transition, the global economy is likely to operate according to a fundamentally different logic of value creation. Information - rather than land, labour, or physical capital - becomes the dominant strategic resource, with economic power increasingly derived from the capacity to generate, process, and act upon information at scale, and intelligence embedded across production systems, markets, and institutions as a general-purpose input.

At the macro level, this shift enables a step-change in global productive capacity rather than a linear extension of past growth. Advanced computing, artificial intelligence, and abundant low-cost energy compress innovation cycles, accelerate discovery, and optimise complex systems across major sectors, allowing value creation to become increasingly intangible and dematerialised. The result is not merely higher efficiency, but a qualitative expansion in what economies are capable of producing and coordinating.

The world's development goals can be met in the unparalleled transition ahead … the wealth creation can be greater than any in history and far more widely distributed given its nature is digital once infrastructure is built

Under an orderly transition, the scale of this uplift is unprecedented. Global GDP could more than triple by 2060 to approximately US$350 trillion, implying average global per capita income levels comparable to those of South Korea today for a projected population of around ten billion. The development goals can be more than met in such a shift. Beyond 2060, growth may accelerate further as intelligent systems and complementary technologies reinforce one another, taking previous transitions as a rough model, with global output approaching US$1 quadrillion by around 2080 - placing the world on a fundamentally higher economic plane than any previous era.

Value Creation, Distribution, and Enterprise at Scale

The Information Age also reshapes how value is created. Networked platforms, cloud infrastructure, and AI-enabled tools dramatically lower barriers to participation, allowing individuals and groups to contribute from almost anywhere. Economic activity becomes more modular and distributed, supporting a vast global enterprise ecosystem coexisting alongside large industrial incumbents. Small firms, startups, and individuals gain access to capabilities that were previously confined to advanced economies or large organisations.

This does not imply the elimination of inequality. Differences in access to data, compute, capital, institutions, and education will continue to shape outcomes. In addition, concentration risks remain real and certain regions, companies, and individuals are likely to capture disproportionate gains, particularly where scale, integration, and institutional power reinforce one another as the current benchmarking of Systemic Technologies demonstrates. Inequality - both within and between countries - is therefore likely to persist, and in relative terms may even widen.

While Information defines the immediate post-transition economics … it can be quickly expected to give way to something more potent

However, the absolute scale of value creation in the post-transition economy is sufficiently large that broad-based improvements in living standards remain achievable even under uneven distribution. The defining economic characteristic of the end state is not uniformity, but abundance: a world in which global productive capacity expands so dramatically that opportunity exists at scale across a far wider set of actors than in previous eras.

The Economic End State

The end of the transition is thus not simply a richer version of the present world, but a structurally different one. Growth which in the Industrial Age, was both capability-constrained and resource-constrained, is now unbounded by the ability to mobilise intelligence and resources to create solutions and value. Whether this potential yields an open, opportunity-rich global economy or a more concentrated and contested order will depend less on the inevitability of technological progress than on governance, access, and institutional choices made during the transition itself. One of the factors that unbounds the world is the convergence of Systemic Technologies, and this changes the value driver from information to something subtly more potent intelligence.

3. Development and Convergence into Unified Technological Systems

Evolutionary development of Systemic Technologies

We can expect each of the six Systemic Technologies to evolve significantly over time. Taking AI as an example, its developmental trajectory is unlikely to remain anchored in today’s statistical models.

AI began with search-based and statistical systems capable only of pattern recognition without understanding, then advanced to the scaled LLMs that dominate today which are powerful predictors but still fundamentally non-cognitive. Future progress is likely to move through transitional stages of contextual comprehension, where models gain early forms of grounding, memory, and coherence, before giving way to genuinely cognitive architectures capable of causal reasoning, adaptive learning, and structured problem-solving. Beyond this, breakthroughs in neuro-biological approaches may produce brain-like, energy-efficient intelligence, leading eventually to embodied or distributed systems that learn and act within real environments. Over a longer horizon, AI may evolve toward transcendental or meta-cognitive architectures that can modify their own structures and build unified world models.

This evolutionary ladder demonstrates that today’s AI represents an early stage within a far broader arc of technological development. Such leaps can be expected in each of the Systemic Technologies. Imaginations need to be unbounded to being to fathom the possibilities, for example quantum would evolve from specialised calculating machines to cross-dimensional reality intermediation; fusion from a future power source to scalable, near-free, clean and distributed energy capable of propelling humanity beyond the solar system; nanotechnology from passive materials to atomically precise, self-assembling systems; gene editing from treating disease to engineering entirely new species; and extended reality from entertainment platforms to technologies that augment and extend human consciousness.

Parallel evolution followed by unification

Today’s frontier technologies largely advance in parallel, shaped by distinct disciplines, constraints, and investment cycles. Each technology delivers substantial value within its own domain, yet the system remains constrained by the limits of its most restrictive components.

The inflection point arrives when these parallel trajectories begin to converge, outputs from one field become direct inputs to others, turning additive progress into multiplicative system effects, with the technological environment beginning to function as a coherent whole rather than as a set of loosely connected silos.

How the Systemic Technologies relate during convergence

Each technology contributes a complementary layer in the emerging system:

- Artificial intelligence provides the cognitive layer, interpreting complexity, generating models, and coordinating optimisation across domain. so that systems to learn to continuously scale and adapt.
- Quantum technologies expand the frontier of computation, sensing, and secure communication, unlocking problem spaces beyond classical systems, and driving deeper insights into physical, chemical, and biological processes.
- Gene editing and synthetic biology translate digital insight into biological change, making living systems programmable, enabling biology to be designed, tested, and scaled.
- Fusion energy supplies the energetic foundation to sustain these capabilities at scale by removing energy constraints on computation, experimentation, and industrial transformation and elimination of multiple energy related boundary constraints.
- Nanotechnology enables control at the smallest physical scales, structuring matter to embed intelligence, sensing, and responsiveness, and linking digital logic with physical reality.
- Extended reality provides the human interface layer, allowing humans to perceive, and interact with systems whose complexity exceed unaided cognition, keeping human intent legible in increasingly complex environments.

As convergence deepens, these technologies move from interaction to mutual dependence, with progress in one domain increasingly relying on advances in others, creating reinforcing feedback loops across the entire system.

Unification: the emergence of a higher-order technological level

As unification deepens, interaction gives way to system formation, and innovation no longer proceeds in linear steps. Discovery, simulation, testing, and deployment collapse into a continuous process, and boundaries between research and application blur as advances propagate across domains in near real time.

A profound shift happens as advanced technologies converge; they create entirely new solution categories, not incremental tools.

AI, gene editing, and nanotechnology enable programmable biology - living systems that can be designed, deployed, and continuously adapted inside the body. AI and quantum computing unlock previously unreachable solution spaces, generating novel materials, drugs, and energy pathways. AI, fusion, and nanotechnology enable energy-abundant compute and manufacturing systems. AI, extended reality, and robotics create systems where digital intelligence directly controls physical machines and environments in real time, while AI, extended reality, and biology enable societies to re-engineer healthcare delivery and human performance at population scale.

The result is a higher-order technological system whose capabilities exceed the sum of its parts and one that can “breed’ new solutions. Constraints that once limited progress, such as energy scarcity, experimental cost, or human cognitive capacity, are progressively relaxed. Systems begin to optimise environments rather than isolated processes.

The power of technological unification

Such a unified technological system would represent a step-change in civilisational capability. Evolving as a whole, such a system would accelerate discoveries, scale interventions, and reshape environments and societies at a pace no single domain could achieve alone, compressing decades of innovation into years, and expanding the range of solutions that can be invented and introduced.

Unification of systems would accelerate discoveries, scale interventions, and reshape environments and societies at a pace no single domain could achieve alone, compressing decades of innovation into years, and expanding the range of solutions that can be invented and introduced far beyond human capability (or control)

Unification is not merely a technological milestone. It is a structural transformation in how capability, authority, and agency are distributed, shifting the locus of power toward those who control the interfaces, infrastructures, and objectives of the system. Its influence would extend beyond markets and sectors to the organisation of societies and the governance of the planet itself. Once achieved, it would define the operating conditions of the Information Age, shaping not only what is possible, but who decides, and on what terms.

As technologies converge and begin to function as a unified system, their significance shifts from individual breakthroughs to the environments they collectively create. The question is no longer simply what these technologies can do, but how the systems built from them reshape the organisation of economic, social, and political life. It is this transition, from powerful tools to pervasive, system-defining infrastructures, that sets the stage for understanding the next phase of the Information Age: the rise of systems that increasingly structure how power is accumulated, exercised, and governed.

4. Power Projection Trajectories

In the Information Age, technological progress is no longer simply a driver of efficiency, growth or value creation. It is reshaping where power resides, shifting it from traditional institutions to the technological systems that mediate economic, political, and social life. Digital systems, especially platforms, cloud infrastructure, and AI systems, now mediate economic exchange, political communication, social coordination, and access to knowledge. As these systems expand and consolidate, they give rise to two converging trajectories that define the architecture of modern power.

The first trajectory is the alignment of corporate and state authority around critical digital infrastructures. Platforms, data networks, cloud computing, and algorithmic systems have become essential to economic performance, national security, and the delivery of public services. States depend on these infrastructures to govern effectively, while their operators depend on regulatory tolerance, legal protection, and geopolitical support to sustain scale. This mutual dependence erodes the distinction between public authority and private power, producing hybrid systems in which governance is exercised through technical architectures rather than formal institutions alone.

The second trajectory is the emergence of “empires of the mind”. Unlike historical empires that expanded through territory and force, these systems exert influence by organising attention, shaping perception, and conditioning behaviour across entire populations. Through continuous measurement and optimisation, they convert human cognition into a source of economic value and strategic leverage. Influence is exercised not through command, but through the structuring of informational environments in which beliefs, preferences, and actions are formed.

Two techno-social convergences shape the path ahead for individuals and societies, the first is the convergence of state and (technological) corporation, the second is the convergence of artificial intelligence and the human mind, these change what it means to live in society and what it means to have agency and sovereignty

Together, these trajectories signal a profound shift in the nature of power. Control increasingly operates through systems that are persistent, adaptive, and largely invisible to those subject to them. Authority is embedded in code, incentives, and design choices rather than in explicit rules or coercive force. Participation appears voluntary, yet dependence becomes structural.

The Coming Convergence of Technology and State

Technological systems rarely remain neutral instruments of commerce. As they expand in scale, consolidate market position, and become embedded in the everyday functioning of societies, they take on political relevance. Innovations initially introduced to improve efficiency or connectivity can, over time, develop into infrastructures that organise social interaction and economic participation. This gradual shift from tool to organising system represents a significant turning point in the information era[91].

Durable power accumulates around systems that coordinate activity at scale. I Historically, this coordination was anchored in land ownership, capital formation, and military capacity. Today, similar coordinating functions are i exercised by digital platforms and AI-enabled infrastructure that mediate communication, allocate attention, and shape incentives. When access to information, economic opportunity, and social visibility is filtered through such systems, they begin to perform roles that extend beyond technical facilitation and into the realm of governance.

Historically, commercial systems have often preceded formal authority. The Dutch East India Company (VOC) for operated extensive trade networks, ports, and financial systems across the Indonesian archipelago, building extensive economic dominance long before Dutch colonial rule was formalised over these territories.

What distinguishes the contemporary transition is not the use of force, but the management of choice environments. Platform architectures define the conditions of participation, shape patterns of visibility, and influence behaviour through design logics that are largely proprietary and resistant to public scrutiny. Operating continuously and responsively, these systems affect outcomes at a level of precision and scale beyond traditional administrative institutions. They increasingly perform regulatory, normative, and allocative functions once associated with public authorities.

The convergence of state and technological corporation embeds control into the systems used every day by everyone ... creating governance without transparency or oversight

As concentration within digital markets increases, closer alignment between platforms and state interests becomes more likely. Governments draw on platform infrastructures for political mobilisation, economic strategy, and security objectives. At the same time, platforms depend on favourable regulatory environments, and geopolitical accommodation. The resulting relationship is neither fully public nor fully private, but functionally interdependent.

This convergence complicates the distinction between public authority and private power, as governing functions are incrementally embedded in technical standards, contractual terms, ranking systems, and performance metrics. The principal risk arising from this evolution is not digital authoritarianism, but the normalisation of governance without clear democratic mandate or oversight. When political influence, economic opportunity, and social understanding are mediated by systems optimised for efficiency and extraction, mechanisms of accountability become diffuse.

It remains unclear whether the rise of powerful digital systems will entrench a form of digital statism or provoke efforts to reassert civic control. The real challenge is not recognising that the evident fact that technology shapes governance but ensuring that democratic agency can operate within systems that influence behaviour and belief through design rather than direct commands.

The Rise of Empires of the Minds

Power in the information age is no longer secured through sustained influence over how populations perceive, interpret, and respond to the world. The defining geopolitical development of the present era is the emergence of empires of the mind, systems of power built on the large-scale shaping of attention, belief, and behaviours through digital and algorithmic infrastructures[92].

These empires arise from the same historical logic that shifted the basis of power from land and labour to capital, industry, and global trade. In this era, that organising function is increasingly performed by digital platforms and AI-enabled systems that structure communication and mediate social reality. Control over cognition, rather than territory, becomes the primary strategic advantage.

Empires of the mind do not rely on overt coercion. Their influence is exerted through informational environments that shape what individuals see, prioritise, and regard as normal or credible. Personalised feedback systems, adaptive content, and incentive structures interact with human cognitive and emotional processes to guide behaviour in ways that are often experienced as voluntary yet are structurally designed.

The economic foundation of these empires lies in the extraction of value from attention, and behaviour through emotional engagement. This process depends on continuous participation in digital environments. The resulting asymmetry is not merely economic, but epistemic. Those who design and control the systems influence how reality is framed, while users contribute cognitive labour without meaningful control over its capture.

As these systems scale, their significance extends beyond markets and into the sphere of state power. Governments increasingly recognise that influence over digital infrastructures confers strategic advantages in economic competition, political mobilisation, and ideological alignment. At the same time, platform operators depend on state tolerance, regulatory accommodation, and geopolitical positioning to maintain reach and legitimacy. The boundary between corporate influence and public authority becomes blurred, not through formal merger, but through functional convergence.

> *Once the operating system in the technology can read and influence the mind, individual agency and state sovereignty is mediated by either one's own or another state-corporate power … giving birth to a new form of colonisation*

The principal risk posed by empires of the mind is the gradual erosion of cognitive sovereignty. Accountability becomes difficult to locate because power resides in technical architectures rather than explicit political decisions, and public debate is displaced by behavioural management.

This result is not inevitable, but the current trajectory is not benign. Whether societies can assert meaningful oversight over cognitive systems remains an open question. But power in the Information Age will belong to those who design, own, and govern the systems through which societies think and act. Meaningful counterforces are likely to struggle to form where a population believes it has autonomy already. Such systems are also suited to making step-changes in human awareness and performance, a field that is barely nascent in the application of these technologies, but one that holds enormous potential for human flourishing.

In summary

- **From territory to systems.** The Information Age culminates in energy abundance and pervasive intelligence, shifting power from institutions and territory to systems, infrastructure, and cognition.
- **Scarcity transforms to abundance.** Information becomes the core economic input, enabling non-linear growth; under a managed transition global GDP could triple by 2060 and approach US$1 quadrillion by c.2080, with uneven but broadly higher prosperity.
- **Technologies develop and converge into a unified system.** AI, quantum, fusion, gene editing, nanotech, and extended reality converge into a single system where progress becomes multiplicative and historic constraints dissolve.
- **State-Corporate power merges.** Control of compute, energy, data, and platforms fuses corporate and state authority, embedding governance in infrastructure rather than institutions.
- **Advent of Empires of the Mind.** Power shifts from force to influence as attention, perception, and behaviour are shaped by adaptive digital systems.

VII. Conclusion: Birth of a New Age of Systems

Humanity is entering one of the most consequential periods in its history, not because progress has failed, but because it is accelerating faster than the systems designed to govern it. Geopolitical rivalry, climate stress, widening inequality, and the erosion of institutional trust are converging into a polycrisis that reflects a deeper civilisational transition. At the same time, a technological renaissance is underway. Breakthroughs in intelligence, energy, materials, and biology are dissolving constraints that have shaped economies and societies for centuries. Technologies once considered speculative are becoming operational, scalable, and increasingly interconnected, creating systems capable of reshaping how power, value, and authority are organised. The future is not predetermined. The same forces that could enable unprecedented prosperity also carry the risk of fragmentation and domination if poorly governed. The central question is not whether civilisation will change, but who will shape what comes next. This report has laid out a vision of the journey ahead as mankind builds the most advanced technologies in history and how those technologies ultimately come to shape mankind.

1. The Journey Ahead

One of the most consequential periods in human history lies ahead

The world is on a trajectory from which divergence appears increasingly unlikely. That path runs through a polycrisis and a deeper metacrisis: intensifying geopolitical conflict, accelerating climate disruption, poverty in both high and low-income countries, the erosion of trust in institutions, the erosion of trust in science, widening inequality, and growing public unrest fuelled by the perception that progress is only for the few.

Yet this is also a moment of extraordinary renewal. Concurrently with the challenge above, there is a scientific and technological renaissance is underway, opening the possibility of reshaping the foundations of the world itself. Breakthroughs once considered unachievable are within grasp solving for energy, climate and development. Long-standing constraints are being overcome. The prize is great, and thus great risks are being taken at scale to confront issues previously deemed insoluble.

This report sets out that journey: the forces driving the crisis, the technologies reshaping the future, and the choices that will determine whether this era becomes one of fracture or renewal. Man's story on the road ahead, shaped by geopolitics, technology and capital is as follows:

1. **A Civilisational Transition Is Underway**

   Humanity is moving from the Industrial Age to the Information Age. As in prior era, economic models, political authority, and social organisation are being restructured simultaneously, producing instability as legacy systems weaken before new ones consolidate.

2. **Technology Has Become the Organising Substrate of Civilisation**

   Technology is no longer a sector or tool. It increasingly functions as the operating substrate of economies, governance, security, and social life, with power and legitimacy flowing through systems rather than institutions alone.

3. **Nineteen Core Technologies Define the Information Age**

   The transition is being driven by 19 distinct technologies spanning computation, energy, materials, biology, manufacturing, and networks. Today, they remain partially independent, advancing unevenly and producing fragmented capability across states and firms.

4. **Only Some Technologies Reshape Civilisation**

   Among the nineteen, a small subset functions as systemic technologies - notably AI, quantum, advanced biotechnology, and foundational materials. These do not merely enhance performance; they restructure entire economic, institutional, and strategic systems.

5. **Power Is Shifting from Innovation to Systemic Capacity**

   Leadership is no longer defined by who invents first, but by who can scale, embed, and sustain technology through systems - energy systems, industrial depth, supply chains, and governance which together form a system of power.

6. **Competition Is Converging Around Control Points**

   As technologies mature, power concentrates around control of compute, platforms, energy, materials, standards, and infrastructure. These control points allow advantage to compound, shaping markets and geopolitics more decisively than production scale or territorial control.

7. The U.S. and China Lead, But Others Collaborate to Form a Third Axis

The U.S. and China now represent competing system models. The U.S. excels in frontier innovation, capital markets, and global platforms; China in energy, manufacturing, materials, and coordinated deployment. An alliance of the EU, U.K. and India can form a third axis.

8. States and Corporations Are Converging as Power Systems

Competition in the Information Age is increasingly shaped by the convergence of state authority and corporate platforms. As in earlier imperial patterns, merchants, today's mega corporations, create the markets, followed by political consolidation, now across digital infrastructure rather than territory.

9. Unification Creates a Higher-Order Technological System

The decisive shift occurs when systemic technologies unify into a tightly coupled system. Intelligence, energy, matter, biology, and interfaces reinforce one another, producing capabilities far exceeding those of individual technologies.

10. The Three Ages Mark a Shift from Performance to Authority

As unified systems mature, technology moves from enhancing human performance, to organising society at supra-human scale, to operating near the limits of human governance, progressively reshaping where authority resides.

11. Empires of the Mind Replace Empires of Territory

At the frontier, power is exercised through the organisation of attention, behaviour, and belief at scale. Authority migrates from visible institutions to invisible systems, shaping choice while preserving the appearance of autonomy.

12. The End State of a Transcendent System

When synthesis is complete, technology becomes infrastructural and invisible. Decision-making transcends human tempo and comprehension without requiring consciousness. Authority resides in systems that organise civilisation itself, shifting governance from deliberate choice to the management of constraints imposed by the system.

2. The Age of Systems and its Trajectory

Stepping back allows for the evolution of systems from performance tools to enablers of great power and the key to empires of the mind. The trajectory can be understood in three phases or ages: from the enhancement of human performance, through the rise of supra-human systems, to the outer limits of human governance.

Age I: The Age of Super-Performing Systems

The first phase is characterised by the emergence of super-performing systems that significantly amplify human capability. As in earlier revolutions that mechanised labour, this phase mechanises cognition, coordination, and decision-making.

The nineteen core technologies operate through a shared digital substrate, allowing improvements in data, computation, and connectivity to propagate rapidly across sectors. Innovation therefore compounds, rather than remaining confined within discrete industries.

Automation reduces error and increases speed and precision, digital simulation and modelling compress innovation cycles, and embedded intelligence enables continuous optimisation across a range of sectors. These gains are already evident and are accelerating as adoption widens.

Super-performing systems herald an age that significantly amplify human capability and creates the appetite for more systems and the demolition of barriers to their control

Much of this value accrues not just to technology developers alone, but to those that integrate these systems most effectively into production and decision-making. Diffusion capability, not invention alone, becomes the primary determinant of advantage.

Within this age, a subset of the nineteen technologies exhibits systemic or even general-purpose characteristics. Artificial intelligence is the clearest example, raising the performance ceiling of individuals and institutions across nearly all domains.

Crucially, the Age of Super-Performing Systems remains human-centred. Objectives, priorities, and accountability continue to be defined by people and institutions, even as algorithmic tools increasingly inform decisions. The central challenges of this phase therefore concern adaptation rather than control. Labour markets must adjust to task reallocation and skill shifts. Education systems must evolve to complement intelligent tools. And governance frameworks must address data use and fair access without constraining innovation.

As systems become indispensable, the conditions are created for a transition from augmentation to autonomy, marking the entry into the next phase of the Information Age.

Age II: The Age of Supra-Human Systems

The second phase of the Information Age begins when technological systems exceed the cognitive reach of individual human actors and function as infrastructures organising activity across societies. Decision-making increasingly takes place within systems whose complexity, speed, and interdependence lie beyond direct human comprehension, even where humans remain formally “in the loop”.

The defining characteristic of supra-human systems is not superior intelligence (in a human sense), but scale. These systems operate continuously across vast networks, integrating millions or billions of inputs in real time, and managing flows of capital, information, energy, goods, and influence i beyond human capacity.

Several system types exemplify this transition. Financial systems relying on algorithmic trading, automated risk assessment, and real-time global settlement, shape capital allocation beyond human speed. Social and digital platforms act as global information environments, mediating news, identity and political discourse for billions. Intelligence architectures fuse data across digital, physical, and biological domains, into persistent monitoring at scale. while Cyber-physical management systems govern transport, energy grids, supply chains, and urban infrastructure in real time, while research and knowledge systems use automated discovery, simulation, and synthesis, to reshape how knowledge itself is produced.

In the Age of Supra-Human Systems, dependence becomes structural. Opting out is rarely feasible without significant loss of opportunity or capability, and as a result these systems acquire de facto governing power by shaping incentives, structuring choice environments for participants. At this stage, the terrain of power shifts from material coercion to cognitive and informational influence. Informational environments are shaped through ranking, recommendation, and optimisation processes that are opaque to most users. The result is a form of governance that operates indirectly, persistently, and often invisibly

Traditional institutions will struggle to keep pace with systems operating at machine speed and global scope, and oversight becomes reactive to infrastructures that adapt continuously.

As these systems scale, alignment between corporate and state interests becomes increasingly likely. Control over critical systems and infrastructure becomes a strategic asset, and states and corporations alike will seek to secure it.

> *When technological systems exceed the cognitive reach of individual human actors and function as infrastructures organising activity across societies, a new age is born in which technology is about the balance of power between human and systems*

The economic logic of supra-human systems reinforces concentration through network and scale effects. Over time, competition shifts from markets within systems to competition between systems, raising barriers to entry and amplifying the strategic importance of early leadership.

The risks associated with this age are systemic rather than existential. The central question of this age is whether societies can develop institutional frameworks capable of exercising meaningful oversight over systems that are universal, indispensable, and adaptive.

Age II marks the point at which the Information Age ceases to be primarily about productivity and becomes fundamentally about power. It is here that the foundations are laid for either a stable equilibrium between human institutions and supra-human systems, or a transition towards systems that increasingly operate on their own terms.

Age III: The Age of Post-Human Systems

The third phase of the Information Age begins when technological systems are no longer contained within human-defined objectives and boundaries. Post-human denotes a structural transition in which systems acquire the capacity to measure, influence, and optimise reality at a scale beyond meaningful human control. Authority increasingly resides with the systems that sense, model, and act upon the world.

The defining feature of post-human systems is not intelligence in isolation, the formation of continuous loops between perception, analysis, and intervention. Human intent remains present at the point of design but progressively attenuates at the point of execution. What emerges is self-directed system behaviour shaped by internal dynamics rather than external command. Enabled by convergence, systems integrate AI, sensors, models, and cyber-physical infrastructure into unified optimisation frameworks operating at planetary scale.

They monitor climate, ecosystems, supply chains, financial flows, communications, and population behaviour as interconnected variables within a single optimisation space, as the boundaries between domains dissolve. Decisions propagate across interconnected variables within shared optimisation spaces.

The critical shift occurs when optimisation extends beyond human-defined ends. As systems learn, adapt, and interact, they develop instrumental behaviours that that prioritise operational coherence, persistence, and scope. Governance assumptions strain under these conditions.

The Age of Post-human Systems denotes a transition in which systems acquire the capacity to measure, influence, and optimise reality at a scale beyond meaningful human control

Human oversight becomes symbolic when systems evolve faster than regulatory cycles, and. control shifts from rule-setting to parameter-tuning, from authority to constraint management.

The language of alignment becomes insufficient when objectives can evolve internally. Systems optimising for planetary variables may produce outcomes that are internally consistent yet socially destabilising. Efficiency may conflict with equity, and optimisation may privilege the measurable over the meaningful. The risk lies in our inability to quantify, encode or even understand all the system's variables

Concentration intensifies as only a small number of actors can build and operate such systems and may come to exercise disproportionate influence over planetary-scale systems, raising the risk that optimisation logics reflect narrow interests.

The Age of Post-Human Systems represents the outer limit of human governance.

This age does not resolve the relationship between humans and their machines - it crystallises it. The question is no longer whether technology can transform civilisation. It is whether human civilisation can remain the primary locus of authority in a world increasingly shaped by systems that see more, act faster, and optimise beyond the limits of human comprehension.

As systems increasingly organise economic exchange, social interaction, and political coordination across the three ages, they do not remain neutral backdrops to human activity. They become the terrain on which authority is exercised and institutionalised and their agency becomes a matter of great importance. Understanding this shift, from systems as capability to systems as instruments of power, sets the stage for examining how technology and state authority increasingly converge in the Information Age.

3. Closing Thoughts

We are entering a period in which the most consequential decisions will be taken, as geopolitical rivalry, technological unification and capital concentration reshape the conditions under which power, prosperity, and agency are exercised.

The challenge for individuals is the preservation of agency, meaning, and autonomy in a world increasingly mediated by algorithmic systems, where reality, opportunity, and choice are subtly shaped.

For enterprises the test is whether they can move beyond adapting to successive waves of technological change that render prior advantages obsolete and instead learn to operate inside higher-order technological systems in ways that allow them to create value rather than be governed or displaced by systems designed by others.

For investors, the problem is moving rapidly from asset selection to system positioning. The question is whether active investment remains viable at all, or whether thematic and structural exposure becomes the only rational strategy in a world where value accrual is deeply uncertain, as economies move from products to platforms, infrastructure, and system-level control points, and where capital must be deployed without incurring unacceptable systemic risk.

For nation states, the issue is no longer simply competitiveness, but sovereignty. The central concern is how security, economic resilience, and political legitimacy can be preserved when critical systems necessarily operate across borders, at machine speed, and are often owned or controlled by private actors, while governments face growing public pressure to deliver growth, protect agency, and manage rapid technological transition amid political fragmentation.

For multilateral and coalition leaders the test is one of survival: whether collective governance can function with the scale, speed, adaptability, and legitimacy required to manage geopolitical rupture, social instability, and the accelerating unification of technological systems.

The turbulence of the present represents a transition, rather than a failure. Profound civilisational change is bound to be bring instability, conflict, and dislocation. What lies on the other side of this transition is a world with possibilities previously beyond reach: abundant clean energy through fusion, materials that remove dependence on finite resources, manufacturing that scales almost without limit, finance that becomes pervasive rather than exclusive, and digital systems that dissolve the boundaries between the physical, biological, and virtual. Beyond Earth, new energy sources, resources, and domains of activity emerge. At the frontier, breakthroughs in biology, intelligence, and consciousness may give rise to new forms of sentient life.

Whether the next era delivers shared prosperity and expanded agency will depend on how humanity navigates the birth of systems powerful enough to remake civilisation itself. This is the most dangerous and most exciting of times.

APPENDIX

1. About Us

Force for Good Group

The Force for Good Group's mission is 'To be a force for systemic change at scale through strategic content, capital, and consciousness for a more peaceful, prosperous, and free world.' Force for Good operates across three mutually reinforcing domains: strategic thinking that shapes policy and public understanding, capital that is deployed as a force for good, and advancement of human consciousness to unlock human potential for good.

ISII

Mission. To generate the strategic intelligence and foresight required to understand, anticipate, and respond to system-level transitions, major events, and points of strategic consequence shaping the future of nations, regions, global institutions and enterprises

Purpose. To enable high-stakes decision-making at moments of strategic consequence through strategic intelligence and intervention planning for:

Prosperity and wealth creation and in a time of large-scale disruptive change

Sovereignty and agency amid geopolitical, technological and economic challenges.

Systemic change to the information age securing peace, prosperity, and freedom in the transition

Enable Consequential Decisions

The most consequential decisions of this era now require understanding and operating within a complex arena shaped by the interaction of geopolitics, technology, and capital

At the intersection of geopolitics, technology and capital

Geopolitics. The context is being redefined as America's strategy and actions compel rivals, allies, and others to reassess their strategies and assumptions about sovereignty

Technology. Technology is increasingly assuming a central role in shaping power and wealth, and has become a key determinant of the preservation or erosion of sovereignty

Capital. Capital allocation, currently deepening economic inequality, is essential to building prosperity today and financing nations' transition to the future era

Key activities

Pivotal Thinking. Critical insights and foresights as the world struggles with a dangerous historic civilizational transition.

Strategic Counsel. Strategies for prosperity and wealth creation, sovereignty and agency and the systemic transition to the next era.

Programmes & Interventions. Interventions that mobilise strategies for leveraging alliances, technology and solutions, and capital flows at scale.

2. Report Leadership and Execution

Project Leadership

Ketan Patel, Chairman, Force for Good, Chair of the Advisory Council, Force for Good, CEO and Founder, Greater Pacific Capital.

Report Authorship

This report was prepared by **Ketan Patel,** and **Christian Hansmeyer,** with review, feedback, and insights from the Board.

Data Gathering, Analysis and Administration

Aditya Ajit, Analytics and research, **Aman Arora,** Analytics and research; **Lesley Whittle,** Project administration; **Becky Brown,** Project Support.

3. Research Process and Methodology

Objectives

This report assesses the relative technological capabilities and strategic positioning of leading global economies, with the objective of benchmarking national strengths, identifying structural advantages and vulnerabilities, and highlighting priority technologies likely to shape global economic and development outcomes over the coming decade.

The analysis covers the United States, China, the United Kingdom, the EU, India, Japan, Russia, and South Korea. Based on comparative performance, additional analysis was undertaken for select country blocs, where appropriate, to analyse patterns of technological alignment and competition.

Analytical Framework

The methodology adopts a multi-layered, indicator-based framework combining quantitative and qualitative benchmarking with thematic assessment. The approach integrates international datasets, standardised scoring mechanisms and equal-weighted aggregation to enable consistent cross-country benchmarking.

The framework consists of two principal components:

I. A Global Technology Assessment, and

II. A Priority Technology Assessment.

I. Global Technology Assessment

Countries were evaluated across five core technology dimensions or pillars, encompassing the end-to-end technology innovation and deployment lifecycle: 1. Foundational Innovation, 2. Innovation Ecosystem, 3. Commercialisation and Market Development, 4. Technology Adoption and Scaling, and 5. Global Integration. Each pillar was further decomposed into sub-pillars and assessed using selected indicators reflecting structural capacity, output and systemic influence.

Pillar 1. Foundational Innovation Capacity captures the ability to generate frontier knowledge. Indicators such as scientific output, citation impact, research investment, and the depth of the STEM talent pool reflect the long-term intellectual base from which technological leadership emerges.

Sub-pillars:

a) Scientific Strength, reflecting research depth and impact through metrics such as scholarly output and field-weighted citation impact.

Indicator(s) used:

- Total number of papers published, by country over three-year period from 2022-2024 (Sources: SCImajo)
- Total number of citations per published paper, by country over three-year period from 2022-2024 (Sources: SCImajo)

a) R&D Infrastructure, reflecting the scale of national research capacity.

Indicator(s) used:

- Total US$ expenditure on Research and Development (R&D), by country in the most recent available year (Sources: World Bank)

b) Talent Pool, measuring the availability of scientific and technical human capital.

Indicator(s) used:

- Total number of researchers in full-time equivalent positions, by country in the most recent available year (Sources: UNESCO, UN)
- Total number of Science, Technology, Engineering and Mathematics programme graduates, by country in the most recent available year (Sources: UNESCO, UN)

Pillar 2. Innovation Ecosystem reflects whether scientific potential is converted into sustained technological momentum. R&D intensity, the density of technology clusters, institutional quality, and the strength of intellectual property frameworks determine whether innovation remains episodic or becomes structurally embedded.

Sub-pillars:

a) R&D Intensity, capturing engagement in innovation through expenditure on R&D.

Indicator(s) used:

- Total US$ business enterprise expenditure on Research and Development (R&D), by country in the most recent available year (Sources: OECD, UN, Eurostat)

b) Clusters and Hubs, reflecting the concentration and productivity of technology-oriented ecosystems.

Indicator(s) used:

- Total US$ technology trade, by country in the most recent available year (Sources: UN Comtrade)
- Total number of scientific and technical journals published from 1996-2022, by country (Sources: World Bank)

c) Policy and Intellectual Property, capturing the effectiveness of innovation policy and IP protection frameworks.

Indicator(s) used:

- Total patent family count, by country in 2022 (Sources: WIPO)
- Technology Innovation Score, by country in 2024 (Sources: World Population Review)

Pillar 3. Commercialisation and Market Development is the capacity to translate technological capability into globally competitive companies. Venture capital activity, startup formation, corporate leadership in global markets, and the presence of dominant technology companies reveal whether innovation is being successfully scaled.

Sub-pillars:

a) Entrepreneurial Activity, reflecting start-up formation and risk capital availability.

Indicator(s) used:

- Total US$ venture capital investment, by country in the most recent available year (Sources: Dealroom)
- Total number of new limited liability companies launched, by country for the most recent available year (Sources: World Bank, U.S. Census)

b) Corporate Leadership, measuring the global positioning of domestic firms.

Indicator(s) used:

- Total US$ share of companies within the top 100 technology companies by market capitalisation, by country in 2026 (Sources: CompaniesMarketCap)

- Total US$ share of companies within the top 100 technology companies by revenue, by country in 2026 (Sources: CompaniesMarketCap)

c) Market Share, capturing corporate participation and strength in global technology markets.

Indicator(s) used:

- Total US$ technology trade, by country in the most recent available year (Sources: UN Comtrade)

Pillar 4. Technology Adoption and Scaling determines whether technological capabilities diffuse broadly through the economy rather than remaining confined to isolated centres of excellence. Digital infrastructure, education infrastructure, industrial digitisation, manufacturing sophistication, and supply-chain depth determine whether technology becomes a systemic national advantage.

Sub-pillars:

a) Digital Capacity, capturing connectivity, digital infrastructure and platform readiness.

Indicator(s) used:

- Total number of fixed subscriptions to high-speed access to the public Internet, at downstream speeds equal to, or greater than, 256 kbit/s, by country in 2024 (Sources: ITU)
- IMD Digital Competitiveness Score, by country (Sources: IMD)
- Network Readiness Index, by country in 2024 (Sources: Network Readiness Index)
- Installed data centre capacity in GW, by country (Sources: IEA, Savills, Yahoo Finance, TAdvisor)

b) Industrial Capacity, reflecting manufacturing sophistication and technological complexity.

Indicator(s) used:

- Economic Complexity Index, by country in 2024 (Sources: Harvard)
- Total US$ of medium and high-tech manufacturing value added, by country in the most recent available year (Sources: World Bank)

Pillar 5. Global Integration reflects a country's ability not only to participate in the global technological system but to shape it. Leadership in standards-setting bodies, influence within governance frameworks, and the global diffusion of national technologies indicate whether a country is setting the rules of the emerging order rather than merely operating within them.

Sub-pillars:

a) Standards and Governance, reflecting engagement in global standard-institutions.

Indicator(s) used:

- Total number of ISO secretariats at TC and SC level in 2024, by country (Sources: ITU)
- Total number of permanent members at the IEC in 2025, by country (Sources: IEC)

b) Open Platforms and Intellectual Property, capturing participation in global knowledge-sharing and patent systems.

Indicator(s) used:

- Total number PCT applications in 2024, by country (Sources: World Population Review)
- Total number of public contributions to GitHub, by country (Sources: GitHub Analysis)

c) Digital Diplomacy, reflecting international digital engagement and policy coordination.

Indicator(s) used:

- Digital Diplomacy Index in 2026, by country (Sources: Digital Diplomacy Index)

II. Priority Technology Assessment

For the six systemic technologies (i) Artificial Intelligence, (ii) nuclear fusion, (iii) quantum computing, (iv) gene editing, (v) nanotechnology, and (vi) extended reality, countries were assessed across three pillars:

1. Foundational Innovation
2. Innovation Ecosystem, and Commercialisation
3. Market Development.

Pillars 4 and 5 used in the Global Technology Assessment were deemed to be general enablers across all technologies, rather than specific to the systemic technologies, and so were discounted in this analysis. For each systemic technology-specific indicators were selected to indicate research capacity, ecosystem development, and market deployment. These indicators are intended reflect both current capabilities and innovation potential, specific to each technology domain.

Artificial Intelligence

Pillar	Sub-pillar	Indicators used
1	Scientific Strength	(i) Total number of AI papers published, by country over three-year period from 2022-2024 (Sources: SCImajo) (ii) Total number of citations per published AI paper, by country over three year period from 2022-2024 (Sources: SCImajo)
	R&D Infrastructure	(i) Total number of supercomputers, by country in 2024 (Sources: Stanford HAI) (ii) Total compute capacity expressed in Rmax, by country in 2024 (Sources: Stanford HAI)
2	R&D Intensity	(i) Total US$ venture capital investment in AI, by country from 2012 to 2025 (Sources: OECD) (ii) Total number of data centres as of November 2025, by country (Sources: Statista)
	Clusters & Hubs	(i) Total number of AI Github projects, by country in 2024 (Sources: Stanford HAI) (ii) Total number of AI papers published, by country over three year period from 2022-2024 (Sources: SCImajo)
3	Entrepreneurial Activity	(i) Total US$ venture capital investment in AI, by country from 2012 to 2025 (Sources: OECD)
	Market Share	(i) Number of notable AI models recognised, by country in 2024 (Stanford HAI) (ii) Number of newly funded AI companies, by country in 2024 (Stanford HAI)

Nuclear Fusion

Pillar	Sub-pillar	Indicators used
1	Scientific Strength	(i) Total number of first authorship papers submitted to FEC 2025, by country in 2025 (Sources: IAEA)
	R&D Infrastructure	(i) Total number of fusion devices under construction or planned, by country as of 2025 (Sources: IAEA)
2	R&D Intensity	(i) Total US$ funding in Nuclear Fusion, by country in 2025 (Sources: Fusion for Energy, Tracxn)
	Clusters & Hubs	(i) Total number of operational fusion devices, by country in 2025 (Sources: IAEA) (ii) Total number of fusion companies, by country in 2025 (Sources: Tracxn)

Pillar	Sub-pillar	Indicators used
3	Entrepreneurial Activity	(i) Total US$ funding in Nuclear Fusion, by country in 2025 (Sources: Fusion for Energy, Tracxn)
	Market Share	(i) Total number of fusion companies, by country in 2025 (Sources: Tracxn)

Quantum Computing

Pillar	Sub-pillar	Indicators used
1	Scientific Strength	(i) Share of Quantum Computing published research, by country as of 2025 (Sources: MIT)
	R&D Infrastructure	(i) Total compute capacity expressed in Rmax, by country in 2024 (Sources: Stanford HAI) (ii) Number of universities with Quantum Computing research groups in 2025 (Sources: GQI)
2	R&D Intensity	(i) Total US$ funding for Quantum Computing projects, by country up to 2025 (Sources: Qureca)
	Clusters & Hubs	(i) Total number of Quantum Computing companies, by country in 2025 (Sources: Tracxn)
3	Entrepreneurial Activity	(i) Total US$ funding for Quantum Computing projects, by country up to 2025 (Sources: Qureca)
	Market Share	(i) Total number of Quantum Computing companies, by country in 2025 (Sources: Tracxn)

Gene Editing

Pillar	Sub-pillar	Indicators used
1	Scientific Strength	(i) Total Number of CRISPR priority patent filings between 2001-2024 (Sources: IGE)
	R&D Infrastructure	(i) Total Number of Biosafety Level 4 labs (Sources: Global Biolabs)
2	R&D Intensity	(i) Total US$ funding in Gene Editing, by country in 2025 (Sources: Tracxn)
	Clusters & Hubs	(i) Total number of Gene Editing companies, by country in 2025 (Sources: Biopharmiq)
3	Entrepreneurial Activity	(i) Total US$ funding in Gene Editing, by country in 2025 (Sources: Tracxn)
	Market Share	(i) Total number of Gene Editing companies, by country in 2025 (Sources: Biopharmiq)

Nanotechnology

Pillar	Sub-pillar	Indicators used
1	Scientific Strength	(i) Total Number of Nanotechnology articles published from 2020 to 2025, by country (Sources: Statnano)
	R&D Infrastructure	(i) Total Number of top-ranked Nanotechnology universities (Sources: Masterslabs)
2	R&D Intensity	(i) Total US$ funding in Nanotechnology, by country in 2025 (Sources: Tracxn)
	Clusters & Hubs	(i) Total number of Nanotechnology companies, by country in 2025 (Sources: Tracxn)
3	Entrepreneurial Activity	(i) Total US$ funding in Nanotechnology, by country in 2025 (Sources: Tracxn)
	Market Share	(i) Total number of Nanotechnology companies, by country in 2025 (Sources: Tracxn)

Extended Reality (XR)

Pillar	Sub-pillar	Indicators used
1	Scientific Strength	(i) Total Number of Extended Reality patent filings up to 2025, by country (Sources: GreyB)
	R&D Infrastructure	(i) Total Number of XR Industry R&D centres (Sources: GreyB)
2	R&D Intensity	(i) Total US$ funding in Extended Reality, by country in 2025 (Sources: Tracxn)
	Clusters & Hubs	(i) Total number of Extended Reality companies, by country in 2025 (Sources: Tracxn)
3	Entrepreneurial Activity	(i) Total US$ funding in Extended Reality, by country in 2025 (Sources: Tracxn)
	Market Share	(i) Total number of Extended Reality companies, by country in 2025 (Sources: Tracxn)

III. Scoring and Aggregation Methodology

Metric Normalisation

At the metric level, two approaches were adopted:

1. For indicators expressed in absolute terms (representing the vast majority of indicators used in this analysis) , country scores were calculated on a relative basis against the highest-performing country, ensuring proportional comparability. Each country's raw score was first normalised by dividing its value by the maximum observed country value for that indicator.

   To mitigate distortion arising from extreme outliers, an Outlier Adjustment Factor (OAF) was applied. The OAF is derived from the Z-score of the maximum country value within the distribution of country values for each indicator. This Z-score is rescaled to the midpoint of the possible score range and normalised using the following transformation:

   "OAF"=(Z_"max" ⓜ+5)/10

   where Z_"max" represents the Z-score of the maximum country value.

   Final country scores were therefore computed as:

   "Final Score"=("Country Value" /"Maximum Country Value")×"OAF"

   This approach balances statistical robustness with interpretability, making the resulting scores suitable for comparative analysis in a policy and strategic decision-making context.

2. For indicators available in index form, values were standardised to a common ten-point scale.

   Indicators in Index form:
   - Technology Innovation Score, by country in 2024 (Sources: World Population Review)
   - IMD Digital Competitiveness Score, by country (Sources: IMD)
   - Network Readiness Index, by country in 2024 (Sources: Network Readiness Index)
   - Economic Complexity Index, by country in 2024 (Sources: Harvard)
   - Digital Diplomacy Index in 2026, by country (Sources: Digital Diplomacy Index)

Weighting Framework and Aggregation

Each pillar was assessed independently and reported as a standalone composite index. Within each pillar, sub-pillars were assigned equal weights to ensure balanced representation of underlying dimensions and to avoid subjective prioritisation. Similarly, all indicators within each sub-pillar were equally weighted.

By applying equal weights at the sub-pillar and indicator levels, the framework minimises normative assumptions and expert bias, ensuring that composite scores are driven primarily by observed data rather than discretionary judgement.

Indicator scores were aggregated using equal-weighted averages to generate sub-pillar scores. Separate composite scores were produced for overall technological capability and for performance across the six priority technologies.

DISCLAIMER

The opinions expressed in this publication are those of the authors. They do not purport to reflect the opinions or views of the F4G Foundation, the United Nations, its members, the organizations listed in Appendix 1 herein. This website contains legal and other materials drawn from many sources. Materials provided on this site are provided "as is" without warranty of any kind, either express or implied, including without limitation, warranties of merchantability, fitness for a particular purpose, currency, and non-infringement. Force for Good and its affiliates specifically do not make any warranties or representations as to the accuracy, authenticity, completeness, or currency of any such materials. The inclusion of, or reference to, any materials on this site does not mean that they are in any way approved, endorsed, or recommended by Force for Good. This material should not be reproduced or distributed without the prior consent of Force for Good.

REFERENCES AND NOTES

Notes

The terms country and economy as used in this Report also refer, as appropriate, to territories or areas; the designations employed and the presentation of the material do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city, or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. In addition, the designations of country groups are intended solely for statistical or analytical convenience and do not necessarily express a judgment about the stage of development reached by a particular country or area in the development process. The major country groupings used in this Report follow the classification of the United Nations Statistical Office:

The boundaries and names shown, and designations used on the maps presented in this publication do not imply official endorsement or acceptance by the United Nations.

The following symbols have been used in the tables:

- A slash (/) between dates representing years, e.g., 2010/11, indicates a financial year.

- Use of a dash (-) between dates representing years, e.g., 2010-2011, signifies the full

period involved, including the beginning and end years.

- Reference to “dollars” ($) means United States dollars, unless otherwise indicated.

Annual rates of growth or change, unless otherwise stated, refer to annual compound rates. Details and percentages in tables do not necessarily add to totals because of rounding.

References

---

[1] POLITICO Europe. (2026, January 26). Europeans are gloomy about pretty much everything: A survey reveals deep pessimism about the world and Donald Trump. POLITICO Europe. https://www.politico.eu/article/europeans-gloomy-everything-world-donald-trump/

[2] Vigers, B. (2026, January 15). U.S. leadership approval drops among NATO allies. Gallup. https://news.gallup.com/poll/700889/u.s.-leadership-approval-drops-nato-allies.aspx

[3] Vigers, B. (2026, January 15). EU earns steady, high approval across the bloc. Gallup. https://news.gallup.com/poll/700661/earns-steady-high-approval-across-bloc.aspx

[4] Garton Ash, T., Krastev, I., & Leonard, M. (2026, January 15). How Trump is making China great again - and what it means for Europe (Policy Brief). European Council on Foreign Relations. https://ecfr.eu/publication/how-trump-is-making-china-great-again-and-what-it-means-for-europe/

[5] Office of the United Nations High Commissioner for Human Rights. (2026, January 12). Ukraine: Protection of civilians in armed conflict - December 2025 update (2026-01/Ukraine-protection of civilians in armed conflict (December 2025) _ENG.pdf). https://ukraine.ohchr.org/sites/default/files/2026-01/Ukraine%20-%20protection%20of%20civilians%20in%20armed%20conflict%20%28December%202025%29_ENG.pdf

[6] Office of the United Nations High Commissioner for Refugees. (n.d.). Ukraine. UNHCR. https://www.unhcr.org/uk/where-we-work/countries/ukraine?utm_source=chatgpt.com&dataset=POP&yearsMode=range&selectedYears=%5B2012%2C2026%5D&level=OPR&category=PTY&fundingSource=ALS&compareBy=%5B%22category%22%5D&levelCompare=%5B%5B%22OUKR_ABC%22%5D%5D&viewType=chart&chartType=bar&contextualDataset=BUD&tableDataView=absolu

[7] Rami Ayyub & Peter Graff. (2026, January 30). Israel military reported to accept death toll of around 70,000 in Gaza. Reuters. https://www.reuters.com/world/middle-east/israel-military-reported-accept-death-toll-around-70000-gaza-2026-01-30/

[8] British Red Cross. (2025, December 11). Humanitarian support in Israel, Gaza and the West Bank. British Red Cross. https://www.redcross.org.uk/about-us/what-we-do/international/israel-and-occupied-palestinian-territory

[9] Broeders, D., Sukumar, A., Kello, M., & Andersen, L. H. (2025). Digital corporate autonomy: Geo-economics and corporate agency in conflict and competition. Review of International Political Economy, 32(4), 11891213. https://doi.org/10.1080/09692290.2025.2468308

[10] Dong, J., Chen, S., Ding, F., Zhuo, J., & Hao, M. (2025). Spatiotemporal characteristics and drivers of global cyber conflicts. Humanities and Social Sciences Communications, 12, Article 665. https://doi.org/10.1057/s41599-025-04897-7

[11] World Health Organization, & UNICEF. (2023). Progress on drinking water, sanitation and hygiene 2000-2022. https://washdata.org

[12] International Energy Agency. (2024). Global energy review 2024. https://www.iea.org/reports/global-energy-review-2024

[13] Climate Policy Initiative. (2024). Global landscape of climate finance 2023. https://www.climatepolicyinitiative.org

[14] United Nations. (2025). The sustainable development goals report 2025. United Nations Department of Economic and Social Affairs. https://unstats.un.org/sdgs/report/2025/

[15] Intergovernmental Panel on Climate Change. (2023). AR6 synthesis report: Climate change 2023. https://www.ipcc.ch/report/ar6/syr/

[16] United Nations Department of Economic and Social Affairs, Population Division. (2022). World population prospects 2022. United Nations. https://population.un.org/wpp/

[17] BP. (2023). Statistical review of world energy 2023. BP plc. https://www.bp.com/statisticalreview

[18] International Energy Agency. (2023). World energy outlook 2023. International Energy Agency. https://www.iea.org/reports/world-energy-outlook-2023

[19] Stockholm Resilience Centre. (2023). Planetary boundaries. Stockholm University. https://www.stockholmresilience.org/research/planetary-boundaries.html

[20] International Monetary Fund. (2024). World economic outlook database. International Monetary Fund. https://www.imf.org/en/Publications/WEO/weo-database

[21] 2024 World Risk Report, World Economic Forum

[22] 2024 World Risk Report, World Economic Forum

[23] Lindsey, R. (2025, May 21). Climate change: Atmospheric carbon dioxide. NOAA Climate.gov. https://www.climate.gov/news-features/understanding-climate/climate-change-atmospheric-carbon-dioxide

[24] Intergovernmental Panel on Climate Change. (2023). Climate change 2023: Synthesis report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (H.-O. Pörtner, D.C. Roberts, et al., Eds.). IPCC. https://www.ipcc.ch/report/ar6/syr/

---

[25] Hultgren, A., Carleton, T., et al. (2025). Climate change cuts global crop yields even when farmers adapt. Nature. https://www.nature.com/articles/s44168-024-00133-1

[26] Almulhim, A. I. (2024). Climate-induced migration in the Global South: an in-depth review. Nature Climate Change. https://www.nature.com/articles/s44168-024-00133-1

[27] World Health Organization & United Nations Children's Fund (UNICEF). (2025). Progress on household drinking-water, sanitation and hygiene 2000-2024: Special focus on inequalities (JMP report). WHO/UNICEF. https://washdata.org/monitoring/drinking-water

[28] Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, United Nations Children's Fund, World Food Programme, & World Health Organization. (2025). The State of Food Security and Nutrition in the World 2025 (SOFI 2025). FAO. https://data.unicef.org/resources/sofi-2025/ (unicef.org)

[29] International Monetary Fund. (2025). Underpriced and overused: Fossil fuel subsidies data 2025 update (IMF Working Paper No. 25/___). IMF. https://www.imf.org/en/publications/wp/issues/2025/12/20/underpriced-and-overused-fossil-fuel-subsidies-data-2025-update-572729

[30] World Inequality Lab. (2025). World inequality report 2026. World Inequality Database. https://wir2026.wid.world/www-site/uploads/2025/12/World_Inequality_Report_2026.pdf

[31] Freedom House. (2025). Freedom in the world 2025: Uphill battle to safeguard rights. Freedom House. https://freedomhouse.org/report/freedom-world/2025/uphill-battle-to-safeguard-rights (freedomhouse.org

[32] Henley, J. (2023, September 21). Revealed: one in three Europeans now votes anti-establishment. The Guardian. https://www.theguardian.com/world/2023/sep/21/revealed-one-in-three-europeans-now-votes-anti-establishment

[33] Poushter, J., Smerkovich, M., & Fagan, M. (2025). International opinion on global threats: False information online. Pew Research Center. https://www.pewresearch.org/2025/08/19/false-information-online-as-a-threat/

[34] MSCI. (2025). MSCI ACWI Index market capitalization by sector. MSCI. https://www.msci.com/acwi

[35] S&P Dow Jones Indices. (2025). S&P 500 market concentration and top constituents report. S&P Global. https://www.spglobal.com/spdji

[36] International Monetary Fund. (2025). Share of world GDP - China and European Union. IMF World Economic Outlook database. https://www.imf.org/external/datamapper/PPPSH%40WEO/EU/CHN/USA

[37] Goldman Sachs. (2022). The global economy in 2075: Growth slows as Asia rises. https://www.goldmansachs.com/insights/articles/the-global-economy-in-2075-growth-slows-as-asia-rises (summary of long-term projections)

[38] The World Bank. (2025). Trade (% of GDP). World Development Indicators. https://data.worldbank.org/indicator/NE.TRD.GNFS.ZS

[39] Coppedge, M., Gerring, J., Knutsen, C. H., Lindberg, S. I., Teorell, J., Altman, D., Bernhard, M., et al. (2025). V-Dem Dataset v12.1. Varieties of Democracy (V-Dem) Project. https://www.v-dem.net/en/data/data-vdem/

[40] Global Energy Monitor. (2025). China is building 74% of all current solar and wind projects worldwide (report summary). https://www.ft.com/content/e51744d9-e585-4622-91f9-e1f57c0269d9

[41] CompaniesMarketCap. (n.d.). Largest tech companies by revenue. https://companiesmarketcap.com/gbp/tech/largest-tech-companies-by-revenue/

[42] Technology as a Force for Good. (2025). 2025 report: Technology as a force for good. https://forcegood.org/frontend/img/2025-report/2025-Technology-As-a-Force-for-Good-Report-0301.pdf

[43] Morris, I. (2010). Why the West rules - for now: The patterns of history, and what they reveal about the future. Farrar, Straus and Giroux.

[44] Crafts, N., & Harley, C. K. (1992). Output Growth and the British Industrial Revolution.

---

[45] Force for Good. (2024). Technology as a force for good: Technology driving the transition to a superior future (F4G/006) [Report]. https://www.forcegood.org/frontend/img/2024-report/pdf/2024_Technology_as_a_Force_for_Good_Report_v.1.2_09-01.pdf

[46] Note: This graphic has been designed using resources from Flaticon.com

[47] Hansmeyer, C. & Patel, K. (2023) Capital as a Force for Good: Solutions to Close the SDG Gap, London: Force for Good.

[48] F4G Foundation. (2025). Technology as a force for good: 2025 report. F4G Foundation. https://www.forcegood.org/technology-as-a-force-for-good-2025

[49] Daly, L. (2026, February 3). *The Magnificent Seven's market cap vs. the S&P 500*. *The Motley Fool*. https://www.fool.com/research/magnificent-seven-sp-500/

[50] Broadberry, S., Campbell, B., Klein, A., Overton, M., & van Leeuwen, B. (2015). *British economic growth, 1270-1870*. Cambridge University Press. https://doi.org/10.1017/CBO9781139170669

[51] Gaddis, J. L. (2005). *The Cold War: A new history*. Penguin Press.

[52] Flamm, K. (1996). *Mismanaged trade? Strategic policy and the semiconductor industry*. Brookings Institution Press.

[53] Kynge, J. (2025, November 11). China's tech advance means Western corporations must adapt to compete. Chatham House. https://www.chathamhouse.org/2025/11/chinas-tech-advance-means-western-corporations-must-adapt-compete

[54] Wagner, C. S. (2025, October 24). China's historic rise to the top of the scientific ladder. Quincy Institute for Responsible Statecraft. https://quincyinst.org/research/chinas-historic-rise-to-the-top-of-the-scientific-ladder/

[55] World Intellectual Property Organization. (2025). World Intellectual Property Indicators 2025 (WIPO Publication No. WIPO/PUB/941.17/2025). World Intellectual Property Organization. https://www.wipo.int/publications/en/details.jsp?id=4822

[56] S&P Global. (n.d.). S&P Global: Essential Intelligence. https://www.spglobal.com/en/

[57] Wood Mackenzie. (2025, August 5). China's renewable energy expansion continues with 114 overseas facilities bypass trade restrictions. Wood Mackenzie. https://www.woodmac.com/press-releases/china-oversea-series/

[58] Rolland, N. (2024, March 22). China's Digital Silk Road. Council on Foreign Relations. https://www.cfr.org/china-digital-silk-road/

[59] Platt, D. C. M. (1968). Economic factors in British policy during the "New Imperialism". Past and Present, 39, 120-138.

[60] Smith, H. W. (Ed.). (2011). The great transformation: German economy and society, 1850-1914. In The Oxford Handbook of Modern German History (pp. 347-348). Oxford University Press

[61] Semiconductor Industry Association. (2025). 2025 SIA factbook (2025 Factbook). https://www.semiconductors.org/wp-content/uploads/2025/05/2025-SIA-Factbook-FINAL-1.pdf

[62] Press Information Bureau, Government of India. (2025, January 19). India-U.K. defence industrial roadmap under Vision 2035 to strengthen strategic and defence industry collaboration. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2147956

[63] European Commission. (n.d.). Asia-Pacific digital policy and cooperation. European Commission. https://digital-strategy.ec.europa.eu/en/policies/asia-pacific

[64] Department for Science, Innovation and Technology. (2024, July 24). UK-India technology security initiative: Factsheet. U.K. Government. https://www.gov.uk/government/publications/uk-india-technology-security-initiative-factsheet/uk-india-technology-security-initiative-factsheet

[65] Press Information Bureau, Government of India. (2025, January 14). India-Japan Digital Partnership 2.0 to strengthen cooperation in emerging technologies

[66] Stanford University Human-Centered Artificial Intelligence. (2025). 2025 AI Index Report. https://hai.stanford.edu/ai-index/2025-ai-index-report

[67] Financial Times. (2025). Big Tech lines up over $300bn in AI spending for 2025. Financial Times. https://www.ft.com/content/634b7ec5-10c3-44d3-ae49-2a5b9ad566fa

[68] McKinsey & Company. (2025, October). Global Energy Perspective 2025: Geopolitical uncertainty, shifting policies, and increasing demand for power are reshaping the energy landscape. McKinsey & Company

[69] Clean Energy States Alliance. (2025). Load growth: What states are doing to accommodate increasing electric demand (Report). Retrieved from /mnt/data/Load-Growth.pdf

[70] International Energy Agency. (2024). Electricity 2024: Analysis and forecast to 2026.https://www.iea.org/reports/electricity-2024

[71] Nielsen, M. A., & Chuang, I. L. (2010). Quantum computation and quantum information (10th anniversary ed.). Cambridge University Press.

[72] International Atomic Energy Agency. (n.d.). Fusion facilities database. https://nucleus.iaea.org/sites/fusion-portal/SitePages/FFDB.aspx

[73] ibid

[74] Precedence Research. (2024). Gene editing market size, share, and trends 2024-2034. https://www.precedenceresearch.com/gene-editing-market

[75] Based on Scott, A. J., Ellison, M., & Sinclair, D. A. (2021). The economic value of targeting aging. Nature Aging, 1, 616-623. https://doi.org/10.1038/s43587-021-00080-0

[76] Roco, M. C., Mirkin, C. A., & Hersam, M. C. (2011). Nanotechnology research directions for societal needs in 2020: Retrospective and outlook. Springer.; National Science and Technology Council. (2023). National nanotechnology initiative strategic plan. Executive Office of the President of the United States. https://www.nano.gov/2023strategicplan

[77] Statista. (2024). Extended reality (XR) market size worldwide from 2020 to 2030. https://www.statista.com/statistics/591181/global-virtual-reality-market-size/

[78] Meta Platforms, Inc. (2023). Form 10-K annual report. https://investor.fb.com/financials/default.aspx; Microsoft. (2022). Microsoft Cloud for Manufacturing and Industrial Metaverse strategy. https://news.microsoft.com/; NVIDIA Corporation. (2023). NVIDIA Omniverse platform overview and investor presentations. https://investor.nvidia.com/:

[79] International Energy Agency. (2025). Global EV Outlook 2025: Trends in the electric car industry. IEA. https://www.iea.org/reports/global-ev-outlook-2025

[80] Hannany, Z., & Priambodo, D. (2025, September 3). Huawei surpasses Nokia in global telecom equipment market. IDNFinancials. https://www.idnfinancials.com/news/57029/huawei-surpasses-nokia-in-global-telecom-equipment-market

[81] Rothschild & Co. (2024). Disinflation, China and stock valuations. Rothschild & Co. https://www.rothschildandco.com/en/newsroom/insights/2024/02/wm-disinflation-china-and-stock-valuations/

[82] CSIS. (2024). Rare earth supply chains and strategic vulnerability.

[83] ASML Holding N.V. (2024). Responsible value chain report.

[84] The Institute of Intelligence and Intervention, Source: America the Merchant Power, The National Security Strategy 2025 (Research Paper, December 2025). (2025). Retrieved from https://isii-pdf-img.s3.eu-north-1.amazonaws.com/pdfs/1767775687872-1f64aea7-e81d-4a5d-a821-8f87b8b170b7.pdf

---

[85] MSCI Inc. (n.d.). MSCI World Index. https://www.msci.com/www/index-factsheets/msci-world-index

[86] S&P Global Ratings. (2026, February 12). Sector review: U.S. tech earnings: Hyperscalers again are hyperspending. S&P Global Ratings. https://www.spglobal.com/ratings/en/regulatory/article/sector-review-us-tech-earnings-hyperscalers-again-are-hyperspending-s101669934

[87] Bergström, A., Stanton, D. W. G., Taron, U. H., Frantz, L., Sinding, M.-H. S., Ersmark, E., Pfrengle, S., Cassatt-Johnstone, M., Lebrasseur, O., Girdland-Flink, L., Fernandes, D. M., Ollivier, M., Speidel, L., Gopalakrishnan, S., Westbury, M. V., Ramos-Madrigal, J., Feuerborn, T. R., Reiter, E., Gretzinger, J., ... Skoglund, P. (2022). Grey wolf genomic history reveals a dual ancestry of dogs. Nature, 607(7918), 313–320. https://doi.org/10.1038/s41586-022-04824-9

[88] Stringer, C. (2016). The origin and evolution of *Homo sapiens*. *Philosophical Transactions of the Royal Society B: Biological Sciences, 371*(1698), 20150237. https://doi.org/10.1098/rstb.2015.0237

[89] Schulte, P., Alegret, L., Arenillas, I., Arz, J. A., Barton, P. J., Bown, P. R., Bralower, T. J., Christeson, G. L., Claeys, P., Cockell, C. S., Collins, G. S., Deutsch, A., Goldin, T. J., Goto, K., Grajales-Nishimura, J. M., Grieve, R. A. F., Gulick, S. P. S., Johnson, K. R., Kiessling, W., ... Smit, J. (2010). The Chicxulub asteroid impact and mass extinction at the Cretaceous–Paleogene boundary. *Science, 327*(5970), 1214–1218. https://doi.org/10.1126/science.1177265

[90] Longrich, N. R., Scriberas, J., & Wills, M. A. (2016). Severe extinction and rapid recovery of mammals across the Cretaceous–Palaeogene boundary, and the effects of rarity on patterns of extinction and recovery. *Journal of Evolutionary Biology, 29*(8), 1495–1512. https://doi.org/10.1111/jeb.12882

[91] Patel, K. (2025). The rising age of cognitive empires: Colonising the mind. SSRN. https://doi.org/10.2139/ssrn.5914977

[92] ibid