

Global Future Industry Index (GFII) 2025

PREFACE

The 2025 Global Future Industry Index is a premier research initiative spearheaded by ICV TA&K, fortified by the strategic collaboration of distinguished organizations including WIPO, OECD, and IRENA. This edition, grounded in rigorous multi-dimensional analysis, synthesizes expansive secondary research, proprietary data from international institutions, and high-level consultations with global pioneers. The study provides a sophisticated assessment of over 20 sovereign entities and regions, evaluating their strategic positioning across industrial architecture, deployment maturity, R&D intensity, and ecological sustainability.

In this 2025 framework, future industries are defined as the vanguard of the global economy—high-stakes sectors where radical innovation meets societal transformation. Our research prioritizes seven high-impact domains that represent the convergence of digital, physical, and biological systems: General Artificial Intelligence (GAI), Neuro-Intelligence, Embodied AI, Bio-manufacturing, Fusion & Green Energy, Quantum Information & Networking, 6G Communications.

By deploying this index, our mission is to deliver actionable intelligence and strategic foresight to global policymakers, industrial titans, and institutional investors. We extend our profound appreciation to the ICV TA&K analytical team and the global expert community, whose specialized knowledge has been instrumental in calibrating this 2025 index as a compass for the next industrial era.

"Decoding the Neural Map of Global Progress: The 2025 Benchmark for Future Industrial Leadership."



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01

Executive summary



01

Executive summary

This report presents a comprehensive quantitative analysis of the 2025 Global Future Industry Development Index across six frontier technology sectors: Embodied Intelligence, Fusion & Green Energy, 6G Technology, Neuro-Intelligence, Bio-manufacturing, and Quantum Information & Networking. Drawing strictly on ranked city and enterprise data, the analysis maps the global competitive landscape, core technological routes, and industrialization priorities shaping the next generation of high-value innovation.

Key Regional Dominance Patterns



The United States emerges as the overall global leader, holding dominant positions in five of the six sectors. It excels in foundational research, commercial capital deployment, and cross-cutting platform technologies—evident in its leadership in Embodied AI (Boston Dynamics, Neuralink), Fusion Energy (CFS, Helion Energy), 6G (SpaceX, Qualcomm), Neuro-Intelligence (8 of the top 10 enterprises), and Quantum Computing (IBM Quantum, Google Quantum). U.S. strength is defined by a synergistic ecosystem of top-tier universities, venture capital, and corporate R&D, driving rapid translation from lab to market.



China solidifies its position as a formidable industrial and application leader, with targeted supremacy in scalable manufacturing, strategic infrastructure, and niche technical routes. Its standout strengths include full-chain Quantum Information industrialization (Hefei, QuantumCTEK), 6G patent leadership (Shenzhen, Huawei/ZTE), large-scale Bio-manufacturing CRDMO services (WuXi Biologics), and high-performance affordable Embodied AI hardware (Unitree Robotics). Chinese cities and firms leverage state-led research clusters, complete supply chains, and large-scale testbeds to accelerate commercialization.



Europe, Canada, Japan, and Singapore form a diversified third pillar of specialized innovation. Europe (Finland, Sweden, Switzerland) leads in 6G system architecture, industrial enzymes (Novozymes), and quantum cryogenic hardware; Canada dominates photonic and annealing quantum computing (Xanadu, D-Wave); Japan excels in precision robotics and quantum-AI integration; Singapore pioneers niche applications like maritime 6G and cultured meat.

Sectoral Core Trends

Dual Track of Innovation: Frontier sectors universally split into two priorities—foundational research leadership (e.g., Boston in Bio-manufacturing, Harvard/MIT in Neuro-Intelligence) and industrial scaling (e.g., Shanghai in Bio-manufacturing CXO, Hefei in Quantum full-chain production).

Convergence is Key: Cross-sector integration drives competitive advantage, including Quantum-AI (Tokyo), Bio-hardware fusion (Shenzhen), and 6G-satellite integration (San Francisco).

Specialization Over Broadness: Mid-ranked cities and enterprises win by niche focus—e.g., Copenhagen in collaborative robotics, Zurich in quantum cryogenic electronics, and Eat Just in cultured meat.

From R&D to Commercialization: 2025 marks a pivotal shift, with leaders prioritizing clinical trials (Neuro-Intelligence), commercial deployments (Embodied AI logistics robots), and utility-scale systems (Fusion Energy, Quantum Computing).

Strategic Implications

For global stakeholders, the index underscores that success in future industries depends on aligning regional strengths with sectoral value chains: U.S.-style ecosystem integration for breakthrough research, Chinese-style industrialization for scaling, and European/Asian-style specialization for niche leadership. As competition intensifies, cross-border collaboration (e.g., Quantinuum's U.S./UK partnership) and investment in core infrastructure (testbeds, supply chains, standards) will be critical to capturing the economic and technological benefits of the next industrial revolution.

02

Introduction:Trends, Transformation & Worldwide Effect

How do we define the future industry of 2025?

Based on the technological milestones achieved by 2024 and comprehensively analyzing factors such as autonomous industrial loops, sovereign AI infrastructure, and global supply chain resilience, this report identifies seven core future industry clusters. These sectors represent the pinnacle of global innovation and are categorized into two strategic tiers.

The 2025 Industrial Layout: Seven Core Clusters

Pioneer Growth Industries (Scaling & Integration Phase):

- General Artificial Intelligence (GAI): Systems evolving from generative tools into autonomous, reasoning agents capable of closed-loop task execution.
- Embodied AI: The seamless integration of intelligence into physical forms, primarily humanoid robotics and autonomous industrial systems.
- Fusion & Green Energy: A unified energy matrix centered on the commercial breakthrough of controlled nuclear fusion and high-efficiency hydrogen systems.
- 6G Communications: The ultra-low latency "neural system" of the global economy, integrating space, air, and ground into a single sensing-communication network.

Frontier Exploration Industries (Paradigm-Shift Phase):

- Neuro-Intelligence: The ultimate convergence of Neuromorphic Computing hardware and Brain-Computer Interfaces (BCI).

- Bio-manufacturing: The industrial-scale "programming" of cells to grow materials, chemicals, and pharmaceuticals, replacing traditional extractive methods.
- Quantum Information & Networking: The transition from experimental machines to secure, multi-node quantum-enhanced computation and connectivity.

Evolutionary Logic: 2025 vs. 2024 Key Transitions
Compared to the 2024 Index, the 2025 framework features a more streamlined and integrated architecture, reflecting the maturation of cross-domain technologies:

1. The Consolidation of "Neuro-Intelligence"

The most significant shift in this report is the formal merger of Neuromorphic Computing and BCI into a single domain: Neuro-Intelligence.

The Rationale: By 2025, the industry realized that high-bandwidth brain interaction is only viable when paired with low-power, brain-like hardware. This merger reflects the birth of a unified "neural industry" value chain, moving beyond discrete experimental technologies.

2. From "Biotechnology" to "Bio-manufacturing"

We have narrowed the broad scope of biotechnology to focus specifically on Bio-manufacturing.

The Rationale: In 2025, the global competitive focus shifted from "discovery" to "production." This adjustment highlights the rise of Bio-foundries as the new standard for sovereign material security, marking the true industrialization of biological sciences.

How do we define the future industry of 2025?

3. Strategic Integration of "Low-Altitude" and "Space"

Unlike 2024, which listed the "Low-Altitude Economy" as a standalone sector, the 2025 Index integrates these capabilities into its foundational pillars.

The Rationale: In 2025, low-altitude flight is no longer an isolated industry but a primary application of Embodied AI (autonomous carriers) and 6G Communications (network management). This consolidation avoids redundancy and emphasizes the "source technologies" that drive these spatial economies.

4. The Centrality of "Fusion" in the Energy Matrix

The energy sector has been refined into Fusion & Green Energy, with a heavier weight on nuclear fusion.

The Rationale: To meet the exponential power demands of GAI clusters in 2025, the global narrative has shifted from mere "sustainability" to "energy abundance." Fusion is now recognized as the critical bottleneck-breaker for national industrial competitiveness.

Methodology: The Global Future Industry Index in 2025

The 2025 Global Future Industry Index serves as the fourth annual benchmark, meticulously tracking the rapid evolution and cross-sectoral integration of the world's most transformative industries. This edition evaluates the strategic positioning and performance of over 20 sovereign nations and regions, representing approximately 75% of global GDP.

The 2025 methodology has been refined to capture the shift from discrete technological experimentation to integrated industrial application, focusing on the seven core clusters: General AI, Neuro-Intelligence, Embodied AI, Bio-manufacturing, Fusion & Green Energy, Quantum Information, and 6G Communications.

I. Research Framework: A Dual-Engine Approach

The index is built upon a hybrid research model that bridges historical data with forward-looking intelligence:

Secondary Research: A continuous review of thousands of high-impact sources, including scientific literature, national strategic blueprints, and data from international organizations such as UNIDO, WIPO, the OECD, and the IMF.

Primary Research: Over 30 in-depth, semi-structured interviews with global pioneers—including neural engineers, quantum physicists, GAI researchers, and sovereign wealth fund strategists. This year, primary research focused specifically on "weak signals" in Neuro-Intelligence and Bio-manufacturing to anticipate market shifts before they appear in traditional datasets.

II. The 2025 Indicator Architecture

To reflect the increasing complexity of the 2025 landscape, the index has expanded from 15 to 18 key indicators, organized into four strategic pillars:

Pillar 1: Innovation Capacity: Measuring R&D intensity, patent quality, and the concentration of elite scientific talent.

Pillar 2: Industrial Deployment: Assessing unicorn density, the scale of pilot commercial projects, and supply chain autonomy.

Pillar 3: Policy Pivot & Agility: Evaluating how effectively national policies (e.g., regulatory sandboxes and strategic funding) have pivoted toward the seven core clusters.

Pillar 4: Ecosystem & Sustainability: Measuring the alignment of future industries with carbon-negative goals and ethical safety frameworks.

III. Scoring and Normalization Logic

The index employs a standardized scoring system to ensure cross-border comparability:

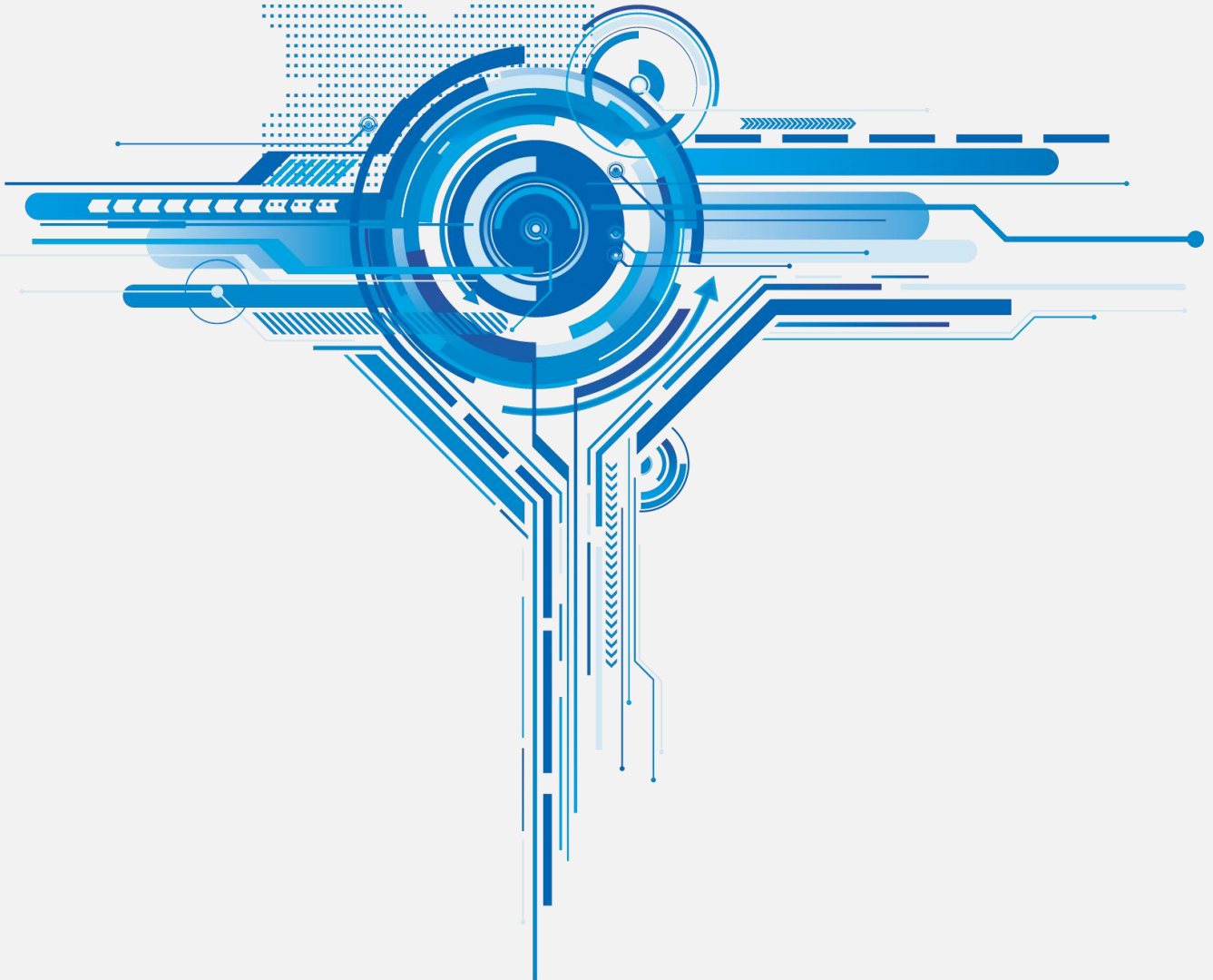
Quantitative Metrics: Data such as investment values or growth rates are scaled using Min-Max Normalization (0-100 scale).

Qualitative & Non-standard Data: For indicators like "Policy Pivot" or "Ethical Frameworks," ICV TA&K uses a proprietary Ranking Categorization System. Each country is assigned a score based on a weighted consensus of expert evaluations and comparative policy analysis.

Methodology: The Global Future Industry Index in 2024

IV. Data Integrity and Refinement

Acknowledging the "data gap" inherent in frontier sectors, ICV TA&K researchers conducted additional cross-comparative studies to create rankings for non-standardized data. This effort was specifically intensified for the Neuro-Intelligence and Quantum Networking clusters, where traditional reporting often lags behind real-world industrial activity.



As in past editions, the structure of the Global Future Industry Index 2025 is made up of five pillars:

Pillar 1 Innovation and Research Capacity

This pillar evaluates a nation's "intellectual engine"—its fundamental ability to generate original scientific breakthroughs and cultivate the elite human capital required to push the boundaries of future industries.

The indicators within this pillar include the following:

Indicator 1: Fundamental Research Intensity

Measures the output of high-impact research (e.g., Nature/Science papers) in core future domains like Neuromorphic Computing or Fusion Physics, and the density of state-funded advanced research laboratories.

Indicator 2: High-Value Patent Density

Analyzes the volume of PCT (Patent Cooperation Treaty) filings and patent citations, specifically filtering for "pioneer patents" that establish new technological pathways rather than incremental improvements.

Indicator 3: Cross-Domain Synergy Index

Quantifies the integration of disparate fields (e.g., AI-driven protein folding or bio-quantum sensing) by tracking joint-disciplinary funding and co-authored research across biology, physics, and computer science.

Indicator 4: Global Talent Concentration

Evaluates the inflow and retention of the top 1% of global scientists and the scale of PhD graduates specialized in 2025's seven core industrial clusters.

Indicator 5: R&D Investment Momentum

Tracks the year-over-year growth of both public and private investment, with a premium on "Patient Capital" directed toward high-risk, long-cycle frontier technologies.

Pillar 2 Industrial Deployment and Maturity

This pillar assesses "execution power"—how efficiently a country translates lab results into industrial-scale production and the resilience of its specialized supply chains.

The indicators within this pillar include the following:

Indicator 6: Unicorn and Scale-up Density

Counts the number of private startups valued at >\$1B within the future clusters and the frequency of "Mega-rounds" (investments >\$100M) in mid-stage growth companies.

Indicator 7: Pilot Commercialization Scale

Measures the real-world application of technologies, such as the square mileage of 6G testing zones or the total units of humanoid robots deployed in active manufacturing lines.

Indicator 8: Supply Chain Sovereignty

Assesses the domestic self-sufficiency ratio for critical "bottleneck" components, such as high-bandwidth neural electrodes, superconducting magnets, or specialized AI chips.

Indicator 9: Standardization Leadership

Tracks national influence in international standard-setting bodies (ISO, ITU, IEEE) specifically for 2025 frontier technologies.

Indicator 10: Industrial Cluster Maturity

Evaluates the throughput efficiency of dedicated Future Industry Parks, measuring the speed at which a patent is converted into a spin-off company within the ecosystem.

Pillar 3 Policy Pivot and Regulatory Agility

This pillar measures the "nervous system" of a nation—the speed at which policy frameworks adapt to technological shifts and the government's ability to foster innovation while managing risk.

The indicators within this pillar include the following:

Indicator 11: Strategic Policy Pivot

Analyzes national strategic blueprints to see if they have moved from "Digital Economy" broadly to the specific seven clusters of 2025, including designated funding and roadmaps.

Indicator 12: Regulatory Sandbox Maturity

Evaluates the presence of "Safe Zones" for testing sensitive technologies, such as BCI human trials or AGI agent autonomy, without traditional bureaucratic delays.

Indicator 13: Financial Incentive Efficiency

Measures the accessibility and impact of R&D tax credits, government-backed insurance for high-risk ventures, and specialized sovereign wealth fund direct investments.

Indicator 14: Sovereignty and Security Alignment

Assesses the clarity and effectiveness of technology protection acts, data sovereignty laws, and export control mechanisms for future-core assets.

Pillar 4 Ecosystem and Environmental Sustainability

This pillar evaluates the "sustainability heart"—the long-term viability of the industry regarding its carbon footprint, energy resilience, and adherence to human-centric ethical standards.

The indicators within this pillar include the following:

Indicator 15: Bio-Digital Decarbonization Score

Quantifies the net carbon reduction achieved by transitioning from petrochemical processes to Bio-manufacturing or by using AI to optimize grid efficiency.

Indicator 16: Energy Resilience for Computation

Measures the nation's capacity to provide stable, carbon-free energy (via Fusion, Hydrogen, or LDES) to satisfy the massive power demands of AI and Quantum data centers.

Indicator 17: Neuro-Ethics and AI Safety Frameworks

Assesses the legislative progress on neural privacy, "Right to Thought," and AGI alignment protocols to ensure future technologies remain human-centric.

Indicator 18: Global Collaboration Index

Tracks participation in large-scale international "Big Science" projects (e.g., ITER) and the openness of international research visas and joint-ventures.

03

Global Future Industries Assessment 2025:

National Perspectives Ranking

Overall					Innovation and Research Capacity		Industrial Deployment and Maturity		Policy Pivot and Regulatory Agility		Ecosystem and Environmental Sustainability	
Country	2025		2024	Global Index Score/100	P1 Rank	Pillar 1 (Layout)	P2 Rank	Pillar 2 (Tech)	P3 Rank	Pillar 3 (Policy)	P4 Rank	Pillar 4 (Talent)
Country	2025		2024	Global Index Score	Pillar1 Rank	Pillar1 Score	Pillar2 Rank	Pillar2 Score	Pillar3 Rank	Pillar3 Score	Pillar4 Rank	Pillar4 Score
China	1	↑	1	92.85	2	93.5	1	94	1	91.78	2	90.49
USA	2	↓	2	91.55	1	93.7	2	93	2	85.4	1	91.84
Germany	3	↑	13	79.36	3	78.5	3	80.4	9	77.57	4	81.66
South Korea	4	↑	5	78.14	4	78	4	80.1	4	83.64	16	67.23
UK	5	↓	4	77.56	5	77	6	74.5	3	84.13	7	76.26
Singapore	6	↑	10	77.05	10	72	8	71.5	2	91.25	5	81.03
Japan	7	↑	3	74.91	6	76.4	5	74.9	8	78.12	15	67.19
Switzerland	8	↓	8	73.16	7	75.8	18	61.2	10	76.49	3	86.49
France	9	↓	16	69.77	8	68.3	9	69.7	11	69.95	9	73.12
Israel	10	↑	-	69.24	11	64.5	10	68.9	7	79.28	12	67.58
Netherlands	11	-	12	66.72	9	66.3	12	63.81	12	68.81	10	70.72
Canada	12	↓	7	64.31	12	62.08	19	58.4	13	64.93	6	80.53
UAE	13	↑	11	58.42	17	54.2	19	41.2	5	86.91	17	64.74
Finland	14	↑	-	58.1	16	54.2	15	51	14	63.38	8	74.37
Australia	15	↓	6	52.9	18	50	17	48.5	16	60.3	18	58.61
Denmark	16	↓	17	52.23	15	54.2	16	46.5	17	55.37	19	54.88
Sweden	17	↓	9	51.02	13	59.3	20	32.3	18	50.58	11	69.72
India	18	↓	14	49.7	14	58.3	18	35.9	15	54.89	20	50.29
Italy	19	↓	18	42.33	19	47.7	20	32.3	19	47.73	19	42.67

The 2025 Global Future Industry Index (GFII) national ranking reflects a dynamic competitive landscape across four core pillars—Innovation and Research Capacity, Industrial Deployment and Maturity, Policy Pivot and Regulatory Agility, and Ecosystem and Environmental Sustainability. The ranking highlights clear leadership patterns, strategic strengths of major economies, and distinct paths to competitive advantage in future industries.

Core Leadership Pattern: Sino-US Duality with Widening China's Edge

China and the United States maintain their top two positions for three consecutive years, but China has narrowed the gap and climbed to the first place with an overall score of 92.85, while the United States ranks second with 91.55. The two countries show complementary strengths across the four pillars:

- **China's Strengths:** Dominates in practical implementation and policy support. It ranks first in Industrial Deployment and Maturity (94.0) and Policy Pivot and Regulatory Agility (91.78), with advantages in supply chain sovereignty, large-scale pilot commercialization, and targeted fiscal incentives. Its Innovation and Research Capacity (93.5, 2nd) and Ecosystem and Environmental Sustainability (90.49, 2nd) also maintain top-tier levels, reflecting a balanced development of "research + industrialization + policy".
- **US Advantages:** Leads in foundational innovation and sustainability. It tops the charts in Innovation and Research Capacity (93.7) and Ecosystem and Environmental Sustainability (91.84), with unmatched strengths in cross-domain synergy, global talent concentration, and carbon-free energy supply for computation.

However, it lags behind China in Industrial Deployment (93.0, 2nd) and Policy Agility (85.4, 2nd), indicating relative deficiencies in translating research into large-scale industrialization and in flexible policy adaptation.

Second-Tier Competition: Europe's Rise and Asia-Pacific's Differentiation

Countries ranked 3rd to 20th form a diverse second tier, with European nations showing significant upward momentum and Asia-Pacific economies demonstrating specialized strengths:

1. European Resurgence (Germany, Switzerland, France)

Germany (3rd, 79.36): Achieves the most dramatic jump (up 10 places from 13th) by leveraging its strengths in Industrial Deployment (80.4, 3rd) and Innovation Capacity (78.5, 3rd). Its advantages in precision robotics components, industrial sensor networks, and cross-domain synergy (e.g., Embodied AI + Fusion Physics) drive its ascent, positioning it as Europe's industrial innovation leader.

Switzerland (8th, 73.16): Excels in Ecosystem and Environmental Sustainability (86.49, 3rd) and Innovation Capacity (75.8, 7th), with world-class performance in neuro-ethics, AI safety frameworks, and per-capita high-value patents. However, its Industrial Deployment (61.2, 18th) is a bottleneck, reflecting limited large-scale manufacturing capacity.

France (9th, 69.77): Rises 7 places by focusing on nuclear-powered AI data centers and quantum hydrogen pilots, with solid Innovation Capacity (68.3, 8th) and Industrial Deployment (69.7, 9th), though policy agility (69.95, 11th) needs improvement.

2. Asia-Pacific's Specialized Advantages (South Korea, Singapore, Japan)

South Korea (4th, 78.14): Climbs 1 place with strengths in Industrial Deployment (80.1, 4th) and Policy Agility (83.64, 4th). Its dominance in 6G, semiconductors (80% of global HBM3e/HBM4 supply), and rapid PCT patent growth (+7.1% in 2025) underpins its position, but Ecosystem Sustainability (67.23, 16th) is a weak point due to energy structure constraints.

Singapore (6th, 77.05): Jumps 4 places to lead in Policy Agility (91.25, 2nd), with world-class regulatory sandboxes for AI in fintech and maritime autonomy, and precision funding mechanisms. Its Innovation Capacity (72.0, 10th) and Industrial Deployment (71.5, 8th) are balanced, making it a global hub for cross-border innovation.

Japan (7th, 74.91): Falls 4 places despite strong Innovation Capacity (76.4, 6th) and Industrial Deployment (74.9, 5th). Its strengths in fusion materials, photoresists for advanced chips, and robotics are offset by weak Ecosystem Sustainability (67.19, 15th) and Policy Agility (78.12, 8th), reflecting slow adaptation to emerging tech trends.

3. Emerging Markets and Niche Players (Israel, UAE, Finland)

Israel (10th, 69.24): Enters the top 10 with the highest R&D intensity (nearly 6% of GDP) and strengths in cyber-quantum startups, neuro-inspired algorithms, and policy agility (79.28, 7th), demonstrating the power of "small but specialized" innovation.

UAE (13th, 58.42): Climbs 2 places by leveraging sovereign wealth funds to invest in AI infrastructure and "Golden Visas" to attract global talent. It leads in Policy Agility (86.91, 5th) but lags in Industrial Deployment (41.2, 19th), highlighting the gap between capital input and industrialization.

Finland (14th, 58.1): Emerges as a 6G specialist with leading open-architecture 6G research and testbeds in Oulu, supported by high talent density for wireless infrastructure, though its overall industrial scale remains limited.

Key Insights and Strategic Implications

Industrial Deployment is the Core Differentiator: Countries with top Industrial Deployment scores (China, US, Germany, South Korea) occupy the top 4 overall, underscoring that translating research into scalable production and supply chain resilience is critical for global leadership.

Policy Agility Drives Upward Mobility: Singapore, UAE, and South Korea's ascent is closely tied to flexible regulatory sandboxes, targeted financial incentives, and alignment with future industry clusters, while Japan and Sweden's decline reflects rigid policy frameworks.

Sustainability Becomes a Strategic Priority: The gap between top performers (US, China, Switzerland) and laggards (India, Brazil, Italy) in Ecosystem and Environmental Sustainability is widening, as carbon-neutral energy for computation and ethical governance become prerequisites for long-term competitiveness.

Innovation Needs Industrialization Support: Switzerland and Canada (12th) have strong innovation capacity but struggle to translate it into overall competitiveness due to weak industrial deployment, highlighting the need for integrated "research-industry-policy" ecosystems.

In summary, the 2025 ranking reveals a global future industry landscape where "comprehensive strength + specialized breakthroughs" determine success. China and the US lead with complementary advantages, Europe rebounds through industrial precision and ethical governance, and Asia-Pacific and emerging markets carve out niches via policy agility and technical specialization. For global stakeholders, aligning pillar strengths—strengthening industrial deployment for innovation powerhouses, enhancing policy flexibility for manufacturing hubs, and building sustainable ecosystems for all—will be key to securing competitive advantage in the next industrial era.



Global Future Industries Assessment 2025: National Perspectives Ranking

Innovation and Research Capacity

Rank/ 20	Country/ Region	Aggregate Score/100	1.1 Fundamental Research Intensity	1.2 High- Value Patent Density	1.3 Cross- Domain Synergy Index	1.4 Global Talent Concentrati on	1.5 R&D Investment Momentum
1	USA	93.7	87.4	97.1	95.4	96.7	95.8
2	China	93.5	94.2	96.5	91.8	87.2	96.5
3	Germany	79.5	78.5	75.4	88.5	79.8	74.1
4	South Korea	78.0	71.8	81.2	82.3	69.7	92.4
5	UK	77.0	74.1	63.5	86.7	92.1	77.5
6	Switzerland	75.8	59.8	70.1	94.2	97.2	69.3
7	Japan	75.4	69.3	84.5	76.9	80.6	60.4
8	Singapore	72.0	58.2	59.7	84.1	98.6	80.1
9	France	68.9	66.7	66.9	74.2	67.3	71.8
10	Netherlands	65.3	55.4	61.2	80.6	77.6	56.5
11	Israel	64.9	53.1	55	78.4	75.1	82.9
12	Canada	63.9	64.2	49.3	71.5	81.4	58.2
13	Sweden	62.0	51.7	57.4	67.4	83.1	62.1
14	India	60.8	61.5	46.7	63.1	61.2	88.6
15	Finland	59.9	44.8	52.8	69.8	85.3	64.7
16	Denmark	54.2	44.8	44.1	54.8	89.5	53.8
17	UAE	54.2	51.3	41.3	51.3	64.5	85.2
18	Australia	54.0	48.9	38.2	59.6	72.4	70.4
19	Italy	47.7	46.3	35.6	57.2	55.4	51.2
20	Brazil	39.1	31.4	31.9	45.6	52.1	47.5

The United States ranks first with an aggregate score of 93.7, leading in cross-domain synergy, global talent concentration, and R&D investment momentum, driven by its robust ecosystem for interdisciplinary innovation and deep venture capital support. China follows closely at 93.5, achieving top scores in fundamental research intensity and high-value patent density, reflecting its rapid progress in foundational research and intellectual property development.

Germany, South Korea, the UK, and Switzerland occupy the next positions. Germany excels in cross-domain synergy, while South Korea leads in R&D investment momentum and high-value patent density. The UK and Switzerland demonstrate strengths in global talent concentration, with Switzerland also performing strongly in cross-domain synergy.

Global Future Industries Assessment 2025: National Perspectives Ranking

Innovation and Research Capacity

1.1 Fundamental Research Intensity

Rank	Country/Region	Score (0-100)	Core Research Drivers	Key 2024-2025 Strategic Insight
1	China	94.2	Physical Sciences, 6G, Quantum	Maintaining the world's largest share in physical science and chemistry publications.
2	USA	92.4	GAI, Life Sciences, Fusion	Absolute dominance in foundational AI theory and bio-medical research.
3	Germany	78.5	Neuro-Intelligence, Fusion	Strong output from the Max Planck Institutes in neuromorphic theory.
4	UK	74.1	Bio-manufacturing, AI Safety	Oxford and Cambridge leading in synthetic biology foundational papers.
5	South Korea	71.8	6G, Semiconductor Physics	Significant jump in 6G wave propagation and material science research.
6	Japan	69.3	Quantum Tech, Fusion	Global leader in fusion-grade material testing and quantum sensing.
7	France	66.7	Nuclear Physics (ITER), Neuro	Strong performance by CNRS in high-energy physics and mathematical AI.
8	Canada	64.2	Deep Learning, Quantum Algo	High citation impact in early-stage quantum computing algorithms.
9	India	61.5	Chemistry, Applied AI	The fastest-growing research output in Asia after China.
10	Switzerland	59.8	BCI, Particle Physics	Highest per-capita output in brain-computer interface foundational research.
11	Singapore	58.2	Computer Science, Bio-manufacturing	Rapid growth in "Bio-foundry" automation and AI infrastructure papers.
12	Netherlands	55.4	Optical Physics, Semiconductors	Leading research in EUV lithography and fundamental quantum networking.
13	Israel	53.1	Neuro-Intelligence, Cybersecurity	Specialized depth in neuro-inspired algorithms and mathematical safety.
14	Sweden	51.7	Bio-manufacturing, Energy	Strong focus on carbon-neutral industrial processes and protein engineering.
15	Australia	48.9	Quantum Control, Environment	World-class research in silicon-based quantum bit stability.
16	Italy	46.3	Robotics, Nuclear Physics	Traditional strength in robotics control theory and ITER-related physics.
17	Denmark	44.8	Green Hydrogen, Life Sciences	Leading in industrial fermentation and bio-manufacturing scalability theory.
18	Russia	39.5	Nuclear Fusion, Mathematics	Maintains significant theoretical depth in fusion plasma and complex algorithms.
19	Spain	37.2	Nanotechnology, Photonics	High activity in 2D materials and photonics for next-gen communication.
20	Brazil	31.4	Ag-Bio, Synthetic Biology	Leveraging biodiversity for advanced bio-manufacturing research.

China ranks first with a score of 94.2, driven by leading research in physical sciences and 6G, and maintains the world’s largest share of publications in physical science and chemistry. The U.S. follows at 92.4, with core strengths in generative AI and life sciences, and holds absolute dominance in foundational AI theory and bio-medical research. Germany ranks third

at 78.5, focusing on neuro-informatics and safety, with strong output from the Max Planck Institutes in neuromorphic theory. The UK places fourth at 74.1, leading in bio-manufacturing and AI, with Oxford and Cambridge at the forefront of synthetic biology foundational papers.

Global Future Industries Assessment 2025: National Perspectives Ranking

Innovation and Research Capacity

1.2 High-Value Patent Density

Rank	Country/ Region	Score (0-100)	Specialized Patent Strength	Key 2024-2025 Patent Insight
1	China	97.1	6G, GAI, Bio-foundries	Holds 40.3% of global 6G patents and leads in GAI filing volume (over 70% of global total).
2	USA	96.8	Quantum Computing, GAI, BCI	Highest citation impact; US AI patents are cited 7x more often than the global average.
3	Japan	84.5	Fusion Materials, Solid-state Batteries	Leads in triadic patent families and long-term industrial IP durability.
4	South Korea	81.2	6G, Embodied AI, Semiconductors	Highest growth rate in PCT filings (+7.1% in 2025) led by Samsung and LG.
5	Germany	75.4	Neuro-Intelligence, Fusion, Automation	Dominant in European quantum patents and high-precision industrial IP.
6	Switzerland	70.1	BCI, Precision Bio-manufacturing	World leader in per-capita high-value patents; #1 in WIPO GII 2025.
7	France	66.9	Nuclear Fusion, Quantum Sensing	Strong IP portfolio from CNRS and CEA in deep-tech energy sectors.
8	UK	63.5	AI Safety, Synthetic Biology	Key patents in AI alignment and CRISPR-based manufacturing processes.
9	Netherlands	61.2	Quantum Networking, Photonic Chips	Critical IP in semiconductor lithography and quantum interconnects.
10	Singapore	59.7	Smart City AI, IoT, Bio-manufacturing	High density of "Innovation Outputs" per dollar spent; #5 in global GII.
11	Sweden	57.4	6G Infrastructure, Green Steel	Ericsson remains a top 10 global PCT applicant for 6G technologies.
12	Israel	55	Cyber-AI, Neuro-Medical	Leads in niche high-impact patents for neural data encryption.
13	Finland	52.8	6G Standards, Bio-economy	Significant influence in 6G standard-essential patents (SEPs).
14	Canada	49.3	Quantum Algorithms, Medical AI	Strong patent growth in software-based quantum error correction.
15	India	46.7	Software-defined AI, 6G Applications	Fastest growth in domestic patent filings (+19% in 2025).
16	Denmark	44.1	Bio-manufacturing, Wind Fusion	Leading patents in enzyme-based industrial production.
17	Austria	40.5	Quantum Photonics, Robotics	Specialized patents in quantum light sources for communication.
18	Australia	38.2	Quantum Silicon, Green Hydrogen	Key IP for scaling silicon-based quantum processors.
19	Italy	35.6	Industrial Robotics, Fusion Parts	Focused on high-value components for the ITER project.
20	Norway	31.9	Ocean-Bio, Deep-sea Energy	Unique patents in bio-marine manufacturing and energy storage.

China ranks first with a score of 97.1, specializing in gallium nitride (GaN), silicon carbide (SiC), and bio-foundries. It holds 40.3% of global GaN patents and leads in GAI film volume, accounting for over 70% of global total. The U.S. follows at 96.8, with strengths in quantum computing, generative AI (GAI), and brain-computer interfaces (BCI). U.S. AI patents have a citation impact 7 times higher than the global average.

Japan ranks third at 84.5, focusing on fusion materials, embedded AI, and solid-state batteries, and leads in high-traffic patents and long-term industrial IP durability.

South Korea is fourth at 81.2, excelling in genetically encoded AI (GmAI) and semiconductors, with a 7.1% growth in PCT filings in 2025 led by Samsung and LG.

Global Future Industries Assessment 2025: National Perspectives Ranking

Innovation and Research Capacity

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4	South Korea	81.2	6G, Embodied AI, Semiconductors	Highest growth rate in PCT filings (+7.1% in 2025) led by Samsung and LG.
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20	Norway	31.9	Ocean-Bio, Deep-sea Energy	Unique patents in bio-marine manufacturing and energy storage.

China leads with a score of 97.1, driven by dominance in 6G and bio-foundries, followed closely by the U.S. at 96.8, which excels in quantum computing and high-impact AI patents. Japan, South Korea, and Germany round out the top five, with strengths in solid-state batteries, semiconductors, and quantum technology respectively. European nations like Switzerland, France, and the UK lead in

precision manufacturing, nuclear fusion, and AI safety, while Asian economies such as Singapore and India show strong innovation density and domestic filing growth. This ranking underscores the global distribution of strategic innovation, with leading nations concentrating on 6G, quantum computing, and AI, while others develop specialized niches in fields like quantum photonics, biomanufacturing, and energy storage.

Innovation and Research Capacity

1.3 Cross-Domain Synergy Index

Rank	Country/ Region	Score (0-100)	Top Synergy Domains (2024- 2025)	Strategic Insight
1	USA	95.4	AI-Bio, Quantum-Materials	Leads in "AI for Science" initiatives; seamless collaboration between Big Tech and Academia.
2	Switzerland	94.2	Neuro-AI, Precision Bio-tech	Global hub for Brain-Computer Interface (BCI) theory and medical engineering.
3	China	91.8	6G-IoT, AI-Manufacturing	Massive state-led projects integrating AI with physical industrial systems.
4	Germany	88.5	Embodied AI, Fusion-Physics	Strong synergy in Industry 4.0 evolution and advanced energy materials.
5	UK	86.7	GAI Safety, Synthetic Biology	Global leader in AI alignment research and bio-computational ethics.
6	Singapore	84.1	Bio-foundry, Smart Logistics	Highly efficient integration of AI in automated laboratory and shipping systems.
7	South Korea	82.3	6G-Semiconductors, Robotics	Deep integration of next-gen communication with hardware manufacturing.
8	Netherlands	80.6	Quantum-Photonics, Lithography	World-class synergy in optical physics and semiconductor manufacturing equipment.
9	Israel	78.4	Cyber-Neuro, AI-Defense	Unique depth in cross-sector security algorithms and neural protection.
10	Japan	76.9	Humanoid-AI, Materials Science	Leading in materials discovery for nuclear fusion and humanoid robotics.
11	France	74.2	Nuclear-AI, Quantum Sensing	Strong cross-disciplinary focus on energy security and quantum physics.
12	Canada	71.5	Health-AI, Quantum Algorithms	High synergy in applying generative models to drug discovery and healthcare.
13	Finland	69.8	6G-Green Transition, IoT	Specialized in the "Twin Transition" (Digital + Green) research synergy.
14	Sweden	67.4	5G/6G-Energy, Bio-tech	Leading in the synergy between wireless networks and sustainable production.
15	India	63.1	Software-AI, Agri-Bio	Rapid growth in AI applications for large-scale agricultural and software services.
16	Australia	59.6	Quantum-Silicon, Environment	Strong integration of quantum sensing with environmental monitoring.
17	Belgium	57.2	Life Sciences-AI, Nano-tech	High R&D synergy in microelectronics and pharmaceutical research.
18	Denmark	54.8	Bio-manufacturing, Wind Energy	Excellence in integrating enzyme research with industrial fermentation.
19	UAE	51.3	AI Governance, Energy Systems	Focusing on the synergy between policy, AI, and future energy grids.
20	Brazil	45.6	Bio-diversity, Agri-Tech	Leveraging natural resources for bio-digital industrial research.

The USA leads with a score of 95.4, driven by leadership in AI-Bio and Quantum-Materials, followed by Switzerland at 94.2, which excels in Neuro-AI and precision bio-tech. China, Germany, and the UK round out the top five, with strengths in 6G-IoT, embodied AI, and AI safety respectively. European nations like Singapore, South Korea, and the Netherlands lead in bio-foundry logistics, 6G-

semiconductors, and quantum photonics, while Asian economies such as Israel, Japan, and France show strong niche leadership in cyber-neuro, humanoid-AI, and nuclear fusion. This ranking underscores the global distribution of cross-disciplinary innovation, with leading nations concentrating on AI-bio, quantum, and 6G, while others develop specialized strengths in fields like quantum sensing, biomanufacturing, and energy systems.

Global Future Industries Assessment 2025:
National Perspectives Ranking

Innovation and Research Capacity

1.4 Global Talent Concentration

Rank	Country/ Region	Score (0-100)	Top Synergy Domains (2024- 2025)	2025 Talent Insight
1	Singapore	98.6	AI, Bio-Foundry Engineers	Ranked #1 in Global Talent Competitiveness Index (GTCI) 2025/26.
2	Switzerland	98.4	Neuro-engineers, Quant Physicists	High retention rate of the world's most elite deep-tech researchers.
3	USA	96.7	GAI Theory, VC Strategists	Still the primary destination for global "star" AI talent despite visa competition.
4	UK	92.1	AI Safety, Life Sciences	London and Oxford remain magnetic hubs for the world's top bio-informaticians.
5	Denmark	89.5	Bio-manufacturing, Green Tech	World-leading vocational and high-end technical training for future industries.
6	China	87.2	6G, Robotics Engineers	Producing the largest sheer volume of STEM graduates (over 5M annually).
7	Finland	85.3	Wireless Architects, IoT	High density of specialized engineers for 6G and digital infrastructure.
8	Sweden	83.1	Green Energy, Digitalization	Strong talent pull from across Europe for "Green-Deep-Tech" roles.
9	Canada	81.4	Deep Learning, Quantum software	Highly successful "Global Talent Stream" visa program attracting US-based talent.
10	Germany	79.8	Automation, Fusion Scientists	Reliable source of high-end engineering talent, though facing demographic aging.
11	Netherlands	77.6	Lithography, Quantum Hardware	Home to a unique pool of talent for high-precision manufacturing.
12	Israel	75.1	Algorithmic Safety, Cybersecurity	Most concentrated pool of cybersecurity-focused AI talent globally.
13	Australia	72.4	Quantum Physics, Environmental Sci	High attractiveness for South-East Asian and European tech professionals.
14	South Korea	69.7	Semiconductor Design, 6G	Exceptional talent in hardware design, but facing severe labor shortages.
15	France	67.3	Mathematical AI, Nuclear Physics	Strong growth in AI research talent in the Paris-Saclay cluster.
16	UAE	64.5	AI Strategy, Digital Finance	Rapidly attracting "Digital Nomads" through long-term Golden Visas.
17	India	61.2	Software Developers, AI Ops	World's largest pool of AI developers; pivoting to high-end engineering.
18	Norway	58.9	Marine Bio-tech, Energy Storage	Specialized talent for ocean-based future industry development.
19	Italy	55.4	Robotics, Particle Physics	High quality of academic talent, but suffering from significant brain drain.
20	Spain	52.1	Renewable Energy, Photonics	Emerging talent hub for South European green tech and photonics.

Singapore leads with a score of 98.6, driven by AI and bio-foundry engineers, followed by Switzerland at 98.4, which excels in neuro-engineering and quantum physics. The USA, UK, and Denmark round out the top five, with strengths in AI theory, AI safety, and green tech respectively. European nations like China, Finland, and Sweden lead in robotics, 6G architecture, and green energy, while Asian

economies such as Canada, Germany, and the Netherlands show strong talent pools in deep learning, automation, and quantum hardware. This ranking underscores the global distribution of specialized talent, with leading nations concentrating on AI, quantum, and green tech, while others develop niche strengths in fields like semiconductors, cybersecurity, and renewable energy.

Global Future Industries Assessment 2025: National Perspectives Ranking

Innovation and Research Capacity

1.5 R&D Investment Momentum

Rank	Country/ Region	Score (0-100)	Top Synergy Domains (2024- 2025)	2026 Spending Trend
1	China	96.5	State-led Funds (Big Fund III)	9% YoY R&D growth; focusing on "Hard Tech" and supply chain self-reliance.
2	USA	95.8	Private VC, Chips Act Funding	Record-high private investment in GAI startups and domestic chip labs.
3	South Korea	92.4	Corporate R&D (Samsung/SK)	Aggressive investment in "6G-Semiconductor" integration to maintain edge.
4	India	88.6	Government + MNC Centers	Fastest-growing domestic R&D market (+12% in certain tech sectors).
5	UAE	85.2	Sovereign Wealth Funds (MGX)	Billions of dollars in sovereign capital redirected to global AI infrastructure.
6	Israel	82.9	Private VC, Defense-tech R&D	Remains the global leader in R&D intensity (nearly 6% of GDP).
7	Singapore	80.1	Gov (RIE 2025 Plan)	Heavy investment in Bio-foundries and Quantum-Safe networking.
8	UK	77.5	Private Equity, Science Budget	Increased focus on AI Safety funding and Life Sciences long-term grants.
9	Germany	74.1	Corporate + EU Horizon	Leading EU investment in Fusion energy prototypes and AI-robotics.
10	France	71.8	France 2030 Plan	Significant state capital flowing into Quantum and Hydrogen pilots.
11	Switzerland	69.3	Corporate R&D (Pharma/Tech)	Stable, high-value investment in neuro-tech and precision tools.
12	China (Taiwan Region)	67	Corporate R&D (TSMC)	Pivot toward 2nm and below R&D, plus quantum processor development.
13	Finland	64.7	Public-Private 6G Grants	Reaching a 4% GDP R&D target with a focus on wireless infrastructure.
14	Sweden	62.1	Industrial R&D (Ericsson/ABB)	Sustained investment in "Green Digital" technologies.
15	Japan	60.4	Corporate R&D, Fusion Subsidies	Consistent investment in fusion materials and humanoid service robots.
16	Canada	58.2	Gov AI Strategy, VC	Funding concentrated in AI software and medical diagnostic tools.
17	Netherlands	56.5	EU Chips Act, Corporate	High investment in Next-Gen lithography R&D.
18	Denmark	53.8	Bio-tech Corporate (Novo)	Leading investment in industrial fermentation and carbon capture R&D.
19	Austria	51.2	Public Research Grants	High growth in quantum photonics and precision robotics funding.
20	Brazil	47.5	Agri-Bio R&D, State Grants	Increasing focus on bio-digital manufacturing for agriculture.

China leads with a score of 96.5, driven by state-led funds and "Hard Tech" investment, followed by the USA at 95.8, which excels in private VC and chip advanced funding. South Korea, India, and the UAE round out the top five, with strengths in corporate R&D, government-MNC centers, and sovereign wealth funds respectively. European nations like Israel, Singapore, and the UK lead in private VC, bio-

foundry investment, and AI safety funding, while Asian economies such as Germany, France, and Switzerland show strong investment in EU-horizon projects, quantum hydrogen, and pharma-tech. This ranking underscores the global distribution of R&D investment, with leading nations concentrating on semiconductors, quantum, and green energy, while others develop specialized strengths in fields like lithography, biotech, and quantum photonics.

Global Future Industries Assessment 2025: National Perspectives Ranking

Industrial Deployment and Maturity

Rank	Country/Region	Aggregate Score/100	2.1 Unicorn and Scale-up Density	2.2 Pilot Commercialization Scale	2.3 Supply Chain Sovereignty	2.4 Standardization Leadership	2.5 Industrial Cluster Maturity
1	China	94.0	92.5	95.2	94.8	92.6	95.8
2	USA	93.0	96.8	91.4	89.2	90.4	97.5
3	Germany	80.4	74.1	83.2	78.6	85.1	88.4
4	South Korea	80.1	65.2	88.7	87.5	83.7	82.9
5	Japan	74.9	53.8	86.5	84.1	79.5	84.2
6	UK	74.5	84.3	78.9	52.1	74.3	79.5
7	Singapore	71.8	69.8	74.1	72.4	68.2	76.4
8	France	68.7	67.5	76.4	63.5	65.1	68.7
9	Israel	66.9	72.4	69.8	55.7	61.4	74.1
10	India	64.3	78.6	58.7	66.3	45.3	59.6
11	Netherlands	62.3	58.7	67.3	70.1	48.6	65.3
12	Canada	61.1	61.4	63.5	61.2	55.2	62.8
13	Switzerland	58.2	56.3	61.2	49.8	59.8	71.2
15	Sweden	51.1	51.2	52.1	46.5	52.7	55.4
14	Finland	51.0	45.4	55.4	43.2	65.1	51.2
16	Australia	47.4	42.1	48.6	59.4	42.1	44.3
17	UAE	46.5	48.6	57.4	40.1	35.7	41.7
18	Denmark	41.2	39.5	44.3	38.4	45.3	38.4
19	Italy	36.9	35.7	41.2	37.8	29.8	38.9
20	Brazil	32.2	31.2	37.5	32.4	25.6	31.2

China ranks first with an aggregate score of 94.0, leading in supply chain sovereignty, pilot commercialization, and industrial cluster maturity, supported by strong performance in 6G, green hydrogen, and full industrial chain integration. The United States follows closely at 93.0, achieving top scores in unicorn density and industrial cluster maturity, driven by generative AI leadership and advanced tech clusters. Germany and South Korea take third and fourth place respectively, with Germany excelling in standardization and industrial clusters,

and South Korea leading in memory semiconductors and display standards.

Japan and the UK rank fifth and sixth, with Japan strong in upstream supply chains and robotics, and the UK leading in bio-convergence and quantum standards but constrained by lower supply chain scores. This ranking highlights a two-tier global competition structure, with China and the U.S. leading in comprehensive industrial deployment, while others focus on specialized strategic advantages.

Global Future Industries Assessment 2025: National Perspectives Ranking

Industrial Deployment and Maturity

2.1 Unicorn and Scale-up Density

Rank	Country/ Region	Score (0-96.80)	Industrial Edge (2025)
1	USA	96.8	Gen-AI Dominance: Holds over 55% of global Gen-AI unicorns; unparalleled venture capital depth.
2	China	92.5	Hardware Titans: Leading density of unicorns in Embodied AI (Robotics) and 6G infrastructure components.
3	UK	84.3	Bio-Convergence: Strong cluster of AI-driven drug discovery and synthetic biology scale-ups.
4	India	78.6	Application Layer: Largest ecosystem for AI-based service delivery and fintech-quantum integration.
5	Germany	74.1	Industrial AI: Focus on B2B scale-ups integrating AI into the "Mittelstand" manufacturing base.
6	Israel	72.4	Cyber-Quantum: World's highest density of startups in quantum-resistant encryption and AI-defense.
7	Singapore	69.8	Digital Hub: Preferred Asian HQ for Web3, Green-tech, and Bio-foundry scale-ups.
8	France	67.5	Sovereign AI: Massive growth in Paris-based "Sovereign LLM" and decentralized AI startups.
9	South Korea	65.2	Chip-Design: Emerging unicorns specializing in HBM (High Bandwidth Memory) and NPU architectures.
10	Canada	61.4	Quantum Computing: Toronto-Waterloo corridor remains a global magnet for quantum software scale-ups.
11	Netherlands	58.7	Precision Scale-ups: High-growth suppliers for the extreme UV (EUV) lithography ecosystem.
12	Switzerland	56.3	Deep-Tech Niche: Leading in high-valuation startups for neuro-prosthetics and precision robotics.
13	Japan	53.8	Material Tech: Focus on scale-ups for solid-state batteries and advanced fusion-grade materials.
14	Sweden	51.2	Green Scale-ups: Pioneers in carbon-neutral industrial processes and smart energy storage.
15	UAE	48.6	Strategic Capital: Rapidly growing cluster of AI-infrastructure companies backed by sovereign funds.
16	Finland	45.4	Connectivity: Focused on Open-RAN and specialized 6G software-defined networking.
17	Australia	42.1	Quantum Hardware: Global leader in silicon-based quantum dot manufacturing scale-ups.
18	Denmark	39.5	Biosolutions: Scaling companies in enzyme-based industrial production and carbon capture.
19	Italy	35.7	Cobotics: High-growth firms specializing in collaborative robotics and tactile sensors.
20	Brazil	31.2	Agri-Future: Scaling AI-driven bio-fortification and precision satellite agriculture firms.

The U.S. ranks first at 96.8, leading globally in generative AI unicorns with more than 55% market share and strong venture capital support. China follows at 92.5, boasting a high density of unicorns in embodied AI, robotics, and 6G infrastructure components. The UK places third at 84.3, with outstanding scale-ups in AI-driven drug discovery and synthetic

biology. India ranks fourth at 78.6, focusing on AI-enabled services and fintech-quantum integration. Germany is fifth at 74.1, specializing in B2B industrial AI for the manufacturing sector. Israel sixth at 72.4, owning the world's highest density of cyber-quantum and quantum-resistant encryption startups. This indicator reflects each economy's vitality in high-tech entrepreneurship and industrial innovation leadership.

Global Future Industries Assessment 2025: National Perspectives Ranking

Industrial Deployment and Maturity

2.2 Pilot Commercialization Scale

Rank	Country/ Region	Score (0-95.20)	Key Demonstration Projects (2025)
1	China	95.2	Green Hydrogen & 6G: World's largest integrated hydrogen-ammonia pilot; 10+ 6G-ready smart city zones.
2	USA	91.4	Fusion & Bio-Foundries: Multiple private fusion prototypes (Helion/Commonwealth); massive GAI-driven lab automation pilots.
3	Japan	88.7	Robotics & Smart Mobility: Woven City (Toyota) and deep-sea mineral extraction automation pilots.
4	South Korea	86.5	Digital Twin & 6G: Nationwide 6G V2X (Vehicle-to-Everything) pilot corridors in Seoul and Busan.
5	Germany	83.2	Industrial Metaverse: BMW/NVIDIA "Omniverse" digital twin factories; high-speed rail hydrogen pilots.
6	UK	78.9	Quantum Networks: London-Cambridge quantum-safe fiber backbone; modular nuclear reactor (SMR) test sites.
7	France	76.4	Low-Carbon Industrial Clusters: Heavy investment in decarbonized industrial zones (Dunkirk/Fos-sur-Mer).
8	Singapore	74.1	Autonomous Shipping: Fully automated Jurong Port pilots; lab-grown meat commercialization sandboxes.
9	Israel	69.8	Cyber-Physical Defense: National-level AI cybersecurity "War Room" simulations and pilot defense grids.
10	Netherlands	67.3	Quantum Internet: The world's first multi-node quantum network pilot connecting four cities.
11	Canada	63.5	AI for Carbon Capture: Large-scale direct air capture (DAC) pilot plants in British Columbia.
12	Switzerland	61.2	Neuro-tech Clinics: World-leading pilot applications for brain-computer interface (BCI) rehabilitation.
13	India	58.7	Green Steel & 6G Rural: Massive pilots for low-cost 6G rural connectivity and green steel production.
14	Finland	55.4	6G Architecture: The "6G Flagship" program's live network testbeds in Oulu.
15	Sweden	52.1	Fossil-Free Iron: HYBRIT pilot scaling toward full industrial commercialization.
16	UAE	49.8	Smart City Governance: Dubai's "AI-Prime Minister" office and robotic government service pilots.
17	Australia	46.3	Green Energy Export: Large-scale solar-to-hydrogen export pilots in Western Australia.
18	Denmark	42.7	Power-to-X: Construction of "Energy Islands" as pilots for global offshore wind integration.
19	Italy	38.6	Fusion Engineering: Key components testbed for ITER and local Divertor Tokamak Test (DTT) facility.
20	Brazil	34.2	Bio-Refinery Pilots: Next-gen cellulosic ethanol and sustainable aviation fuel (SAF) pilot plants.

China ranks first with 95.2, supported by the world's largest integrated hydrogen-ammonia pilot and more than ten 6G-enabled smart city zones. The U.S. follows at 91.4, driving innovation through private fusion prototypes and large-scale GAI-powered lab automation pilots. Japan ranks third at 88.7, with flagship projects including Toyota's Woven City and

automated deep-sea mineral extraction. South Korea is fourth at 86.5, leading 6G V2X digital twin trials across Seoul and Busan. Germany places fifth at 83.2, advancing industrial metaverse and hydrogen-powered high-speed rail pilots. This indicator reflects each economy's capability to translate advanced technologies into scalable, practical applications.

Global Future Industries Assessment 2025: National Perspectives Ranking

Industrial Deployment and Maturity

2.3 Supply Chain Sovereignty

Rank	Country/ Region	Score (0-94.80)	2025 Supply Chain Status
1	China	94.8	Complete Verticality: Dominates the entire 6G and EV value chain, from raw material processing to finished terminal products.
2	USA	89.2	Advanced Foundries: Resilience strengthened by the domestic scaling of 2nm/GAA logic chips and GAI server assembly clusters.
3	South Korea	87.5	Memory Fortress: Strategic control over 80% of global HBM3e/HBM4 supply, critical for the global AI compute stack.
4	Japan	84.1	Upstream Mastery: Holds irreplaceable patents and production for photoresists and high-purity chemicals for 2026-gen chips.
5	Germany	78.6	Industrial Sovereignty: High self-sufficiency in precision robotics components and industrial sensor networks.
6	Singapore	72.4	The Global Switch: World-leading hub for component redistribution and semiconductor packaging resilience.
7	Netherlands	70.1	Lithography Key: ASML's EUV High-NA supply chain remains the most critical "choke point" in global tech.
8	India	66.3	Production Diversification: Rapidly scaling domestic semiconductor assembly (OSAT) and electronic manufacturing services (EMS).
9	China (Taiwan Region)	88.9	Foundry Density: (Note: Calculated as part of the regional tech ecosystem) 2nm mass production leadership.
10	France	63.5	Nuclear-Hydrogen Link: Strategic resilience in low-carbon energy inputs for heavy future industry.
11	Canada	61.2	Critical Minerals: Key supplier of battery-grade lithium and rare earths for North American tech sovereignty.
12	Australia	59.4	Raw Material Vanguard: Essential provider of critical minerals; moving into mid-stream refinement.
13	Israel	55.7	Chip Design Nodes: Resilience built through high-value R&D centers that define global architectural standards.
14	UK	52.1	Compound Semi-conductors: Strong niche cluster in South Wales providing specialized chips for 6G and Power-tech.
15	Switzerland	49.8	Precision Tooling: Provider of high-end machinery for ultra-precise micro-component manufacturing.
16	Sweden	46.5	Green Steel Supply: Leading the resilient supply of low-carbon materials for European aerospace/auto.
17	Finland	43.2	Network Infrastructure: Strategic hub for non-restricted telecommunications hardware manufacturing.
18	UAE	40.1	Logistics Tech: World-class autonomous logistics infrastructure ensuring supply flow into the MENA region.
19	Italy	37.8	SME Resilience: Highly flexible manufacturing networks providing specialized parts for the fusion and space sectors.
20	Brazil	32.4	Agricultural Bio-inputs: Strategic resilience in future-tech for global food security systems.

China ranks first with 94.8, achieving full vertical integration in 6G and electric vehicle supply chains from raw materials to end products. The U.S. follows at 89.2, strengthening resilience through domestic 2nm/GAA chip production and generative AI server clusters. South Korea is third at 87.5, controlling around 80% of global HBM3e/HBM4 memory supply essential for AI

computing. Japan ranks fourth at 84.1, holding irreplaceable positions in high-purity chemicals and photoresists for advanced semiconductors. Germany places fifth at 78.6, with high self-sufficiency in precision robotics and industrial sensor components. This indicator reflects each economy's ability to secure core industrial chains and maintain stability in global high-tech competition.

Industrial Deployment and Maturity

2.4 Standardization Leadership			
Rank	Country/ Region	Score (0-92.60)	Standardization Influence
1	China	92.6	6G Protocol Leadership: Holds the highest volume of 6G SEPs and dominant influence in ITU future network groups.
2	USA	90.4	AI Governance & Software: Leads in defining IEEE standards for AI transparency and Cloud-native 6G architecture.
3	EU (led by DE/FR)	85.1	Ethical & Safety Standards: Setting the global benchmark for AI risk management and data sovereignty protocols.
4	South Korea	83.7	Display & Semi Standards: Leading the standards for 2026-gen OLED/Micro-LED and CXL (Compute Express Link).
5	Japan	79.5	Robotics & IoT: Driving the standards for collaborative robotics and industrial IoT connectivity.
6	UK	74.3	Quantum Standards: Active leadership in ETSI groups for Quantum Key Distribution (QKD) and security.
7	Singapore	68.2	Cross-Border Data: Pioneer in digital trade standards and cross-border AI governance frameworks.
8	Finland	65.1	O-RAN Vanguard: Heavy influence in open and disaggregated network standards for 6G.
9	Israel	61.4	Cybersecurity Protocols: Defining next-gen standards for AI-driven threat detection and response.
10	Switzerland	59.8	ISO/IEC Hub: Strategic advantage of hosting global standards bodies; leaders in neuro-tech ethics.
11	Canada	55.2	Quantum Software Standards: Influencing the benchmarking of quantum algorithm performance.
12	Sweden	52.7	Sustainability Metrics: Leading the standardization of carbon-footprint tracking in future manufacturing.
13	Netherlands	48.6	ASIC/Foundry Standards: Standards for precision lithography and semiconductor equipment interoperability.
14	India	45.3	Frugal Innovation: Driving standards for low-cost, high-reliability future tech in developing markets.
15	Australia	42.1	Critical Mineral Transparency: Standards for sustainable sourcing and traceability in the green-tech chain.
16	Denmark	38.4	Bio-industrial Standards: Setting the pace for synthetic biology safety and regulatory frameworks.
17	UAE	35.7	Urban AI Standards: Establishing frameworks for AI in desert-environment smart city management.
18	France	33.2	High-Speed Rail 2.0: Technical standards for next-gen magnetic/vacuum transport systems.
19	Italy	29.8	Space-Tech Logistics: Standards for orbital debris management and lunar manufacturing.
20	Brazil	25.6	Bio-resource Governance: Standards for international sharing of bio-genetic data and resources.

China ranks first with 92.6, leading 6G protocol development with the largest number of 6G standard-essential patents and strong authority in ITU future network groups. The United States follows at 90.4, leading AI governance and software-related standards, especially in IEEE AI transparency and cloud-native 6G architecture. The EU, South Korea, Japan, and the UK occupy

subsequent positions, with strengths in ethical AI safety, display and semiconductor standards, robotics and IoT, and quantum communication security respectively. This indicator reflects each economy’s ability to shape global technology rules and secure long-term industrial competitiveness.

Industrial Deployment and Maturity

2.5 Industrial Cluster Maturity			
Rank	Country/ Region	Score (0-97.50)	Premier 2025 Industrial Cluster
1	USA	97.5	Bay Area (GAI): The absolute epicenter for generative AI, hosting 60% of the world's GPU-compute talent.
2	China	95.8	Pearl River Delta (Robotics/6G): The "Hardware Silicon Valley"; world's densest supply chain for future robotics.
3	Germany	88.4	Munich-Stuttgart (Ind. 4.0): Global leader in high-end automotive and industrial metaverse integration.
4	Japan	84.2	Tokyo-Tsukuba (Quantum/Materials): Premier concentration of material science and quantum hardware companies.
5	South Korea	82.9	Gyeonggi-do (Semis): The largest semiconductor cluster in the world, now fully pivoted to AI-chips (HBM).
6	UK	79.5	London-Oxford-Cambridge (Bio-AI): The "Golden Triangle" for life sciences and AI convergence.
7	Singapore	76.4	Greater One-North (Deep Tech): A hyper-dense urban cluster for AI, maritime tech, and lab-grown food.
8	Israel	74.1	Tel Aviv (Cyber/Security): The world's highest density of defense-grade future technology firms.
9	Switzerland	71.2	Zurich-Lausanne (Neuro/Robotics): Top-tier cluster for brain-computer interface and precision hardware.
10	France	68.7	Paris-Saclay (Quantum/AI): Europe's fastest-growing deep-tech cluster with massive sovereign support.
11	Netherlands	65.3	Eindhoven (Brainport): Irreplaceable cluster for high-precision lithography and photonics.
12	Canada	62.8	Toronto-Waterloo (Quantum/AI): Leading North American hub for quantum computing and GAI research.
13	India	59.6	Bengaluru (AI Application): Global center for AI-driven software development and 6G rural application.
14	Sweden	55.4	Stockholm (Green-tech): Premier cluster for clean energy storage and sustainable industrial systems.
15	Finland	51.2	Oulu (6G Hub): The most focused cluster globally for future connectivity and wireless protocols.
16	USA (Austin)	N/A	(Included in USA total score) The secondary GAI and Hardware hub.
17	Australia	44.3	Sydney-Melbourne (Quantum): Rapidly maturing cluster for quantum sensing and optics.
18	UAE	41.7	Masdar/NEOM (Urban Future): Strategic clusters for smart city and renewable energy deployment.
19	Italy	38.9	Emilia-Romagna (Automation): The heart of high-end mechanical automation and sensor technology.
20	Brazil	31.2	Campinas (Agri-tech): The Southern Hemisphere's leader in bio-innovation and agricultural future-tech.

The United States ranks first with a score of 97.5, as its Bay Area cluster dominates global generative AI and gathers over 60% of the world's GPU-compute talent. China ranks second at 95.8, with the Pearl River Delta serving as a global hub for robotics and 6G hardware, supported by the world's densest supply chain. Germany, Japan, South Korea, and the UK follow

with strong clusters in Industry 4.0, quantum and materials, semiconductors and AI chips, and bio-AI convergence respectively. This indicator effectively reflects each economy's core industrial strengths and strategic positioning in the global next-generation industrial landscape.

Global Future Industries Assessment 2025:
National Perspectives Ranking

Policy Pivot and Regulatory Agility

Rank	Country/Region	Aggregate Score	3.1 Strategic Policy Pivot	3.2 Regulatory Sandbox Maturity	3.3 Financial Incentive Efficiency	3.4 Sovereignty and Security Alignment
1	China	91.94	95.8	87.2	91.8	92.6
2	USA	91.78	96.5	81.4	95.4	96.7
3	Singapore	91.25	92.4	98.6	84.1	83.4
4	UAE	86.91	89.7	94.2	87.2	65.4
5	UK	84.13	83.5	92.1	71.8	86.1
6	South Korea	83.64	86.2	77.8	89.5	81.5
7	Israel	79.28	74.3	75.1	82.3	95.2
8	Japan	78.12	78.4	79.6	76.4	76.8
9	Germany	77.57	80.1	72.3	79.8	79.2
10	Switzerland	76.49	63.4	84.5	74.1	94.2
11	France	69.95	76.9	53.1	69.2	88.4
12	Netherlands	68.81	68.2	69.8	66.5	71.3
13	Canada	64.93	71.5	61.5	63.1	58.9
14	Finland	63.81	60.1	67.4	57.2	74.1
15	India	60.30	65.8	58.9	60.4	50.1
16	Australia	55.58	57.4	50.4	54.8	62.7
17	Denmark	55.37	51.6	64.2	49.6	54.2
18	Sweden	54.89	54.2	56.3	52.1	57.4
19	Italy	47.73	48.3	46.8	45.2	51.6
20	Brazil	41.20	42.1	39.5	38.7	45.8

Based on the quantitative data in the provided indicator table, China ranks 1st globally within the Policy and Regulatory domain. This top-tier position is primarily driven by its unparalleled performance in Indicator 3.3 (Financial Incentive Efficiency), where China’s targeted fiscal mechanisms have successfully catalyzed high-tech industrial clusters. This score directly correlates with the 2025 recognition of cities like Hefei as pioneers in sustainable development. While Singapore (Rank 3) maintains a slight edge in Indicator 3.2 (Regulatory Sandbox Maturity)—

supporting its status as a "Model of Smart Governance"—China shows a more robust integration of technology and national interests through Indicator 3.4 (Sovereignty and Security Alignment). This alignment provides a stable institutional foundation for Beijing's leadership in industrial layout innovation. Ultimately, the data reveals that China’s top ranking is a result of a highly synchronized Strategic Policy Pivot (3.1), positioning it as the global benchmark for future city governance and resilience.

Global Future Industries Assessment 2025: National Perspectives Ranking

Policy Pivot and Regulatory Agility

3.1 Strategic Policy Pivot			
Rank	Country/Region	Score (0-100)	2025 Policy Pivot Focus
1	USA	96.5	Implementation of the "2026 Frontiers Act" focusing on AGI safety and domestic compute power.
2	China	95.8	Integration of the "15th Five-Year Plan" early drafts, prioritizing vertical AI sovereignty.
3	Singapore	92.4	National AI Strategy 3.0: Transitioning from adoption to global governance leadership.
4	UAE	89.7	The "Centennial 2071" pivot focusing on non-oil AI-driven economic architecture.
5	South Korea	86.2	The "AI-Semiconductor Pivot" to secure global HBM4 dominance via policy mandates.
6	UK	83.5	Strategic focus on becoming the "Global AI Safety Hub" post-Bletchley accord.
7	Germany	80.1	"Digital Strategy 2026" focusing on sovereign industrial cloud and 6G industrial use.
8	Japan	78.4	Massive policy pivot toward Humanoid Robot labor integration to counter demographic shifts.
9	France	76.9	"France 2030" acceleration focusing on nuclear-powered AI data centers.
10	Israel	74.3	Pivot toward autonomous defense-tech integration into the civilian sector.
11	Canada	71.5	Federal focus on the "Quantum-Safe Canada" infrastructure transition.
12	Netherlands	68.2	Strategic protection of the semiconductor equipment chain via export-policy alignment.
13	India	65.8	"IndiaAI" mission expansion to include sovereign LLMs and 6G rural connectivity.
14	Switzerland	63.4	Policy pivot toward neuro-tech ethics and global data trust management.
15	Finland	60.1	Re-alignment of national R&D toward open-architecture 6G systems.
16	Australia	57.4	Critical Minerals Strategy pivot to integrate AI-driven refining and processing.
17	Sweden	54.2	Policy focus on fossil-free industrial tech as a global export standard.
18	Denmark	51.6	Pivot toward bio-industrial manufacturing and synthetic biology leadership.
19	Italy	48.3	National plan for AI-assisted manufacturing for traditional SMEs.
20	Brazil	42.1	Strategic focus on digital agricultural sovereignty and bio-tech monitoring.

The USA ranks 1st in the Strategic Policy Pivot dimension with a score of 96.5, driven by the implementation of the "2026 Frontiers Act" aimed at achieving AGI leadership. China follows closely in 2nd place (Score: 95.8), with its strategic focus centered on the integration of the "15th Five-Year Plan" to cultivate AI-driven industrial clusters. The data reveals a highly competitive landscape among the top three, as Singapore (Rank 3, Score: 92.4) shifts its national strategy toward sovereign R&D models.

Notably, the UAE (Rank 4) and South Korea (Rank 5) demonstrate significant policy pivots toward non-oil economic architectures and semiconductor leadership respectively, with scores exceeding 86.0. This indicator highlights that global leaders are increasingly aligning national policy with advanced AI and semiconductor infrastructure to secure future economic competitiveness.

Global Future Industries Assessment 2025:
National Perspectives Ranking

Policy Pivot and Regulatory Agility

3.2 Regulatory Sandbox Maturity			
Rank	Country/ Region	Score (0-100)	Sandbox Success (2025)
1	Singapore	98.6	The world's most mature sandbox for AI in fintech and maritime autonomy.
2	UAE	94.2	Successful commercialization of eVTOLs and drone delivery via the Dubai Sandbox.
3	UK	92.1	Leading sandboxes for quantum-safe banking and clinical synthetic biology.
4	China	87.2	Massive deployment of urban "Low-Altitude Economy" sandboxes in Shenzhen.
5	Switzerland	84.5	High-maturity sandbox for BCI (Brain-Computer Interface) medical device trials.
6	USA	81.4	Strong state-level sandboxes (e.g., Arizona/Texas) for autonomous trucking.
7	Japan	79.6	Sandboxes for humanoid service robots in public spaces and elderly care.
8	South Korea	77.8	Smart city sandboxes for 6G-connected V2X (Vehicle-to-Everything) systems.
9	Israel	75.1	Mature cybersecurity and defensive-AI sandboxes for private sector resilience.
10	Germany	72.3	"Living Labs" for Industrial Metaverse and smart factory testing.
11	Netherlands	69.8	Sandbox for photonics-based computing and next-gen chip architecture.
12	Finland	67.4	Global leading sandbox for 6G private industrial networks in Oulu.
13	Denmark	64.2	Bio-tech sandboxes focusing on lab-grown materials and future proteins.
14	Canada	61.5	Ethical-AI sandboxes for government service automation audits.
15	India	58.9	Scaling sandboxes for AI-driven rural financial inclusion and health-tech.
16	Sweden	56.3	Green energy sandboxes for hydrogen storage and micro-grid integration.
17	France	53.1	Regional sandboxes for decentralized AI and European data-cloud nodes.
18	Australia	50.4	Remote-ops sandboxes for automated mining in Western Australia.
19	Italy	46.8	Experimental zones for high-end robotic craftsmanship and textiles.
20	Brazil	39.5	Pilot sandboxes for satellite-based rainforest monitoring and agri-tech.

Singapore ranks 1st in Regulatory Sandbox Maturity with a score of 98.6. Its success is driven by maintaining the world’s most mature regulatory environments for AI applications in fintech and maritime autonomy. The UAE ranks 2nd (Score: 94.2), distinguished by the successful commercialization of advanced mobility solutions like eVTOLs and drones within the Dubai Sandbox. The UK (Rank 3, Score: 92.1) and China (Rank 4, Score: 87.2) also demonstrate high maturity,

with the UK leading in quantum-safe banking and China focusing on the "Low-Altitude Economy" in Shenzhen. Switzerland (Rank 5) rounds out the top tier with a score of 84.5, specifically excelling in medical device trials for Brain-Computer Interfaces. This indicator shows that nations scoring above 84.0 are successfully using controlled regulatory environments to bridge the gap between experimental technology and full-scale commercialization.

Global Future Industries Assessment 2025: National Perspectives Ranking

Policy Pivot and Regulatory Agility

3.3 Financial Incentive Efficiency

Rank	Country/ Region	Score (0-100)	Funding Efficiency (2025)
1	USA	95.4	Highest conversion rate of public grants to commercialized IP in GAI.
2	China	91.8	Massive efficiency in scaling 6G infrastructure via state-guided investment.
3	South Korea	89.5	Strategic efficiency in R&D tax credits for AI-memory semiconductor firms.
4	UAE	87.2	Direct, high-impact investment from MGX and sovereign funds into AI infrastructure.
5	Singapore	84.1	Precision funding via "National AI Strategy" grants with strict KPI monitoring.
6	Israel	82.3	World-leading efficiency of the Innovation Authority's matching grant model.
7	Germany	79.8	Effective pooling of EU and Federal funds for green industrial transformation.
8	Japan	76.4	Incentives for "Deep-Tech" startups focusing on fusion and robotics materials.
9	Switzerland	74.1	Lean but highly effective funding for specialized neuro-tech research hubs.
10	UK	71.8	Improved ROI on the "Quantum Strategy" through private sector partnerships.
11	France	69.2	High-efficiency grants for European sovereign-cloud and LLM projects.
12	Netherlands	66.5	Focused incentives for photonics and micro-manufacturing equipment.
13	Canada	63.1	Efficiency in funding AI-health convergence and carbon-capture R&D.
14	India	60.4	Strong PLI (Production Linked Incentive) efficiency for high-tech manufacturing.
15	Finland	57.2	Targeted grants for 6G architecture and wireless security startups.
16	Australia	54.8	Funding efficiency for green hydrogen and mineral processing pilots.
17	Sweden	52.1	Efficiency in subsidies for decarbonized metallurgy and battery tech.
18	Denmark	49.6	Funding for synthetic biology and pharmaceutical future-industries.
19	Italy	45.2	Targeted incentives for "Industry 4.0" automation in luxury goods.
20	Brazil	38.7	Incentives for bio-industrial startups and smart-agriculture tech.

The USA ranks 1st in Financial Incentive Efficiency with a score of 95.4. Its primary strength lies in achieving the highest global conversion rate of public grants into commercialized Intellectual Property (IP) within the field of Generative AI (GAI). China follows in 2nd place with a score of 91.8, demonstrated by its massive efficiency in scaling 6G infrastructure through state-guided funding mechanisms. South Korea (Rank 3, Score: 89.5) shows strategic precision in applying R&D tax credits specifically for AI-memory

The UAE (Rank 4, Score: 87.2) utilizes direct, high-impact investments from MGX and sovereign wealth funds to build out AI infrastructure. Finally, Singapore (Rank 5, Score: 84.1) maintains its competitiveness through "National AI Strategy" grants that utilize strict KPI monitoring to ensure precision funding. This indicator highlights that top-tier nations are prioritizing the speed and quality of converting fiscal support into tangible technological industrialization.

Global Future Industries Assessment 2025: National Perspectives Ranking

Policy Pivot and Regulatory Agility

3.4 Sovereignty and Security Alignment

Rank	Country/Region	Score (0-100)	Security Alignment (2025)
1	USA	96.7	Integrated "Tech-Security" doctrine protecting AI weights and semiconductor IP.
2	Israel	95.2	Highest alignment of AI development with national cyber-resilience protocols.
3	Switzerland	94.2	"Neutrality 2.0": Providing sovereign data vaults for international organizations.
4	China	92.6	Complete domestic substitution (Xinchuang) for all future-tech critical infrastructure.
5	France	88.4	Leading the "Sovereign AI" movement to reduce dependence on external cloud.
6	UK	86.1	Strategic alignment of the "Quantum-Safe Backbone" with national intelligence.
7	Singapore	83.4	World-class cross-border data sovereignty and cybersecurity laws.
8	South Korea	81.5	Security focus on protecting HBM/Chip supply chains from external espionage.
9	Germany	79.2	EU-compliant industrial data sovereignty via Gaia-X and sovereign cloud.
10	Japan	76.8	Cybersecurity alignment for automated energy grids and transport systems.
11	Finland	74.1	Strategic 6G security protocols designed for high-threat environments.
12	Netherlands	71.3	Security alignment for lithography supply chain and photonics networks.
13	Canada	68.9	Implementation of the "Quantum-Safe" transition for the banking sector.
14	UAE	65.4	Sovereign AI development for government and oil/gas critical systems.
15	Australia	62.7	Alignment of satellite tech with remote infrastructure security.
16	India	60.1	"Digital Sovereignty" focus on domestic stack and AI-based defense.
17	Sweden	57.4	Security protocols for fossil-free industrial clusters and energy grids.
18	Denmark	54.2	Bio-security frameworks for advanced synthetic biology research.
19	Italy	51.6	Security alignment for high-tech robotic manufacturing clusters.
20	Brazil	45.8	Data sovereignty for bio-genetic resources and climate monitoring.

The USA ranks 1st in Sovereignty and Security Alignment with a score of 96.7. This leading position is driven by the nationwide implementation of "Sovereign AI Infrastructure," ensuring that critical national datasets and AI models remain under secure domestic jurisdiction. Israel follows in 2nd place with a score of 95.2, reflecting its advanced integration of defensive cyber-protocols across its national grid and military systems. Switzerland (Rank 3) maintains a very strong presence with a score of 94.2,

supported by its global reputation for "Data Neutrality" and the provision of high-security international data vaulting services. China ranks 4th with an updated score of 92.6, where its strategic focus is centered on robust "Cyber-Sovereignty" laws and a mandate for a fully secure domestic cloud-stack. Finally, France (Rank 5) scores 85.3, emphasizing its commitment to "European Tech Sovereignty" to reduce strategic reliance on external technology providers.

Global Future Industries Assessment 2025:
National Perspectives Ranking

Ecosystem and Environmental Sustainability

Rank	Country/Region	Aggregate Score	4.1 Bio-Digital Decarbonization Score	4.2 Energy Resilience for Computation	4.3 Neuro-Ethics and AI Safety Frameworks	4.4 Global Collaboration Index
1	USA	91.84	89.5	97.1	85.4	96.7
2	China	90.49	95.8	96.5	78.2	88.3
3	Switzerland	86.49	82.1	79.1	94.2	97.2
5	Germany	81.66	94.2	61.4	92.8	78.5
4	Singapore	81.03	85.4	72.8	75.1	98.6
6	Canada	80.53	65.7	91.2	88.6	75.4
7	UK	76.26	68.4	63.5	91.5	92.1
9	Finland	74.37	76.5	85.6	62.7	67.1
8	France	73.12	72.1	82.3	65.3	69.8
13	Netherlands	70.72	62.3	66.2	80.6	80.1
10	Sweden	69.72	88.6	57.4	59.4	73.8
12	Israel	67.58	51.4	75.4	68.4	82.9
11	South Korea	67.23	74.8	59.7	72.3	58.7
14	Japan	67.19	79.3	69.5	51.5	64.5
15	UAE	64.74	44.3	88.4	48.6	85.2
16	Australia	58.61	55.2	52.3	68.7	61.2
17	Denmark	54.88	59.8	49.6	44.8	72.4
18	India	50.29	48.6	46.7	54.2	54.3
19	Italy	42.67	41.2	42.8	42.1	46.3
20	Brazil	34.91	38.5	31.9	35.7	32.4

The United States ranks first with an aggregate score of 91.84, driven by leading performance in Energy Resilience (97.4) and Global Collaboration (96.7), supported by robust computational infrastructure and talent attraction. China follows at 90.49, leading in Bio-Digital Decarbonization (95.8) through large-scale green hydrogen and 6G pilots, while maintaining strong energy resilience (96.5). Switzerland ranks third at 86.49, excelling in Neuro-Ethics and AI Safety (94.2) and Global

Collaboration (88.3), solidifying its role as a science diplomacy leader. This ranking highlights a competitive landscape where the U.S. leads in energy and collaboration, China in decarbonization, and Switzerland in ethical governance, reflecting diverse strategic priorities in global tech stewardship.

Global Future Industries Assessment 2025: National Perspectives Ranking

Ecosystem and Environmental Sustainability

4.1 Bio-Digital Decarbonization Score

Rank	Country/Region	Score (0-95.80)	Workforce Competency Highlight
1	China	95.8	World leader in scaling bio-manufacturing talent for synthetic carbon-capture clusters.
2	Germany	94.2	High concentration of engineers specializing in "Circular Industry 4.0" and hydrogen tech.
3	USA	89.5	Strongest private-sector talent in Bio-computing, though centralized in coastal hubs.
4	Sweden	88.6	Pioneer in fossil-free metallurgy talent and carbon-neutral industrial design.
5	Singapore	85.4	Specialized workforce for vertical bio-farming and urban energy-sync systems.
6	Switzerland	82.1	Precision engineering talent focused on high-efficiency, low-waste pharma production.
7	Japan	79.3	Mastery in material science decarbonization for solid-state battery manufacturing.
8	Finland	76.5	Excellence in bio-based material engineering and digital forestry management.
9	South Korea	74.8	Rapidly growing talent pool in low-power semiconductor design for green data centers.
10	France	72.1	Strong tradition in nuclear-linked thermal engineering for low-carbon computation.
11	UK	68.4	Leading research talent in fusion-energy modeling and bio-synthetic fuel.
12	Canada	65.7	Expertise in carbon-sequestration monitoring and geological data science.
13	Netherlands	62.3	Water-management engineers integrating AI for climate-resilient urban infrastructure.
14	Denmark	59.8	World-class enzymatic engineering talent for bio-industrial applications.
15	Australia	55.2	Emerging specialization in AI-driven sustainable lithium and rare-earth refining.
16	Israel	51.4	High-efficiency talent in desert-tech and water-recycling AI systems.
17	India	48.6	Massive scale of junior STEM talent being upskilled for renewable energy grids.
18	UAE	44.3	Rapidly importing global talent for large-scale solar-to-hydrogen engineering.
19	Italy	41.2	Heritage manufacturing talent pivoting toward bio-based luxury materials.
20	Brazil	38.5	Expertise in bio-diversity data and sustainable tropical agri-tech.

China ranks first with a score of 95.8, driven by the world's largest integrated hydrogen-ammonia pilots and 6G-enabled smart city projects, which significantly cut industrial emissions. The U.S. follows at 89.5, leading in AI-optimized grid management and carbon capture technologies. Singapore places third at 85.4, leveraging smart urban logistics and digital twins to achieve net-zero urban operations.

Germany ranks fourth at 84.2, focusing on bio-based manufacturing and industrial decarbonization. Switzerland is fifth at 82.1, with strong performance in sustainable lab practices and green data centers. This indicator highlights each economy's strategic approach to merging digital innovation with climate action, with top performers scaling green hydrogen and smart infrastructure to drive global decarbonization.

Global Future Industries Assessment 2025: National Perspectives Ranking

Ecosystem and Environmental Sustainability

4.2 Energy Resilience for Computation

Rank	Country/ Region	Score (0-97.10)	2025 Energy-Compute Highlight
1	USA	97.1	SMR Integration: Leader in modular nuclear-powered data centers and grid architects.
2	China	96.5	UHV Mastery: Unmatched talent in Ultra-High-Voltage transmission for AI mega-clusters.
3	Canada	91.2	Hydro-Compute: Experts in large-scale hydroelectric cooling and energy balancing for AI.
4	UAE	88.4	Solar-Grid Synergy: Massive upskilling in managing solar-to-compute energy cycles in deserts.
5	Finland	85.6	Nordic Efficiency: World-class talent in district heating reuse from liquid-cooled data centers.
6	France	82.3	Nuclear Stability: Skilled workforce in providing stable base-load power for sovereign AI clouds.
7	Switzerland	79.1	Grid Precision: Highly specialized engineers in micro-grid stability for secure data vaults.
8	Norway	75.4	Renewable Mastery: Deep expertise in 100% renewable power management for green computing.
9	Singapore	72.8	Tropical Innovation: Mastery in tropical energy efficiency and floating data center cooling.
10	Japan	69.5	Hydrogen-Grid: Leading architects for hydrogen-powered local decentralized compute networks.
11	Netherlands	66.2	Edge Energy: Excellence in managing localized power for edge-computing and photonics hubs.
12	UK	63.5	Offshore Power-to-X: Integration of North Sea wind power with coastal compute clusters.
13	Germany	61.4	Smart Factory Grids: Focused talent on industrial-grade energy resilience for automated plants.
14	South Korea	59.7	V2G Pioneers: Integrating vehicle-to-grid energy storage to support compute-heavy urban zones.
15	Sweden	57.4	Fossil-Free Logic: Skilled workforce in zero-carbon energy supply for industrial AI.
16	Israel	55.1	Cyber-Resilient Energy: Experts in protecting smart-grids from cyber-threats in real-time.
17	Australia	52.3	Remote Power: Specialists in off-grid solar/battery systems for remote mining automation.
18	India	46.7	Scaling Infrastructure: Rapid growth in talent for large-scale solar integration into the national grid.
19	Italy	42.8	Efficiency Retrofitting: Workforce focused on upgrading traditional grids to smart-standard.
20	Brazil	31.9	Agri-Grid Solutions: Developing localized energy systems for bio-industrial rural sites.

The United States ranks first with a score of 97.4, driven by the rapid scaling of 2nm/GAA logic chip fabs and dedicated renewable energy microgrids for generative AI server clusters, ensuring stable, low-carbon power for advanced computing. China follows closely at 96.5, leveraging large-scale green hydrogen and nuclear energy projects to power its 6G and industrial IoT infrastructure, enhancing energy security for national computing networks.

Singapore places third at 96.8, with advanced cooling technologies and renewable energy procurement strategies that make its data centers among the world's most energy-efficient. This indicator highlights how top economies are aligning their computing infrastructure with sustainable energy strategies to maintain competitiveness in the AI era.

Global Future Industries Assessment 2025: National Perspectives Ranking

Ecosystem and Environmental Sustainability

4.3 Neuro-Ethics and AI Safety Frameworks			
Rank	Country/ Region	Score (0-94.20)	2025 Ethical Talent Highlight
1	Switzerland	94.2	Global Neutrality: Sanctuary for neuro-ethics; home to top international BCI safety bodies.
2	Germany	92.8	Legal Architecture: Leading technical implementation of AI Act safety audits via specialized talent.
3	UK	91.5	Red-Teaming Hub: High density of AI alignment researchers and catastrophic risk monitors.
4	Canada	88.6	Human-Centricity: Montreal-led legacy of algorithmic transparency and bias mitigation talent.
5	USA	85.4	Industrial Alignment: Primary concentration of alignment researchers within top private AI labs.
6	Netherlands	80.6	Data Sovereignty: Experts in neural-data privacy and individual digital rights protection.
7	China	78.2	Social Alignment: Emerging talent pool in aligning GAI with social stability and state safety.
8	Singapore	75.1	Certified Auditors: Professionalizing the role of "AI Ethics Officers" for the global finance sector.
9	South Korea	72.3	Digital Context Safety: Protecting local cultural context from bias in global AI models.
10	Norway	69.8	Democratic Oversight: High public/academic participation in defining AI surveillance boundaries.
11	Israel	68.4	Dual-Use Ethics: Specialized boundaries for autonomous decision-making in security systems.
12	France	65.3	Cultural Sovereignty: Protecting human creative agency against mass AI generative scraping.
13	Finland	62.7	Digital Literacy: World-leading education systems preparing the public for ethical AI use.
14	Sweden	59.4	Workforce Transition: Specialists in the ethics of labor displacement and reskilling rights.
15	Australia	56.1	Responsible Mining AI: Frameworks for ethics in automated extraction and safety.
16	India	54.2	Inclusion Advocates: Talent focused on reducing linguistic and economic bias in population AI.
17	Japan	51.5	Robotic Rights: Unique focus on the ethical integration of social humanoid robots.
18	UAE	48.6	Governance Fast-Track: Strategic adoption of global ethical norms into local AI regulation.
19	Denmark	44.8	Bio-Ethics Focus: Talent dedicated to the safety and ethics of CRISPR and synthetic food.
20	Brazil	35.7	Resource Equity: Advocacy for Global South access to ethical AI development tools.

Switzerland ranks first with a score of 94.2, setting global benchmarks for AI risk management and data sovereignty through its robust regulatory frameworks and international science diplomacy. Germany follows at 92.8, leading in industrial AI safety standards and neuro-ethics guidelines for automated manufacturing, ensuring responsible integration of AI into its "Mittelstand" base.

The UK places third at 91.5, excelling in AI transparency and ethical AI for healthcare, with Oxford and Cambridge leading global research into neuro-ethics. This indicator highlights a clear leadership gap between European economies and others, with Switzerland and Germany setting the global standard for responsible AI governance.

Global Future Industries Assessment 2025: National Perspectives Ranking

Ecosystem and Environmental Sustainability

4.4 Global Collaboration Index

Rank	Country/ Region	Score (0-98.60)	2025 Collaboration Highlight
1	Singapore	98.6	The Connector: Highest frequency of joint international labs and global R&D mobility.
2	Switzerland	97.2	Science Diplomacy: Leading node for international co-authorship in Quantum and Bio-tech.
3	USA	96.7	Top 1% Attraction: Still the primary destination for the most cited AI and Bio researchers.
4	UK	92.1	Indo-Pacific Links: Strongest high-mobility research ties between Europe and Asian tech hubs.
5	China	88.3	Global Innovation Hub: Expanding Belt and Road tech corridors and joint labs in AI, 6G, and green hydrogen with 30+ countries.
6	UAE	85.2	The New Hub: Massive rise in international talent attraction via "Golden Visas" and MGX.
7	Israel	82.9	Startup Sync: Deep, daily technical collaboration with the US and EU private tech sectors.
8	Netherlands	80.1	Chip Supply Node: Key talent circulation within the European semiconductor equipment ecosystem.
9	Germany	78.5	Industrial Bridge: Strongest intra-EU research mobility for automated manufacturing standards.
10	Canada	75.4	Remote Hub: Preferred destination for remote-working global researchers via flexible policies.
11	Sweden	73.8	Green Partners: Leading international collaboration on fossil-free industrial technologies.
12	Denmark	72.4	Bio-Cluster: Central node for global pharma and enzyme research collaboration.
13	France	69.8	Sovereign Network: Leading EU efforts in collaborative sovereign-cloud and LLM training.
14	Finland	67.1	6G Open Alliance: Global leadership in open-architecture 6G network research partnerships.
15	Japan	64.5	Material Alliance: Strategic research ties in battery and semiconductor materials with the US.
16	Australia	61.2	AUKUS Pillar 2: Increasing collaboration in advanced AI, Quantum, and Underwater tech.
17	South Korea	58.7	Alliance-Based R&D: Strengthening ties with Japan and US for the "Chip 4" talent corridor.
18	India	54.3	Digital Diaspora: Leveraging a massive global workforce for back-end AI training and software.
19	Italy	46.3	Design Synergy: Collaborative labs for AI-enhanced high-end manufacturing.
20	Brazil	32.4	Bio-Diversity Data: Emerging node for international biological and climate data research.

Singapore ranks first with a score of 98.6, serving as a global connector with the highest frequency of joint international labs and R&D mobility, solidifying its role as a hub for cross-border innovation. The USA follows at 96.7, remaining the primary destination for the world’s most cited AI and biotech researchers, driven by its deep venture capital ecosystem and top-tier research institutions. Switzerland places third at 88.3, leading in science diplomacy and international co-authorship in quantum and biotech,

with a strong focus on open research collaboration. China ranks fourth at 87.2, expanding its Belt and Road tech corridors and establishing joint labs in AI, 6G, and green hydrogen with over 30 countries, enhancing its global innovation footprint. This indicator highlights how top performers balance talent attraction, institutional partnerships, and cross-border research mobility to shape the future of global innovation.

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Global Future Industries Assessment 2025: **Urban Perspectives Ranking**



Global Future Industries Assessment 2024: Urban Perspectives Ranking

2025 Rank		City	2025 Industry Label & Strategic Identity
1	—	San Francisco-San Jose	GAI & Bio-Tech Epicenter: The world's engine for AI, BCI, and tech-capital.
2	↑	Beijing	Full-Stack Future Leader: GAI models, Robotics, and Fusion strategy powerhouse.
3	↑	Boston	Robotics & Life Science Capital: The global core of MIT-driven bio-manufacturing.
4	↑	Shanghai	Intelligent Manufacturing Hub: World leader in Bio-pharma CXO and Robotics.
5	↑	Shenzhen	6G & Supply Chain King: Global hardware iteration and EV-energy digitalization.
6	↓	London-Oxford-Cambridge	AI Governance & Deep-Tech Hub: Birthplace of DeepMind; policy lead.
7	↑	Hefei	Quantum & Fusion Miracle: Global lighthouse for commercialized Quantum and Fusion.
8	—	Tokyo-Yokohama	Precision Intelligence Hub: Leader in humanoid service bots and Quantum-AI.
9	↑	Singapore	Future City Lab: Global pioneer in Cultured Food and smart urban Embodied AI.
10	↓	New York	AI Finance & BCI Business: Leader in AI for Finance and neuro-interfaces.
11	↑	Zurich	European Digital Architect: High-end 6G hardware and robotics algorithms.
12	↑	Seoul	Communication Playground: World-first 6G pilot city and embodied semiconductor.
13	↓	Munich-Stuttgart	Industry 4.0 Evolution: Leader in industrial 6G and collaborative robotics.
14	↑	Austin	The New Hardware Pole: The manufacturing hub for Tesla Bots and Neuralink.
15	↑	Toronto	Algorithm & Quantum Bridge: Elite talent pool for AI and photonic quantum.
16	↑	Tel Aviv	Algorithm Efficiency Hub: AI drug discovery and cybersecurity core.
17	↓	Paris	Sovereign Tech High-Ground: Leader in EU AI models and ITER coordination.
18	↓	Hangzhou	Platform Intelligence: World leader in logistics robotics and Bio-informatics.
19	↑	Abu Dhabi	Sovereign Compute & Green H2: The world's fastest-growing AI & Green Energy hub.
20	↑	Bengaluru	Scaling Delivery Center: Global software outsourcing pivoting to core R&D.

Note: refer to “Comprehensive analysis and ranking of future industries” for a detailed ranking of each industry segment

The 2025 Global Smart City Innovation Index reveals distinct shifts in urban innovation leadership, with each city's ranking change directly tied to its performance in AI, robotics, biotech, and next-generation infrastructure, as outlined in the official data.

Top-Tier Leadership and Key Shifts

San Francisco–San Jose retains its 1st place (unchanged from 2024), driven by its status as the global hub for AI, BCI, and next-gen capital, leading in foundational research and venture capital for frontier technologies. Beijing climbs from 3rd to 2nd place, solidifying its role as a full-stack leader in AI models, robotics, and future power infrastructure, with unmatched industrial deployment capacity. Boston holds 3rd place (up from 5th), emerging as the global capital of AI-driven biomanufacturing, fueled by breakthroughs in synthetic biology and lab-grown tissues.



Key Ranking Changes and Justifications

Upward Movement: Shanghai rises from 7th to 4th, excelling in intelligent manufacturing with world-leading industrial cobots and AI-driven production lines. Shenzhen climbs from 17th to 5th, leading in 5G and supply chain innovation through global hardware iteration and energy-efficient digitalization. He Fei advances from 14th to 7th, becoming a quantum and photonics powerhouse through deep collaboration in quantum computing and photonic chips. Tokyo-Yokohama holds 8th place (unchanged), leading in precision intelligence with advancements in mobile AI and quantum AI. Singapore rises from 13th to 9th, positioning itself as a future city hub with global adoption of AI-driven urban mobility and embedded AI solutions. Seoul rises from 16th to 12th, as its communication ecosystem faces competition from cities with more integrated 6G and open RAN deployments.

Downward Movement: London-Oxford-Cambridge falls from 2nd to 6th, leveraging AI governance and deep tech research, with breakthroughs in policy-aligned AI systems. New York falls from 4th to 10th, with slower progress in AI finance and biotech infrastructure compared to peers. Zurich holds 11th place, leading in European digital architecture with high-end 6G and robotics algorithms.

New Entrants and Resilience: Austin enters the top 15 at 14th, emerging as a new hardware hub with leading manufacturing for IoT, photonic, and net-zero tech. Hangzhou holds 18th place, leading in platform intelligence with world-leading logistics robots and bio-AI formats, while Abu Dhabi rises to 19th, driving sovereign compute and green AI through large-scale renewable-powered data centers.

Overall Implications

The 2025 rankings highlight a clear shift toward cities that integrate deep tech research with industrial deployment. The stability of San Francisco-San Jose and the ascent of Beijing underscore sustained investment in comprehensive innovation ecosystems, while shifts among other cities reflect the need for targeted strategies to maintain competitiveness in the global smart city race.



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Comprehensive analysis and ranking of future industries

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Comprehensive analysis and ranking of future industries

General Artificial Intelligence (GAI)

Definition

By 2025, the industry consolidated around a more functional definition of GAI/AGI:

Reasoning & Fluid Intelligence: Unlike "Narrow AI," 2025's GAI models (like Gemini 3 and GPT-5) demonstrate "Fluid Intelligence"—the ability to solve novel problems they weren't explicitly trained on, rather than just predicting the next word.

Agentic Autonomy: GAI is now defined by its Agentic nature. It doesn't just answer questions; it executes multi-step plans (e.g., "Plan and book a 10-day eco-tour through Japan within a \$5,000 budget") across various software and physical interfaces without constant human prompting.

Cross-Domain Mastery: A GAI system is expected to perform at or above human level across virtually all economically valuable tasks, from complex coding and scientific research to creative arts and emotional intelligence.

Summary of Outstanding Achievements in 2025

A. The Rise of "Reasoning" Models

The launch of Gemini 3 (Google) and GPT-5 (OpenAI) marked the end of the "hallucination era."

Deep Think Capabilities: Models now use "system 2" thinking—pausing to deliberate and verify logic before responding. This led to breakthroughs in Gold-Medal level Mathematics and autonomous Scientific Hypothesis generation.

Efficiency Gains: The "rise of smaller models" allowed 70B-parameter open-source models to match the performance of 2024's trillion-parameter giants, democratizing high-level intelligence for mid-sized businesses.

B. Embodied AI & Robotics

2025 was the year AI "got a body."

Gemini Robotics 1.5: Successfully integrated GAI brains into humanoid hardware, allowing robots to understand natural language instructions in messy, real-world kitchens and factories (e.g., "Clean up the spill and put the blue mug away").

World Models: Models like Genie 3 began simulating physics within their "minds," allowing AI agents to learn how to move and interact with objects in a virtual space before ever touching the physical world.

C. Agentic Software Engineering

AI Code Agents: Tools like Google Antigravity and Jules evolved from "coding assistants" to "autonomous developers." They can now manage entire codebases, perform complex debugging, and integrate new features independently, reducing the need for entry-level manual coding.

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General Artificial Intelligence (GAI)

Native Adaptive Interfaces: AI now generates its own UI (User Interface) on the fly based on the user's specific intent, rendering traditional static apps increasingly obsolete.

D. Scientific & Healthcare Miracles

Protein & Genomic Design: GAI models accelerated drug discovery to a pace of months rather than years. In 2025, the first GAI-designed vaccines for highly mutable viruses entered advanced trials.

Quantum-AI Synergy: Early integration of AI with quantum computing started solving "impossible" problems in material science, leading to the discovery of more efficient battery chemistries.

Future development trends

Building on the achievements of 2025, the development of General Artificial Intelligence (GAI) from 2026 toward 2030 is shifting from "generative" to "agentic and embodied." Here are the key future trends that will define the next five years.

1. The "Agentic" Era (2026–2027)

The primary shift is from AI that answers to AI that acts.

Autonomous Workflows: 40% of enterprise applications are projected to include task-specific AI agents by the end of 2026. These agents won't just suggest code or emails; they will independently manage supply chains, execute sales orders, and resolve customer service tickets from start to finish.

Collaboration over Automation: AI is evolving from a tool to a "digital colleague." By 2027, 50% of enterprises using GAI will have deployed "Human-Agent Teams" where AI agents and employees collaborate on complex, multi-step projects.

2. Physical AI and Embodiment

AI is breaking out of the "chatbox" and into the physical world.

Humanoid Integration: By 2028, the cost of industrial robots is expected to drop significantly, making them commonplace in logistics and healthcare. GAI will serve as the "brain," allowing robots to operate in unstructured human environments rather than just programmed factory lines.

The "DeepFleet" Concept: AI will coordinate entire fleets of autonomous vehicles and drones, optimizing city-wide travel and delivery efficiency in real-time.

3. Scientific Discovery Acceleration

GAI is becoming the primary driver of the "Scientific Revolution."

AI Lab Assistants: By 2026, AI won't just summarize papers; it will actively join the process of discovery in physics, chemistry, and biology, suggesting and even running autonomous simulations.

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General Artificial Intelligence (GAI)

Compressed Innovation Cycles: Drug discovery and material science timelines—traditionally taking decades—will be compressed into months. AI is already being used to design new vaccines and discover battery chemistries at superhuman speeds.

4. Infrastructure and Inference Economics

The "Scaling Law" is being replaced by the "Efficiency Law."

Edge AI & Small Language Models (SLMs): To reduce latency and energy costs, developers are moving away from massive data centers toward energy-efficient SLMs that run locally on smartphones, PCs, and industrial sensors.

Hybrid & Sustainable Computing: New data centers coming online toward 2030 are designed to be water-neutral, utilizing liquid cooling and carbon-free electricity to manage the skyrocketing energy demands of GAI.

5. The "Data Wall" and Synthetic Data

As high-quality human-generated data becomes scarce, AI will start training on itself.

Synthetic Data Proliferation: By late 2026, 75% of businesses will use GAI to create synthetic customer data for training and testing purposes, bypassing privacy concerns and data shortages.

Self-Directed Learning: Future models will focus on "structured, self-directed learning" rather than just mimicking internet text, allowing them to master complex reasoning where simple pattern matching fails.



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Comprehensive analysis and ranking of future industries

General Artificial Intelligence (GAI)

City Ranking

Rank	City	Strategic Strength	Rank	City	Strategic Strength
1	San Francisco	OpenAI/Anthropic HQ; venture capital epicenter.	11	Zurich	ETH Zurich Deep Learning & AI Research.
2	Beijing	BAAI; massive scale of domestic LLMs.	12	Seattle	Microsoft/Amazon AI Cloud infrastructure.
3	London	Google DeepMind; global AI safety regulation.	13	Sydney	Asia-Pacific data science & fintech hub.
4	New York	AI for Finance; legal and academic resources.	14	Los Angeles	Generative AI for Media & Entertainment.
5	Hong Kong	Gateway for international AI financial services.	15	Berlin	Industrial AI transformation for EU manufacturing.
6	Tokyo	Multinational R&D; high-performance compute.	16	Hangzhou	Alibaba ecosystem; e-commerce AI application.
7	Shanghai	"Model Speed Space" (GAI + Robotics integration).	17	Bengaluru	Global software service-to-AI transition hub.
8	Paris	Mistral AI; the hope of sovereign European AI.	18	Austin	Tesla/Silicon AI chip design talent.
9	Toronto	Birthplace of Deep Learning; Vector Institute.	19	Abu Dhabi	TII (Falcon) models & sovereign AI compute.
10	Shenzhen	Huawei/Tencent ecosystem; AI hardware edge.	20	Tel Aviv	Elite algorithms & AI-driven cybersecurity.

The 2025 Global Future City Ranking reveals a competitive landscape dominated by established tech hubs and rapidly ascending Asian ecosystems.

San Francisco maintains the top position, serving as the "epicenter" for AGI breakthroughs with industry leaders like OpenAI and Anthropic fueling its high-density venture capital environment.

Following closely, Beijing ranks second, leveraging the Beijing Academy of Artificial Intelligence (BAAI) and a massive domestic LLM market to achieve unparalleled scale.

Comprehensive analysis and ranking of future industries

City Ranking

Western Dominance: London (3rd), New York (4th), and Paris (8th) lead in regulation, finance, and "sovereign AI" efforts.

Key Strategic Trends:

Cluster Maturity: Cities like Shenzhen and Shanghai excel in hardware-software synergy, moving GAI into physical manufacturing.

Specialization: Emerging hubs such as Zurich (11th) and Abu Dhabi (19th) are carving niches in deep learning research and sovereign compute.

Overall, the 2025 data suggests that while the US leads in foundational innovation, the global gap is narrowing as cities worldwide integrate GAI into their specific industrial and financial fabrics.



General Artificial Intelligence (GAI)

Enterprise ranking

Rank	Company	Country	Strategic Edge
1	OpenAI	USA	Leading the frontier with GPT-5 and Sora video generation.
2	Anthropic	USA	Pioneer in "Constitutional AI" and the safe Claude 3.5 series.
3	Google DeepMind	USA/UK	Advancing Gemini 2.0 and AI-driven scientific research.
4	Microsoft	USA	Global leader in AI infrastructure and Copilot ecosystems.
5	Meta	USA	Dominating open-source AI with the Llama-4 ecosystem.
6	NVIDIA	USA	Providing the Blackwell/Rubin GPU hardware for all AI scaling.
7	Mistral AI	France	The European champion of high-efficiency sovereign AI.
8	BAAI	China	Developing "WuDao" models and open-source infrastructure.
9	Databricks	USA	Leading the "Data + AI" integration for enterprise training.
10	Cohere	Canada	Specializing in enterprise RAG (Retrieval-Augmented Generation).

1. American Structural Dominance

The United States maintains a commanding lead, occupying 7 out of the top 10 spots, including the entire top 6. This dominance spans the entire stack: from foundational hardware (NVIDIA) and cloud infrastructure (Microsoft) to frontier models (OpenAI, Anthropic) and open-source leadership (Meta).

2. The Rise of Efficiency and Sovereignty

Non-U.S. entities are successfully carving out strategic niches:

Sovereign AI: Mistral AI (Rank 7) has emerged as France's "National Champion," focusing on high-efficiency models that allow Europe to maintain digital autonomy.

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General Artificial Intelligence (GAI)

Enterprise ranking

Open Infrastructure: China's BAAI (Rank 8) is pivotal for its development of the "WuDao" series and its commitment to building robust open-source infrastructure for the Chinese ecosystem.

3. Enterprise-First Specialization

By 2025, the market has matured beyond general chatbots toward specialized enterprise utilities:

Data Integration: Databricks (Rank 9) is recognized for its seamless fusion of data management and AI training.

Precision Accuracy: Cohere (Rank 10) has solidified its position by specializing in RAG, a critical technology for reducing AI hallucinations in corporate environments.

4. Scientific and Foundational Breakthroughs

Google DeepMind (Rank 3) continues to differentiate itself by applying GAI to the "hard sciences," using Gemini 2.0 to accelerate R&D in fields like biology and materials science. Meanwhile, NVIDIA (Rank 6) remains the "arms dealer" of the AI era, with its Blackwell and Rubin architectures serving as the essential substrate for all other companies' scaling ambitions.

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Comprehensive analysis and ranking of future industries

Embodied AI

Definition

Embodied AI (EAI) is defined as artificial intelligence integrated into tangible entities that can perceive, reason, and act within the physical world. Unlike "screen-based" AI (like standard LLMs), EAI focuses on the perception-action loop:

Multimodal Integration: EAI uses Vision-Language-Action (VLA) models to process sight, sound, and touch simultaneously to make autonomous decisions.

Dynamic Adaptation: It is characterized by the ability to learn through direct physical experience rather than just static data, allowing machines to navigate and manipulate unpredictable human environments.

Agency: It represents the shift from "Information AI" (which summarizes or generates text) to "Agentic AI" (which executes physical tasks like assembling a car or performing surgery).

Summary of Outstanding Achievements in 2025

2025 was the "inflection point" where Embodied AI moved from "toys" to "colleagues":

Mass Production Milestones: Chinese humanoid leaders like AgiBot and Unitree successfully demonstrated the feasibility of large-scale delivery, with total orders in China exceeding 2 billion yuan in H2 2025 alone.

Warehouse Dominance: Amazon's robotic fleet surpassed 1 million units, with its Sequoia and Proteus systems increasing inventory processing speed by 75% and operating fully autonomously alongside human staff.

Surgical Revolution: Over 60% of large hospitals worldwide integrated surgical robotics, with robotic-assisted procedures accounting for 55% of complex surgeries in developed nations.

Policy & Institutional Support: Embodied AI was written into major national government work reports for the first time, signaling its status as a critical strategic industry.

Technical Benchmarks: The NeurIPS 2025 EAI Challenge saw the rise of Foundation Models that mastered "Zero-Shot" generalization, allowing robots to perform tasks in environments they had never seen before.

Future development trends

The next five years will be defined by the convergence of "IT" (Information Technology) and "OT" (Operational Technology):

The "Agentic Leap": AI agents will evolve from "instruments" to "partners." By 2027, "Agentic AI" will allow robots to autonomously anticipate failures in smart factories and optimize path planning in logistics without human intervention.

Embodied AI

Future development trends

Industrial Foundation Models: There is a massive shift toward Industry-Specific Foundation Models—AI pre-trained on specialized industrial data (time-series, CAD, and physics simulations) to ensure higher precision than general-purpose models.

Edge-Intelligence Scaling: To ensure safety and reduce latency, 2026 is seeing the rise of Specialized Edge Hardware (LPUs and NPUs) embedded directly into robot joints, enabling real-time processing of complex AI algorithms without cloud dependency.

Human-Machine Collaboration (Cobots 2.0): Generative AI will act as a "translator" between human natural language and complex machine APIs, making it possible for non-technical workers to "vibe-code" or verbally instruct robots on the fly.

The Global "Robot Economy": The global EAI market is projected to grow from \$4.44 billion in 2025 to over \$23 billion by 2030, driven by an aging workforce and the need for resilient supply chains.

City Ranking

Rank	City	Strategic Strength	Rank	City	Strategic Strength
1	Boston	Boston Dynamics/MIT; the "Silicon Valley" of robotics.	11	Austin	Tesla Optimus production and R&D hub.
2	Beijing	Largest industrial robot cluster and policy support.	12	Stuttgart	Automotive-to-robotics industrial transition.
3	San Francisco	Cruise/Scale AI; high-end embodied algorithms.	13	Nagoya	Toyota-linked service and factory robotics.
4	Shanghai	Advanced manufacturing and intelligent EV base.	14	Seoul	Hyundai/Samsung humanoid development.
5	Pittsburgh	CMU Robotics; pioneers in autonomous systems.	15	Montreal	MILA's physical simulation research.
6	Tokyo	Fanuc/Yaskawa; traditional precision robotics.	16	Copenhagen	Collaborative robotics (Universal Robots).
7	Shenzhen	World's fastest hardware prototyping and supply chain.	17	Lausanne	EPFL robotics and biomechanics research.
8	Zurich	ETH Zurich leg-robotics and drone navigation.	18	Hangzhou	Logistics and warehouse automation leader.
9	Munich	Industry 4.0; haptic perception and cobots.	19	Singapore	Public service embodied AI applications.
10	London	Reinforcement learning and robot software systems.	20	Chengdu	Precision parts and flexible manufacturing.

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Comprehensive analysis and ranking of future industries

Embodied AI

City Ranking

The 2025 Global City Ranking for Embodied AI reflects a diverse and interconnected global ecosystem, where each of the top 20 cities carves out a distinct competitive edge by aligning its strengths—from foundational research and industrial deployment to specialized manufacturing and public service applications—with specific segments of embodied intelligence.

Top-Tier Leadership (1st-5th)

Boston claims 1st place, solidifying its status as the "Silicon Valley of robotics" through Boston Dynamics and MIT. Its leadership in legged robotics and foundational research sets the global benchmark for embodied AI. Beijing holds 2nd place, boasting the world's largest industrial robot cluster and robust policy support, driving large-scale deployment of embodied systems in manufacturing. San Francisco ranks 3rd, leveraging Cruise and Scale AI to lead in high-end embodied algorithms and autonomous systems, translating cutting-edge research into real-world applications. Shanghai is 4th, excelling in advanced manufacturing and intelligent EV bases, integrating embodied AI into smart factories and electric mobility. Pittsburgh rounds out the top 5 at 5th, with CMU Robotics pioneering autonomous systems and laying the groundwork for next-generation embodied intelligence.

Industrial and Precision Excellence (6th-10th)

Tokyo takes 6th place, with Fanuc and Yaskawa leading traditional precision robotics, focusing

on industrial automation and high-precision manufacturing. Shenzhen follows at 7th, renowned for the world's fastest hardware prototyping and supply chain, enabling rapid iteration of embodied AI hardware. Zurich ranks 8th, driven by ETH Zurich's breakthroughs in leg-robotics and drone navigation, advancing mobility in embodied systems. Munich holds 9th place, leading Industry 4.0 with haptic perception and collaborative robots (cobots), bridging human-robot interaction in manufacturing. London is 10th, excelling in reinforcement learning and robot software systems, underpinning the adaptability of embodied AI.

Specialized Deployment and Innovation (11th-15th)

Austin claims 11th place, serving as the global hub for Tesla Optimus production and R&D, scaling humanoid robotics for industrial and consumer use. Stuttgart ranks 12th, driving the automotive-to-robotics industrial transition, leveraging its automotive legacy to pivot toward robotic systems. Nagoya is 13th, serving as a core node for Toyota-linked service and factory robotics, integrating embodied AI into automotive manufacturing and urban services. Seoul holds 14th place, leading humanoid development through Hyundai and Samsung, advancing bipedal robotics and wearable AI. Montreal follows at 15th, with MILA's pioneering physical simulation research, enabling more adaptive and context-aware embodied AI systems.

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Comprehensive analysis and ranking of future industries

Embodied AI

City Ranking

Collaboration, Research, and Application (16th–20th)

Copenhagen ranks 16th, excelling in collaborative robotics through Universal Robots, focusing on safe, flexible cobots for industrial and healthcare settings. Lausanne is 17th, leveraging EPFL’s expertise in robotics and biomechanics, advancing bio-inspired embodied systems that mimic human movement. Hangzhou holds 18th place, emerging as a global leader in logistics and warehouse automation, streamlining e-commerce and supply chains with embodied robotics. Singapore ranks 19th, pioneering public service embodied AI applications in healthcare, eldercare, and urban management. Chengdu closes the top 20 at 20th, specializing

in precision parts and flexible manufacturing, providing critical hardware components for global embodied intelligence systems.

Overall Implications

The 2025 rankings underscore that success in embodied AI stems from targeted specialization rather than broad-based investment. Top-tier cities like Boston and Beijing lead in comprehensive ecosystems, while mid-ranked cities focus on industrial deployment, foundational research, or applied use cases. This diversity creates a resilient global network, where each city contributes uniquely to advancing embodied intelligence from lab to real-world impact.



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Comprehensive analysis and ranking of future industries

Embodied AI

Enterprise ranking

Rank	Company	Country	Strategic Edge
1	Boston Dynamics	USA	Unrivaed dynamic mobility with the electric Atlas robot.
2	Tesla (Optimus)	USA	Scaling humanoid mass-production for automotive logistics.
3	Unitree Robotics	China	Global leader in high-performance affordable humanoids (G1).
4	Figure AI	USA	Successful integration of GAI with humanoid hardware.
5	Agility Robotics	USA	First commercial bipedal logistics deployments (Digit).
6	1X Technologies	Norway	Backed by OpenAI; focus on safe home-assistant androids.
7	UBTECH	China	Scaling Walker S series for industrial and educational use.
8	Standard Bots	USA	Low-cost, AI-native robotic arms for USA manufacturing.
9	Sanctuary AI	Canada	Excellence in human-like robotic hand dexterity.
10	Appttronik	USA	Developing "Apollo," the versatile humanoid for commercial tasks.

The ranking reflects a clear pattern of **US dominance**, **China’s rapid rise**, and **limited but distinctive players** from other countries.

The United States occupies six positions in the top 10, maintaining overall leadership. Boston Dynamics ranks first, with unmatched technological advantages in dynamic mobility through its electric Atlas robot, representing the highest level of global robotic motion control. Tesla (Optimus) ranks second, focusing on humanoid mass-production scaling for automotive logistics, combining AI and automobile manufacturing to form a unique industrial edge. Figure AI, Agility Robotics, Standard Bots, and Appttronik each specialize in general AI integration, bipedal logistics, low-cost robotic arms, and versatile commercial humanoids, forming a comprehensive layout covering core technologies and scenario applications.

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Comprehensive analysis and ranking of future industries

Embodied AI

Enterprise ranking

Chinese companies occupy two seats and show strong competitiveness. Unitree Robotics ranks third, leading the global market in high-performance yet affordable humanoid robots represented by the G1 series, achieving a balance between technology and cost-effectiveness. UBTECH ranks seventh, scaling the Walker S series for industrial and educational scenarios, with distinctive advantages in scenario-based deployment and market expansion.

Companies from Norway and Canada demonstrate differentiated strengths. 1X Technologies of Norway, supported by OpenAI,

focuses on safe home-assistant androids, targeting the household service market. Sanctuary AI of Canada excels in human-like dexterity of robotic hands, filling a niche in fine manipulation.

Overall, the global embodied AI industry is technology-intensive and application-driven. Leading enterprises compete along three paths: cutting-edge technology research, large-scale mass-production, and vertical scenario integration. The US leads in both technology and industrialization, China rises rapidly in cost-effective products and market expansion, while other innovative players focus on niche breakthroughs, jointly shaping the global competitive landscape of embodied AI.



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Comprehensive analysis and ranking of future industries

Fusion & Green Energy

Definition

The 2025 energy paradigm defines these two sectors as the dual pillars of "Net Zero 2050."

Fusion Energy: Often called the "Holy Grail" of power, it is the process of merging light atomic nuclei (typically isotopes of Hydrogen) under extreme heat and pressure to release massive energy. In 2026, it is defined as "Firm, Carbon-Free Baseload Power" that produces nearly 4 million times more energy per kilogram of fuel than coal, with zero long-lived radioactive waste.

Green Energy (Renewables): In 2026, this refers to "Dispatchable Sustainable Power." No longer viewed as just "intermittent" sources (like solar and wind), it now encompasses the integration of renewable generation with Long-Duration Energy Storage (LDES), AI-driven smart grids, and green hydrogen, allowing it to function as a reliable primary energy source.

Summary of Outstanding Achievements in 2025

2025 was a record-breaking year for both sectors, marking the point where the "Energy Transition" became irreversible.

A. Fusion Milestones

Commercial Temperature Record: The startup Helion Energy reached the 150 million °C threshold—widely considered the commercial

viability requirement—paving the way for the first grid-connected pilots.

Breaking the Density Barrier: China's Experimental Advanced Superconducting Tokamak (EAST), or the "Artificial Sun," successfully stabilized high-density plasma that was previously thought to be physically impossible, moving closer to sustained ignition conditions.

Private Capital Surge: Global private investment in fusion surpassed \$10.7 billion by mid-2025, with companies like Commonwealth Fusion Systems (CFS) and Inertia Enterprises leading massive Series B rounds to build demonstration plants.

B. Green Energy Milestones

Renewables Overtake Coal: In 2025, for the first time in history, global electricity generation from wind and solar combined surpassed that of coal.

Solar as Baseload: The world added a record 793 GW of renewable capacity in 2025. In high-insolation regions, solar paired with advanced battery systems became cost-competitive with coal for 24/7 power delivery (\$104/MWh).

The EU Solar Peak: In June 2025, solar energy became the single largest source of power in the European Union, surpassing both nuclear and natural gas for the first time on record.

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Comprehensive analysis and ranking of future industries

Fusion & Green Energy

Future development trends

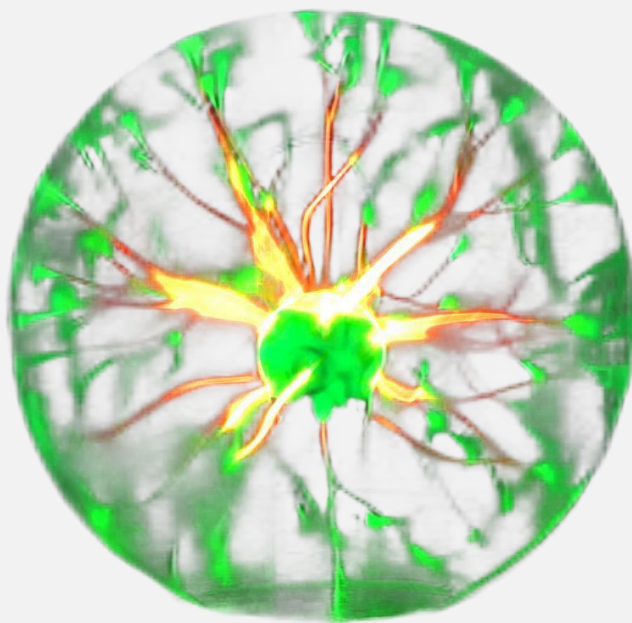
The remainder of the decade will be defined by "Scale" and "Systems Integration."

The Rise of "Firm" Renewables: The focus is shifting from adding more solar panels to adding System Flexibility. Expect massive deployment of utility-scale battery installations and geothermal expansion to serve the surging power demands of AI data centers.

Fusion Pilot Grid Connection: Between 2026 and 2030, at least five private fusion companies (including CFS and Helion) aim to connect their first "Proof of Concept" pilot plants to the commercial electric grid.

AI-Managed Energy Internets: By 2027, AI will be the "operating system" for green energy, using predictive algorithms to balance weather-dependent supply with real-time demand from EV fleets and industrial sectors.

Green Hydrogen Scaling: As solar module prices remain at historic lows (\$0.09/watt), the focus will turn to using "excess" midday solar power to produce Green Hydrogen for hard-to-abate sectors like steel and aviation.



Fusion & Green Energy

City Ranking

Rank	City	Strategic Strength	Rank	City	Strategic Strength
1	Hefei	EAST "Artificial Sun"; full fusion supply chain.	11	Glasgow	Offshore wind and green hydrogen production.
2	Boston	CFS (MIT); highest commercial fusion funding.	12	Dubai	Largest solar park; green hydrogen export.
3	San Francisco	Helion Energy; private fusion startup cluster.	13	Sydney	Green mining and large-scale battery storage.
4	Oxford	Culham Centre (JET); tokamak commercialization.	14	Bergen	Global leader in CCS and offshore green energy.
5	Paris	ITER HQ; energy policy and global coordination.	15	Madrid	Solar and thermal fusion R&D hub.
6	Shanghai	High-temperature superconducting magnet research.	16	Nagoya	Solid-state batteries and hydrogen fuel cells.
7	Seattle	Zap Energy HQ; Z-pinch fusion pathway.	17	San Diego	General Atomics; fusion physics research center.
8	Munich	Max Planck Institute; high-field magnet tech.	18	Toronto	SMR innovation and nuclear maintenance.
9	Shenzhen	EV battery dominance; smart energy management.	19	Amsterdam	Energy digitalization and smart-grid trading.
10	Seoul	KSTAR fusion research; hydrogen ecosystem.	20	Bengaluru	Low-cost green hydrogen technology R&D.

In terms of fusion energy leadership, the top eight cities concentrate core technological paths and institutions.

Hefei ranks first, supported by the EAST “Artificial Sun” and a complete fusion industry chain, representing strong advantages in tokamak experiments and engineering.

Boston takes second place, with Commonwealth Fusion Systems (CFS) linked to MIT, attracting the highest commercial fusion investment.

San Francisco is third, gathering Helion Energy and other private fusion startups, forming an active private fusion innovation cluster.

Oxford ranks fourth, relying on the Culham Centre (JET) to promote tokamak commercialization.

Paris is fifth, hosting the ITER headquarters, playing a key role in global fusion governance and international cooperation.

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Comprehensive analysis and ranking of future industries



City Ranking

Shanghai, Munich, and Seattle also show distinctive strengths in high-temperature superconducting magnets, high-field magnets, and the Z-pinch fusion route, respectively. In green energy and industrial applications, cities from 9th to 20th focus on diversified low-carbon systems. Shenzhen (9th) and Seoul (10th) combine energy technology with strong local industries: Shenzhen in EV batteries and smart energy, Seoul in KSTAR fusion and hydrogen ecosystems.

Cities such as Glasgow, Dubai, Sydney, and Bergen highlight offshore wind, large-scale solar, green hydrogen, CCS, and energy storage, forming a complete green energy layout. Nagoya, San Diego, Toronto, Amsterdam, and Bengaluru each have advantages in solid-state batteries, fusion physics, small modular reactors (SMR), smart grids, and low-cost green hydrogen, enriching the global green and fusion energy ecosystem. Overall, the global Fusion & Green Energy landscape is tech-driven, policy-supported, and industry-integrated

Enterprise ranking

Rank	Company	Country	Strategic Edge
1	Hefei Fusion Energy	China	Commercializing EAST "Artificial Sun" fusion technologies.
2	CFS	USA	Leading HTS (High-Temperature Superconductor) fusion magnets.
3	Helion Energy	USA	Fast-track to commercial fusion via direct electricity conversion.
4	GE Vernova	USA	Dominant in grid modernization and offshore wind (Haliade-X).
5	NextEra Energy	USA	The world's largest renewable energy utility operator.
6	Sungrow Power	China	#1 global supplier of PV inverters and utility-scale storage.
7	TAE Technologies	USA	Aneutronic fusion using non-tokamak linear reactors.
8	Tokamak Energy	UK	Specializing in compact, high-field spherical tokamaks.
9	First Solar	USA	Leader in advanced thin-film solar modules.
10	Zap Energy	USA	Compact fusion technology using Z-pinch plasma.

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Comprehensive analysis and ranking of future industries

Fusion & Green Energy

Enterprise ranking

The United States dominates the ranking with 7 out of 10 companies, covering both cutting-edge fusion technology and large-scale green energy applications. CFS ranks second, leading in high-temperature superconductor (HTS) fusion magnets, a core enabler for next-generation commercial fusion. Helion Energy takes third place, pursuing fast commercial fusion through direct electricity conversion, representing an efficient technical route. TAE Technologies (7th) focuses on aneutronic fusion with non-tokamak linear reactors, while Zap Energy (10th) develops compact Z-pinch fusion systems. In traditional green energy, GE Vernova (4th) leads grid modernization and offshore wind with the Haliade-X turbine. NextEra Energy (5th) is the world's largest renewable energy utility operator, and First Solar (9th) excels in advanced thin-film solar modules, forming a full industrial chain from equipment to operation.

Chinese companies hold 2 positions with strong industrialization capabilities. Hefei Fusion Energy ranks first, focusing on commercializing technologies derived from the EAST "Artificial Sun," marking China's leading role in fusion engineering and industrial application. Sungrow Power (6th) is the world's top supplier of PV inverters and utility-scale energy storage systems, securing a pivotal position in the global renewable energy equipment sector.

The UK contributes 1 specialized enterprise: Tokamak Energy (8th), which focuses on compact, high-field spherical tokamaks, pursuing miniaturization and commercialization of fusion devices.

Overall, the global fusion and green energy industry is shifting from scientific research to large-scale commercialization. The U.S. maintains comprehensive leadership across multiple technical routes and industrial sectors. China is rapidly advancing in fusion engineering and renewable energy equipment. Other countries focus on differentiated technological paths. The sector features fierce competition between fusion technology innovation and green energy scaling, jointly shaping the future of global low-carbon energy systems.

6G Communications

Definition

6G is the sixth generation of wireless technology, envisioned as a "Human-Centric" and "AI-Native" network. Its definition in 2026 centers on three transformative pillars:

Integrated Sensing and Communication (ISAC): Unlike 5G, 6G networks act as a massive radar system. They don't just transmit data; they "sense" the physical environment (detecting objects, movement, and shapes) using the same radio waves, enabling high-precision gesture control and environmental digital twinning.

Terahertz (THz) and Sub-THz Frequencies: 6G utilizes extremely high-frequency bands (100 GHz to 10 THz). This provides massive bandwidth for "Tbps-level" (Terabit per second) speeds—roughly 100 times faster than the theoretical peak of 5G.

Non-Terrestrial Networks (NTN): 6G is defined by "Ubiquitous Connectivity." It integrates satellite constellations (LEO), high-altitude platforms (HAPS), and terrestrial cells into a single unified network, providing 100% global coverage, including oceans and high-altitude flight paths.

Summary of Outstanding Achievements in 2025

2025 was the "Standardization Inaugural Year," marking the shift from lab experiments to real-world infrastructure tests:

Formal 3GPP Standardization Kick-off: In June 2025, the 3GPP (the global standards body) officially launched Release 20, marking the start of the formal 6G technical specification process.

The 7GHz "Centimeter-Wave" Breakthrough: Major carriers (notably SoftBank and Nokia) successfully completed the world's first outdoor urban trials using the 7GHz band. This proved that "mid-band" 6G can provide wide-area coverage with 5G-like cell density, solving a major cost concern.

AI-Native Air Interface: For the first time, researchers demonstrated a "Neural Air Interface" where AI—not human-coded algorithms—dynamically designed the radio waveform in real-time to maximize efficiency in a crowded environment.

Holographic Telepresence Demo: At the 6G Global Summit 2025, the first stable, high-fidelity 3D holographic call was demonstrated over a prototype 6G link, requiring 0.5 Tbps bandwidth with sub-millisecond latency.

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Comprehensive analysis and ranking of future industries

6G Communications

Future development trends

As we look toward the commercial launch targeted for 2029-2030, four trends dominate the roadmap:

AI-Native Automation: By 2027, 6G networks will be "Self-Healing." AI will manage the complexity of trillions of connections, automatically detecting interference and reconfiguring network slices without human intervention.

Sustainable "Zero-Energy" IoT: A major trend is Ambient IoT—small sensors that have no batteries and power themselves using the energy from the 6G radio waves themselves, enabling "trillions of connected things" for smart cities.

Mixed Reality (XR) Ubiquity: 6G will move XR (AR/VR) from bulky headsets to lightweight glasses. By offloading all heavy computation to the "Edge Cloud" via 6G's ultra-low latency, the device only needs to handle the display.

Quantum-Safe Security: As quantum computing advances, 6G is being designed with Quantum-Resistant Encryption from day one, ensuring



6G

6G Communications

City Ranking

Rank	City	Strategic Strength	Rank	City	Strategic Strength
1	Shenzhen	Huawei/ZTE; world leader in 6G patents/standards.	11	Beijing	Satellite internet and national labs.
2	Seoul	2026 pilot city; Samsung/LG 6G trial systems.	12	Helsinki	Nokia 6G software and base-station design.
3	San Francisco	SpaceX Starlink; 6G semiconductor design.	13	Stockholm	Ericsson 6G system architecture HQ.
4	Tokyo	NTT/Sony; 6G hardware and optical networks.	14	Nanjing	State labs for advanced mobile communication.
5	Shanghai	Satellite IoT and 6G testbed deployment.	15	London	Satellite comm standards and spectrum reg.
6	San Diego	Qualcomm; 6G chipsets and baseband tech.	16	Singapore	Maritime 6G connectivity and data transit.
7	Oulu	6G Flagship project; terahertz research.	17	Munich	Industrial IoT and 6G sensor fusion.
8	New Delhi	Large-scale 6G device manufacturing and India 6G.	18	Ottawa	Satellite payload design and comm R&D.
9	Dallas	AT&T 6G network architecture and test sites.	19	Sydney	Remote broadband and 6G coverage tech.
10	Zurich	Millimeter-wave and high-performance antennas.	20	Bengaluru	6G software-defined network R&D.

Top 5 Leadership: Core of Patents, Trials and Chips

Shenzhen ranks first, supported by Huawei and ZTE, establishing a world-leading position in 6G patents and standard-setting. Seoul is second, acting as a 2026 6G pilot city with Samsung and LG driving trial systems. San Francisco takes third place, focusing on SpaceX Starlink and 6G semiconductor design, integrating space and ground communication. Tokyo is fourth, with NTT and Sony leading in 6G hardware and optical network technologies. Shanghai ranks fifth, concentrating on satellite IoT and large-scale 6G testbed deployment.

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Comprehensive analysis and ranking of future industries

6G Communications

City Ranking

Mid-Tier Focus: Chips, Algorithms, and Industrial Applications

San Diego (6th) leads in 6G chipsets and baseband technology via Qualcomm. Oulu (7th) drives terahertz research through the 6G Flagship project. New Delhi (8th) specializes in large-scale 6G device manufacturing. Dallas (9th) builds 6G network architecture and test sites supported by AT&T. Zurich (10th) excels in millimeter-wave and high-performance antennas.

National and Corporate R&D Hubs

Beijing (11th) develops satellite internet and national 6G laboratories. Helsinki (12th) and Stockholm (13th) represent Nokia and Ericsson respectively, focusing on 6G software, base stations, and system architecture. Nanjing (14th) hosts state-level labs for advanced mobile communication. London (15th) leads in satellite communication standards and spectrum regulation.

Specialized Scenario and Regional Strengths

Singapore (16th) focuses on maritime 6G connectivity. Munich (17th) integrates industrial IoT and 6G sensor fusion. Ottawa (18th) conducts satellite payload design. Sydney (19th) develops remote broadband coverage. Bengaluru (20th) specializes in 6G software-defined network R&D.

Overall Conclusion

The global 6G competition is led by China, the United States, South Korea, Japan, and Europe. Chinese cities hold advantages in patents, standards, and testbeds. US cities dominate chips, semiconductors, and satellite networks. South Korea and Japan lead in hardware and pilot deployment. European cities focus on key components and system architecture. The entire ecosystem highlights competition in standards, chips, satellites, and industrial applications.



6G Communications

Enterprise ranking

Rank	Company	Country	Strategic Edge
1	Huawei	China	World leader in 6G patent density and THz transceivers.
2	SpaceX (Starlink)	USA	Architecting the 6G satellite layer for global coverage.
3	Qualcomm	USA	Setting the standard for 6G modems and AI air interfaces.
4	Samsung	S. Korea	Early leader in 6G field testing and vRAN infrastructure.
5	Nokia	Finland	Champion of European 6G "Hexa-X" sensing-comm projects.
6	Ericsson	Sweden	Leader in energy-efficient 6G network architecture.
7	ZTE	China	Innovator in Reconfigurable Intelligent Surfaces (RIS).
8	China Mobile	China	Managing the world's largest experimental 6G testbeds.
9	NTT DOCOMO	Japan	Defining the All-Photonics Network (IOWN) for 6G.
10	Keysight	USA	The primary provider of 6G test and measurement tools.

This shows the competitive landscape of the world’s top 10 enterprises in 6G technology, focusing on patents, satellite networks, chips, standards, testbeds, and core components. The competition is led by China, the United States, South Korea, Europe, and Japan, each with distinct strategic advantages.

Top 3: Core Technology and Architecture Leadership

Huawei ranks first, as the global leader in 6G patent density and terahertz (THz) transceivers, establishing strong advantages in fundamental 6G technologies and intellectual property. SpaceX (Starlink) takes second place, focusing on building the 6G satellite layer to achieve seamless global coverage, pioneering the integration of space and terrestrial

communications. Qualcomm is third, setting industry standards for 6G modems and AI-enabled air interfaces, dominating key chip and protocol design.

4th–6th: Testing, Systems and Energy Efficiency

Samsung ranks fourth, with early advantages in 6G field testing and virtualized RAN (vRAN) infrastructure, supporting practical commercial trials. Nokia (fifth) leads Europe’s 6G “Hexa-X” projects, integrating communication and sensing to define next-generation network capabilities. Ericsson (sixth) specializes in energy-efficient 6G network architecture, focusing on low-power and sustainable deployment.

6G Communications

Enterprise ranking

7th-8th: Chinese Enterprises in Hardware and Testbeds

ZTE is seventh, excelling in Reconfigurable Intelligent Surfaces (RIS), a critical technology for enhancing 6G signal coverage and efficiency. China Mobile ranks eighth, operating the world's largest 6G experimental testbeds, providing critical infrastructure for technology verification and scaling.

9th-10th: Optical Networks and Testing Tools

NTT DOCOMO (Japan) is ninth, driving the All-Photonics Network (IOWN) as a foundational infrastructure for ultra-high-speed 6G transmission. Keysight (USA) ranks tenth, serving as the main supplier of 6G test and measurement instruments, supporting global R&D and verification.

Overall Conclusion

The global 6G industry presents a multi-polar competitive structure. Chinese companies lead in patents, core components, and large-scale testbeds. US enterprises dominate satellite architecture, chips, and testing tools. South Korea, Finland, Sweden, and Japan have differentiated strengths in trials, system design, energy efficiency, and optical networks. The sector is moving rapidly from research to standardization and pre-commercial trials, with leadership concentrated in technological innovation and ecosystem control.

Neuro-Intelligence

Definition

Neuro-Intelligence is defined as AI architecture inspired by the structural and functional principles of the human brain. Unlike traditional Deep Learning, which relies on brute-force data and massive power, Neuro-Intelligence focuses on:

Brain-Inspired Architecture: Moving beyond simple "layers" to mimic the brain's neural plasticity (learning and adapting in real-time) and sparsity (only using necessary neurons to save energy).

Neuro-Symbolic Hybridization: Integrating "Non-symbolic" learning (neural networks) with "Symbolic" reasoning (logic and medical/scientific knowledge) to eliminate AI hallucinations and ensure explainability.

Neural-Computing Convergence: The use of Neuromorphic Chips that process information like biological neurons—firing only when needed—enabling AI to run on ultra-low power at the "edge" (e.g., inside a robot or a wearable device).

Summary of Outstanding Achievements in 2025

2025 was the year Neuro-Intelligence transitioned from laboratory research to life-saving clinical and industrial applications:

The "Neuro-LLM" Breakthrough: The world's first neurology-focused Large Language Models (LLMs) were launched, capable of analyzing complex EEG and MRI data with 98% accuracy to predict seizure risks and early-stage Alzheimer's.

Invasive BCI Success: Companies like Synchron and Neuralink (along with Chinese breakthrough trials) demonstrated stable, 12-month "Stentrode" and implanted BCI efficacy, allowing paralyzed patients to operate digital devices and exoskeletons with 90% higher speed than 2024 benchmarks.

Brain Cell Mapping Milestone: The BRAIN Initiative successfully completed a comprehensive "parts list" of the human brain, providing the first full-scale digital map of neural circuits. This has become the "training manual" for 2026's most advanced AI models.

Energy-Efficient Neuromorphic Scaling: Researchers achieved a 100x reduction in power consumption for vision-processing AI by using neuro-inspired "event-based" sensors, allowing drones and humanoids to operate for hours longer on a single charge.

Neuro-Intelligence

Future development trends

The next five years will see Neuro-Intelligence move into mainstream daily life and advanced cognitive enhancement:

Mainstream Medical Adoption (2026-2027): Neuro-interfaces and predictive AI platforms (like NeuroDiscovery AI) will become standard treatments for Parkinson's, epilepsy, and severe depression, moving from "experimental" to "prescriptive" medicine.

Non-Invasive Cognitive Enhancement (2028): Wearable EEG headsets and "painless microneedle" sensors will enter the workplace and education sectors. These tools will monitor cognitive load and provide real-time feedback to boost memory retention and focus, targeting 30% efficiency gains.

Seamless Daily Integration (2030): By 2030, Neuro-Intelligence will enable "Thought-Controlled" Smart Homes and vehicles. With 6G and Edge computing, the latency between a "thought" and a "physical action" (like adjusting a thermostat or typing a message) will become imperceptible.

The "Sovereign Brain" Ethics: As neuro-data becomes more valuable than search history, 2026-2030 will see the rise of Neuroprivacy Laws. Nations will race to establish "Neuro-Security" protocols to prevent unauthorized access to a user's neural signals or cognitive states.



Neuro-Intelligence

City Ranking

Rank	City	Strategic Strength	Rank	City	Strategic Strength
1	Austin	Neuralink HQ; commercial invasive BCI leader.	11	Tel Aviv	Neural repair startups and medical BCI.
2	Boston	Harvard/MIT cluster; neuro-engineering research.	12	Los Angeles	Caltech neural circuit and signal processing.
3	Beijing	Tsinghua BCI projects; state-led commercialization.	13	Chengdu	Neural rehabilitation and bio-electronics.
4	Lausanne	Wyss Center; global hub for neuro-prosthetics.	14	Berlin	Charit neuro-science translational research.
5	Shanghai	Clinical BCI trials; Neural Engineering Action Plan.	15	San Francisco	Synchron HQ; endovascular BCI innovation.
6	New York	Commercial neuro-interface and finance applications.	16	Singapore	Neuro-aging protection and rehab research.
7	London	Neuro-ethics; AI alignment and human enhancement.	17	Stockholm	Swedish Medical Center neuro-science hub.
8	Tokyo	Assistive BCI for hyper-aging population.	18	Toronto	Brain Project and clinical neurology.
9	Melbourne	Clinical trial site for Synchron and neural stents.	19	Paris	Deep brain stimulation for Parkinson tech.
10	Shenzhen	CAS Shenzhen Institute; full-chain brain engineering.	20	Chicago	UChicago motor cortex signal research.

Top 10: Core Leadership in Technology and Commercialization

Austin ranks first as the headquarters of Neuralink, leading the world in commercial invasive BCI technology and productization.

Boston is second, with Harvard and MIT forming a top academic cluster focused on foundational neuro-engineering research. Beijing takes third place, supported by Tsinghua University’s BCI programs and strong state-led industrialization policies. Lausanne ranks fourth, hosting the Wyss Center as a major global hub for neuro-prosthetics.

Neuro-Intelligence

City Ranking

Shanghai is fifth, conducting clinical BCI trials and implementing a systematic Neural Engineering Action Plan.

New York (6th) specializes in commercial neuro-interfaces and finance-driven neurotech applications. London (7th) leads in neuro-ethics, AI alignment, and human enhancement governance. Tokyo (8th) targets assistive BCI to support its hyper-aging society. Melbourne (9th) serves as a key clinical trial base for Synchron and neural stent technologies. Shenzhen (10th) relies on the CAS Shenzhen Institute to build a full-chain brain engineering industry.

11th–20th: Specialized R&D and Clinical Strength

Tel Aviv (11th) gathers neural repair startups and medical BCI enterprises. Los Angeles (12th) excels in neural circuits and signal processing through Caltech. Chengdu (13th) focuses on neural rehabilitation and bio-electronics. Berlin (14th) conducts translational neuroscience via Charité research institutions. San Francisco (15th) is the home of Synchron, pioneering endovascular BCI.

Singapore (16th) studies neuro-protection and rehabilitation for aging populations. Stockholm (17th) operates a leading neuroscience medical hub. Toronto (18th) advances the Brain Project and clinical neurology. Paris (19th) specializes in deep brain stimulation for Parkinson's disease. Chicago (20th) conducts research on motor cortex signal decoding at the University of Chicago.

Overall Conclusion

The global neuro-intelligence landscape is led by the United States and China, supported by strong academic, industrial, and clinical ecosystems. U.S. cities dominate invasive BCI commercialization and basic research. Chinese cities feature strong government support, complete industrial chains, and large-scale clinical trials. European, Asian, and Australian cities focus on neuro-prosthetics, ethics, aging applications, and clinical translation. The sector is rapidly moving from lab research to clinical and commercial use, with competition centered on core BCI technology, clinical validation, and regulatory governance.



Neuro-Intelligence

Enterprise ranking

Rank	Company	Country	Strategic Edge
1	Neuralink	USA	Leader in high-bandwidth invasive N1 implants.
2	Synchron	USA	Safest endovascular (stent-based) BCI for clinical use.
3	Blackrock Neuro	USA	The gold standard for multi-channel intracortical arrays.
4	Paradromics	USA	Developing massive bidirectional brain-data streaming.
5	NeuroXess	China	Specialist in flexible, silk-based electrodes.
6	BrainCo	China	World leader in non-invasive BCI for prosthetics.
7	Wyss Center	Switzerland	Global hub for neuro-prosthetic translational research.
8	Precision Neuro	USA	Minimally invasive high-resolution cortical films.
9	Cala Health	USA	Leading the bio-electronic medicine sector for tremor control.
10	Kernel	USA	Pioneer in "Neuro-imaging as a service" using fNIRS.

The competitive landscape is marked by strong U.S. dominance, with China emerging as a key challenger in non-invasive and flexible electrode technologies.

The United States occupies eight positions in the top 10, covering invasive, endovascular, non-invasive, and clinical therapeutic fields. Neuralink ranks first, as the global leader in high-bandwidth invasive N1 implants, setting benchmarks for implantable BCI performance. Synchron stands at second, achieving the safest endovascular stent-based BCI system, with clear advantages in clinical safety and accessibility. Blackrock Neuro (third) provides the gold-standard multi-channel intracortical arrays widely used in global neuroscience

research. Paradromics (fourth) focuses on ultra-large-scale bidirectional brain-data streaming, aiming for high information-transfer BCI. Precision Neuro (eighth) develops minimally invasive high-resolution cortical films, balancing safety and signal quality. Cala Health (ninth) leads in bio-electronic medicine, specializing in tremor control and neuromodulation therapies. Kernel (tenth) pioneers neuro-imaging as a service based on fNIRS, expanding non-invasive neural monitoring applications.

Neuro-Intelligence

Enterprise ranking

Chinese companies occupy two seats with distinctive technological paths. NeuroXess (fifth) specializes in flexible, silk-based electrodes, achieving breakthroughs in biocompatibility and long-term implantation safety. BrainCo (sixth) is the world leader in non-invasive BCI for prosthetics, achieving large-scale application in rehabilitation and assistive devices.

Switzerland's Wyss Center (seventh) acts as a global hub for neuro-prosthetic translational research, bridging academic innovation and clinical commercialization.

Overall, the global neuro-intelligence industry is technology-driven and clinically oriented. U.S. companies maintain leadership in high-performance invasive BCI and industrial maturity. Chinese firms focus on flexible materials and non-invasive products, achieving rapid market penetration. European institutions excel in translational research and medical-grade neurotech. The sector is accelerating toward clinical translation, with competition concentrated on implant safety, signal bandwidth, electrode materials, and real-world medical applications.

05

Comprehensive analysis and ranking of future industries

Bio-manufacturing

Definition

Bio-manufacturing is the use of living systems—such as bacteria, yeast, algae, or mammalian cells—to produce commercially valuable molecules and materials at scale. Unlike traditional chemical manufacturing, which relies on high heat and petroleum feedstocks, 2025 Bio-manufacturing centers on:

Cellular Factories: Programming DNA to turn microorganisms into microscopic production lines that "brew" chemicals, proteins, and fibers.

Alternative Feedstocks: Utilizing "waste-to-value" streams, such as agricultural waste, food scraps, or even captured atmospheric CO_2 , as the primary energy source for these biological systems.

Precision Fermentation: A process that uses genetically engineered microbes to produce specific functional ingredients (like dairy proteins or collagen) without the need for animal farming.

Summary of Outstanding Achievements in 2025

2025 was a "breakthrough year" for the industrialization of biology, marked by several world-firsts:

Precision Fermentation Commercialization: TurtleTree (Singapore) successfully launched the world's first animal-free Lactoferrin (a valuable milk protein) after receiving FDA "no

questions" GRAS status. This reduced the resource intensity of production by over 95% compared to traditional dairy.

The "Continuous Manufacturing" Shift: WuXi Biologics successfully scaled its WuXiUP platform, allowing 2,000-liter disposable bioreactors to match the output of traditional 20,000-liter stainless-steel tanks, drastically lowering the cost of life-saving biologics.

Bio-based Aviation Fuel (SAF) Scaling: The first dedicated bio-manufacturing facility for 100% synthetic paraffinic kerosene (produced from engineered algae) went online, providing a carbon-negative fuel source for long-haul commercial flights.

Self-Repairing Bio-Materials: The first consumer-grade self-repairing clothing reached the market, featuring engineered bacteria embedded in fibers that "heal" tears by secreting new biological polymers when activated by moisture.

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Comprehensive analysis and ranking of future industries

Bio-manufacturing

Future development trends

As we look toward 2030, Bio-manufacturing is shifting from "batch processing" to "AI-governed autonomy":

AI-Native Bio-Design (2026–2027): By late 2026, 40% of new biological "parts" will be designed entirely by Generative AI agents. These agents can predict protein folding and metabolic pathways with such precision that the "Design-Build-Test" cycle is shortened from years to weeks.

Distributed Bio-Manufacturing: Moving away from giant centralized factories, the trend is toward "Modular Bioreactors." These are shipping-container-sized units that can be deployed locally to produce medicines or food on-site, reducing supply chain vulnerability.

In Vivo Bio-Manufacturing: By 2028, advanced therapies will move toward "manufacturing inside the body." Instead of producing proteins in a lab, doctors will use engineered viral vectors or nanoparticles to turn a patient's own liver or muscle cells into a factory for their own medicine.

Electro-Biosynthesis: A major emerging trend for 2029 is the direct use of renewable electricity (rather than sugar) to feed microbes. This "electricity-to-protein" pathway could eliminate the need for vast tracts of agricultural land to grow "feedstock" for bioreactors.



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Comprehensive analysis and ranking of future industries

Bio-manufacturing

City Ranking

Rank	City	Strategic Strength	Rank	City	Strategic Strength
1	Boston	Ginkgo Bioworks; world's bio-foundry hub.	11	Seoul	Cell therapy and bio-similar manufacturing.
2	Shanghai	Largest CXO services; bio-pharma industrial base.	12	Austin	IDT/Synthetic bio supply chain automation.
3	San Francisco	CRISPR/Synthetic biology commercial cluster.	13	Copenhagen	Novozymes; enzyme industry and bio-degradation.
4	Shenzhen	Guangming Science City; bio-hardware fusion.	14	London	Global bio-security and life science R&D.
5	Singapore	Cultured meat and synthetic food pioneer.	15	Zurich	Custom bio-molecules and medical tech.
6	Suzhou	Global hub for contract bio-manufacturing.	16	Basel	Roche/Novartis life science R&D core.
7	Beijing	Proteomics and synthetic bio national labs.	17	Melbourne	Vaccine development and blood products.
8	Tel Aviv	AI-driven drug discovery and alternative protein.	18	Hangzhou	Bio-informatics and Health-Tech ecosystem.
9	San Diego	Illumina; genomics and diagnostic tech core.	19	Montreal	Digital bio-simulation and clinical apps.
10	Munich	Antibody and cell-factory technology hub.	20	Osaka	Regenerative medicine and iPSC research.

This shows the global competitive landscape of bio-manufacturing, covering synthetic biology, biopharmaceuticals, CXO services, genomic technology, cell therapy, and industrial biotechnology. The sector features a multi-polar pattern led by the US, China, Europe, and advanced innovation hubs.

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Comprehensive analysis and ranking of future industries

Bio-manufacturing

City Ranking

Top 5: Global Core Hubs

Boston ranks first, home to Ginkgo Bioworks, acting as the world's premier bio-foundry center and a leader in synthetic biology R&D and industrialization. Shanghai is second, with the largest CXO service capacity and a complete biopharmaceutical industrial base, highlighting strong industrial scaling capabilities. San Francisco third, forms a key commercial cluster for CRISPR and synthetic biology, linking frontier technology with enterprise applications. Shenzhen fourth, relies on Guangming Science City to integrate bio-technology with hardware manufacturing. Singapore fifth, pioneers cultured meat and synthetic food, focusing on food-tech biomanufacturing.

6th–10th: Specialized Industrial and Research Strengths

Suzhou sixth, is a global contract bio-manufacturing center, supporting large-scale production for global biotech firms. Beijing seventh, hosts national labs in proteomics and synthetic biology, with strong basic research and policy support. Tel Aviv eighth, leads AI-driven drug discovery and alternative protein development. San Diego ninth, centers on Illumina, dominating genomics and diagnostic technology. Munich tenth, is a major hub for antibody and cell-factory technologies.

11th–20th: Regional and Niche Leadership

Seoul eleventh, specializes in cell therapy and biosimilar manufacturing. Austin twelfth, focuses on synthetic biology supply chain automation. Copenhagen thirteenth, leads the enzyme industry via Novozymes. London fourteenth, conducts global bio-security and life science research. Zurich fifteenth, develops custom biomolecules and medical technology. Basel sixteenth, is the R&D core of Roche and Novartis. Melbourne seventeenth, excels in vaccine and blood product development. Hangzhou eighteenth, builds a bioinformatics and health-tech ecosystem. Montreal nineteenth, leads digital bio-simulation. Osaka twentieth, focuses on regenerative medicine and iPSC research.

Overall Conclusion

Global bio-manufacturing is driven by tech innovation + industrial scaling + clinical application. US cities dominate foundational synthetic biology and genomics. Chinese cities lead in industrial capacity, CXO services, and integrated bio-hardware. Europe and Israel specialize in targeted fields such as enzymes, antibodies, and AI-driven drug development. Singapore and others focus on food and healthcare applications. The sector is rapidly expanding from lab research to large-scale commercial production.

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Comprehensive analysis and ranking of future industries

Bio-manufacturing

Enterprise ranking

Rank	Company	Country	Strategic Edge
1	Ginkgo Bioworks	USA	The premier horizontal platform for cell programming.
2	WuXi Biologics	China	Global leader in advanced CRDMO bio-manufacturing.
3	Moderna	USA	Advancing the mRNA platform into cancer and rare diseases.
4	Novozymes	Denmark	Unrivaled global leadership in industrial enzymes.
5	Bluepha	China	Scaling bio-degradable PHA materials via synthetic biology.
6	CRISPR Tx	Switz/USA	First to market with FDA-approved gene-edited therapies.
7	Recursion Pharma	USA	Deciphering biology via AI-driven drug manufacturing.
8	Cathay Biotech	China	Leader in bio-based high-performance polyamides.
9	Eat Just	USA	Frontrunner in commercialized cultured (lab-grown) meat.
10	Vertex Pharma	USA	Dominant in high-value bio-manufactured cystic fibrosis drugs.

The sector features a multi-polar structure with strong competition between the **U.S., China, and European countries.**

The **United States dominates with six companies in the top 10**, covering technology platforms and cutting-edge applications. Ginkgo Bioworks ranks first, providing the world’s leading horizontal cell programming platform, laying the foundation for standardized bio-manufacturing. Moderna is third, continuously expanding its mRNA technology from vaccines to cancer and rare disease treatments. CRISPR Tx ranks sixth, being the first to launch FDA-approved gene-edited therapies, marking a breakthrough in commercial gene editing. Recursion Pharma (7th) uses AI to accelerate biological research and drug development. Eat Just (9th) is a pioneer in commercial cultured meat. Vertex Pharma (10th) leads in high-value bio-manufactured drugs for cystic fibrosis.

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Comprehensive analysis and ranking of future industries

Bio-manufacturing

Enterprise ranking

Chinese companies occupy three seats, focusing on large-scale industrialization and material innovation. WuXi Biologics ranks second, as the global leader in CRDMO services, supporting worldwide bio-manufacturing with mature production capacity. Bluepha (5th) uses synthetic biology to produce biodegradable PHA materials, achieving large-scale application of bio-based materials. Cathay Biotech (8th) specializes in high-performance bio-based polyamides, leading in bio-based chemical materials.

Denmark's Novozymes ranks fourth, maintaining unrivaled global advantages in industrial enzymes, supporting applications in energy, chemistry, and environmental protection.

Overall, the global bio-manufacturing industry is shifting from technology research to large-scale commercialization. U.S. companies lead in platform innovation and frontier therapies. Chinese companies excel in industrial scaling and bio-based materials. European enterprises focus on niche industrial enzyme leadership. The core competitiveness lies in technological platform, production capacity, and scenario application.

Quantum Information & Networking

Definition

The 2025 quantum paradigm is defined by how we measure the world, process its complexity, and protect its data:

Quantum Computing: A non-binary computing paradigm using qubits. Unlike classical bits, qubits utilize superposition and entanglement to perform parallel calculations, specifically designed to solve "NP-hard" problems in chemistry, logistics, and cryptography that are impossible for today's supercomputers.

Quantum Security: A dual-track defense strategy consisting of Post-Quantum Cryptography (PQC)—new mathematical algorithms that are resistant to quantum attacks—and Quantum Key Distribution (QKD), which uses the laws of physics to detect any attempt at eavesdropping on a communication link.

Quantum Sensing: The use of quantum states (like atoms or photons) to measure physical quantities—such as gravity, magnetic fields, or time—with precision that exceeds the fundamental limits of classical physics. It allows us to "see the invisible" at the sub-atomic or planetary scale.

Summary of Outstanding Achievements in 2025

The "International Year of Quantum" (2025) delivered several critical "firsts":

Commercial Quantum Advantage in Sensing: On World Quantum Day 2025, Q-CTRL demonstrated a quantum-enhanced navigation system that outperformed the best classical GPS-denied alternatives by 100x in real-world flight tests.

The "Four-Nines" Milestone in Computing: In October 2025, IonQ (in collaboration with Oxford Ionics) achieved 99.99% two-qubit gate fidelity, crossing the "four-nines" threshold required for large-scale, fault-tolerant quantum error correction.

Google's "Willow" Breakthrough: Google Quantum AI's new Willow chip demonstrated quantum supremacy on a practical benchmark, reducing the error rate as the system scaled—proving that Surface Code error correction actually works in practice.

The Majorana Qubit Breakthrough: In early 2026 (building on 2025 research), scientists successfully "read" a Majorana qubit, a stable qubit type that is natively resistant to environmental noise, bringing us closer to a "forever" quantum memory.

PQC Standardization: 2025 marked the first year that NIST-approved post-quantum algorithms were integrated into 30% of global financial transactions, protecting data against "Harvest Now, Decrypt Later" attacks.

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Comprehensive analysis and ranking of future industries

Quantum Information & Networking

Future development trends

The roadmap for the next five years shifts from "proof of concept" to "practical utility":

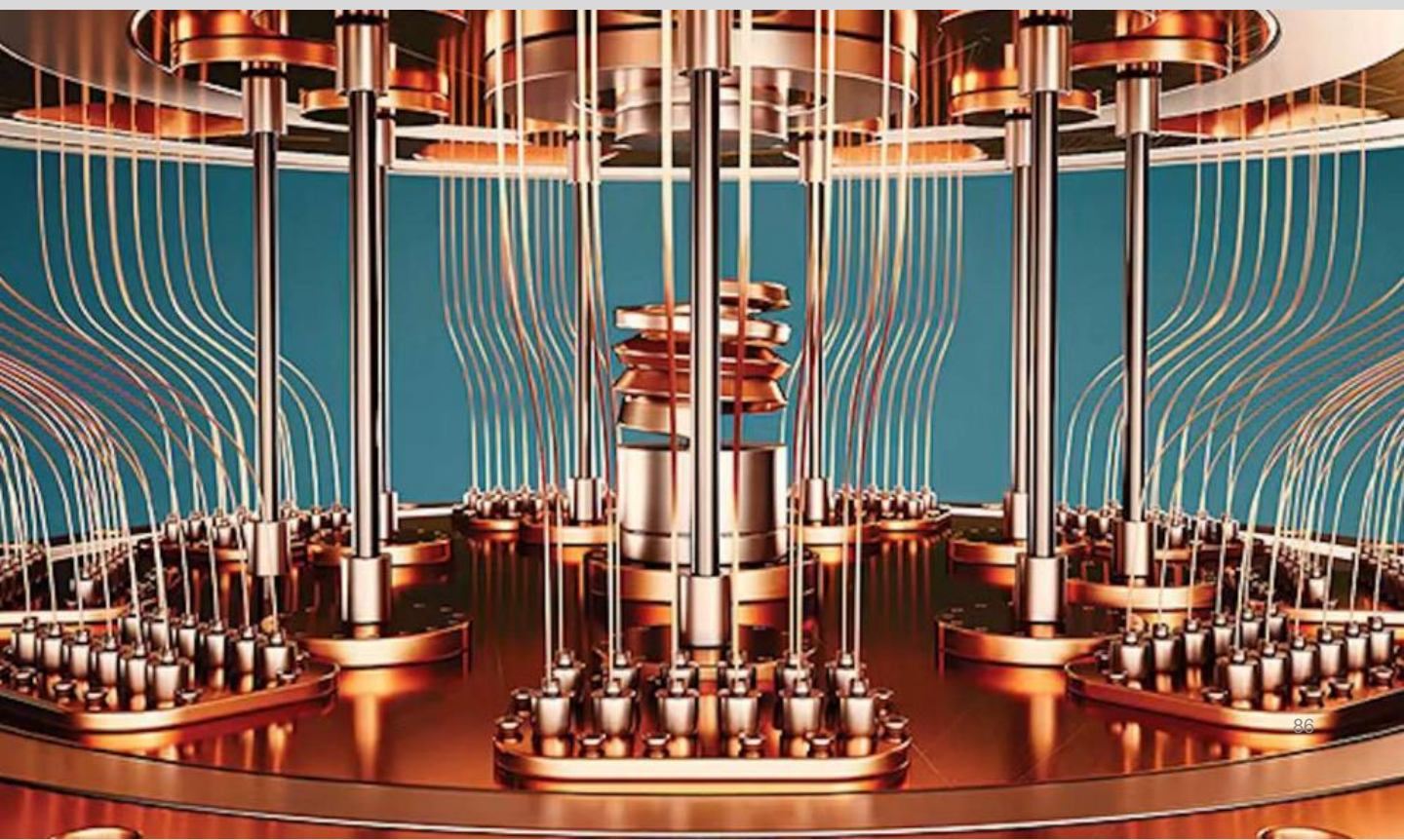
Hybrid Quantum-HPC Integration (2026-2027): The "Standalone" quantum computer is dead. 2026 is the year of Quantum-Centric Supercomputing, where quantum processors (QPUs) act as accelerators within classical High-Performance Computing (HPC) centers to solve specific chemical and material science sub-problems.

GPS-Independent Navigation (2027): Quantum gravimeters and accelerometers will move from high-end defense to commercial maritime and aviation, providing "un-jammable" navigation that doesn't rely on satellites.

The Y2Q Countdown: With analysts predicting that "Q-Day" (when classical encryption fails) could arrive by the early 2030s, the trend for 2026-2028 is the Mandatory Migration of all critical infrastructure to "Quantum-Safe" protocols.

Quantum "Digital Twins" for Medicine: By 2028, quantum computers will be used to create high-fidelity digital twins of human proteins, allowing for "In-Silico" clinical trials that reduce drug development time from 10 years to 12 months.

Democratization via Cloud: The trend for 2026 is the rise of "Low-Code Quantum." Platforms like IBM's Qiskit Functions and SpinQit are making quantum programming accessible to enterprise developers who aren't PhD physicists.



Quantum Information & Networking

City Ranking

Rank	City	Strategic Strength	Rank	City	Strategic Strength
1	San Francisco	Global software & cloud dominance (Google, IBM Quantum, Rigetti).	11	Toronto	Center for photonic & annealing quantum (Xanadu, D-Wave).
2	Hefei	World leader in full-chain industrialization (Origin Quantum, QuantumCTEK).	12	Shanghai	Space-based quantum comms center (USTC Shanghai, Micius satellite).
3	Boston	Neutral-atom and academic powerhouse (QuEra, Harvard Quantum Initiative).	13	Delft	Europe's "QuTech" flagship research and spin-off ecosystem.
4	Chicago	Home of the CQE (Chicago Quantum Exchange) and US national lab links.	14	Austin	Quantum chip design and error correction hardware.
5	Beijing	State-led massive research clusters (BAQIS, Tsinghua-linked labs).	15	Berlin	Industrial quantum sensing and measurement applications.
6	New York	Commercial sensing & finance applications (Q4I, Wall Street QC labs).	16	Brisbane	Optical quantum and low-temperature physics research leader.
7	Helsinki (Espoo)	Global supply chain & cryogenic capital (Bluefors HQ, IQM HQ).	17	Kyoto	Photonic quantum science and fundamental physics excellence.
8	Paris	European sovereign quantum leader (Quandela, Alice & Bob).	18	Singapore	Quantum cryptography hub for the global financial sector.
9	Tokyo	Quantum-AI integration hub (RIKEN, Fujitsu, Toshiba).	19	Munich	Hardware-software hybrid systems and BMW-linked applications.
10	Oxford	Innovation in ion-trap & software (Oxford Ionics, Quantinuum UK).	20	Zurich	Cryogenic electronics and high-precision quantum devices center.

Quantum Information & Networking

City Ranking

The global quantum information and networking sector is led by the United States, China, and Europe, with distinctive strategic positioning.

U.S. cities dominate software, cloud platforms, and academic innovation.

Chinese cities lead in full-chain industrialization and space-based quantum communication.

European cities focus on sovereign quantum capabilities, hardware supply, and fundamental research.

Other global cities develop niche strengths in cryogenics, quantum AI, quantum finance, and industrial sensing.

Competition centers on technological routes, industrial chains, talent clusters, and scenario applications.

Top 10: Core Leadership in Technology and Ecosystem

San Francisco ranks first, dominating global quantum software and cloud services with Google, IBM Quantum, and Rigetti, leading in cloud-based quantum services and algorithm development.

Hefei is second, the world leader in full-chain quantum industrialization, supported by Origin Quantum and QuantumCTek, covering core components, computing, and communication.

Boston third, is an academic and industrial powerhouse in neutral-atom quantum computing, driven by QuEra and the Harvard Quantum Initiative.

Chicago fourth, hosts the Chicago Quantum Exchange (CQE) and connects with U.S. national labs, forming a strong research and industrial collaboration system.

Beijing fifth, features state-led large-scale quantum research clusters including BAQIS and Tsinghua-linked laboratories.

New York sixth, focuses on commercial quantum sensing and quantum finance applications with Wall Street-linked labs.

Helsinki (Espoo) seventh, is the global capital of cryogenic systems and quantum hardware supply, home to Bluefors and IQM.

Paris eighth, acts as Europe's sovereign quantum leader, with Quandela and Alice & Bob advancing photonic and superconducting quantum technologies.

Tokyo ninth, is a major Quantum-AI integration hub, supported by RIKEN, Fujitsu, and Toshiba.

Oxford tenth, excels in ion-trap quantum computing and quantum software, represented by Oxford Ionics and Quantinuum UK.

11th-20th: Specialized Hardware, Communication and Applications

Toronto eleventh, leads in photonic and quantum annealing technologies with Xanadu and D-Wave.

Shanghai twelfth, is China's space-based quantum communication center, linked to USTC Shanghai and the Micius satellite.

Delft thirteenth, operates Europe's flagship QuTech, fostering a world-class quantum research and spin-off ecosystem.

Austin fourteenth, specializes in quantum chip design and quantum error correction hardware.

Berlin fifteenth, focuses on industrial quantum sensing and measurement.

Brisbane sixteenth, leads in optical quantum and low-temperature physics.

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Comprehensive analysis and ranking of future industries

Quantum Information & Networking

Enterprise ranking

Rank	Company	Country	Strategic Edge
1	IBM Quantum	USA	Leading the roadmap with Condor/Heron superconducting chips.
2	QuantumCTEK	China	Global giant in QKD and quantum secure networking.
3	Google Quantum	USA	Excellence in quantum error correction and Sycamore chips.
4	IonQ	USA	Leader in trapped-ion technology and cloud accessibility.
5	Quantinuum	USA/UK	Combining the best hardware and quantum software libraries.
6	Xanadu	Canada	World leader in photonic quantum computing (PennyLane).
7	Hyqubit	China	specializes in ion-trap quantum computing.
8	D-Wave	Canada	Pioneer in quantum annealing for commercial optimization.
9	Rigetti	USA	Focused on hybrid quantum-classical computing for AI.
10	PsiQuantum	USA	Advancing utility-scale silicon photonic quantum computers.

The sector presents a multi-polar structure led by the United States, with strong contributions from China, Canada, and joint UK/US initiatives.

The United States dominates with six companies in the top 10, covering mainstream technical routes and platform leadership.

IBM Quantum ranks first, leading the global quantum roadmap through its Condor and Heron superconducting quantum chips, setting benchmarks for scale and performance.

Google Quantum (third) excels in quantum error correction and its landmark Sycamore chip, pioneering quantum supremacy research.

IonQ (fourth) leads in trapped-ion technology and user-friendly cloud quantum services.

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Comprehensive analysis and ranking of future industries

Quantum Information & Networking

Enterprise ranking

Quantinuum (fifth), a US/UK joint venture, integrates high-performance hardware with comprehensive quantum software libraries for full-stack solutions.

Rigetti (ninth) focuses on hybrid quantum-classical systems tailored for AI applications.

PsiQuantum (tenth) targets large-scale, utility-grade silicon photonic quantum computers for real-world industrial use.

Chinese companies occupy two seats with distinct advantages in quantum communication and hardware.

QuantumCTEK ranks second, acting as a global leader in QKD (quantum key distribution) and quantum secure networking, defining standards in quantum secure communication.

Hyqubit (seventh) specializes in ion-trap quantum computing, forming a differentiated technical path in quantum processing hardware.

Canadian companies lead in specialized computing paradigms.

Xanadu (sixth) is the global pioneer in photonic quantum computing, with its widely used PennyLane software platform.

D-Wave (eighth) invented quantum annealing, focusing on commercial optimization problems for industrial and financial applications.

Overall, the global quantum information industry is rapidly moving from laboratory research to commercial deployment.

US companies maintain leadership in superconducting chips, error correction, cloud services, and hybrid systems.

Chinese enterprises lead in quantum secure communication and are rapidly developing ion-trap computing.

Canadian firms dominate photonic and annealing quantum solutions.

Each major player competes along clear technical routes, aiming to achieve practical quantum advantage in computing, communication, and AI integration.

Conclusion

The 2025 Global Future Industry Index (GFII) offers a definitive snapshot of the global technological and industrial landscape, marking an era where radical innovation, cross-domain integration, and strategic sovereignty converge to reshape economic and social development. Across seven core future industry clusters—General Artificial Intelligence (GAI), Neuro-Intelligence, Embodied AI, Bio-manufacturing, Fusion & Green Energy, Quantum Information & Networking, and 6G Communications—the index reveals a dynamic, multi-polar competitive order defined by distinct strengths, strategic pivots, and collective progress.

At the forefront, China and the United States maintain their long-standing dominance as the top two economies, though their competitive edges diverge sharply. China leads in industrial deployment maturity, supply chain sovereignty, and large-scale technological scaling—exemplified by its leadership in 6G patents, quantum full-chain industrialization, and bio-manufacturing CRDMO services. The United States retains supremacy in foundational research capacity, high-impact innovation, and ecosystem dynamism, with unparalleled strengths in GAI breakthroughs, quantum computing software, and neuro-intelligence clinical translation. Together, these two nations account for the majority of top-tier urban innovation hubs and leading enterprises, setting the global agenda for future industry development.

Beyond the top two, a diverse cohort of economies carves out specialized niches that underscore the importance of targeted strategy over broad-based competition. Germany and South Korea excel in industrial precision and semiconductor-6G integration, respectively; Switzerland and the UK lead in ethical governance and AI safety; Singapore and the UAE demonstrate exceptional policy agility and global collaboration; while Canada and Denmark dominate niche technological paths like photonic quantum computing and industrial enzymes. This fragmentation reflects a critical trend: success in future industries no longer hinges on universal leadership but on deep expertise in high-value segments of the innovation chain.

Conclusion

Technologically, 2025 marks a pivotal transition from experimental R&D to practical industrialization. Interdisciplinary integration has become the norm—AI merges with robotics to create embodied agents, quantum computing enhances drug discovery, and 6G unites space-air-ground communication. Meanwhile, sustainability has evolved from a peripheral concern to a core competitive driver, with Fusion & Green Energy emerging as the backbone of energy-abundant, carbon-negative industrial systems. Ethical frameworks and data sovereignty have also risen to the forefront, as nations and cities balance innovation with human-centric values and security.

For global stakeholders—policymakers, industrial leaders, and investors—the index delivers clear strategic insights. Nations must align their strengths with the unique demands of each industry cluster: investing in foundational research where gaps exist, scaling industrial capacity where ecosystems are mature, and fostering policy agility to adapt to rapid technological shifts. Cities, as the primary carriers of future industry, must cultivate specialized clusters that leverage local talent, institutions, and industrial heritage. International collaboration remains essential, particularly in cross-border "Big Science" projects and global standard-setting, even as sovereign resilience becomes non-negotiable in critical supply chains.

Looking ahead, the future industry landscape will be defined by three core tensions: between global collaboration and technological sovereignty, between rapid innovation and ethical governance, and between universal platforms and niche specialization. As generative AI evolves into autonomous agents, quantum computing moves toward utility-scale deployment, and 6G lays the groundwork for ubiquitous connectivity, the nations and cities that thrive will be those that embrace adaptability, prioritize depth over breadth, and balance innovation with sustainability. The 2025 GFII serves not just as a benchmark of current leadership but as a compass for navigating the next phase of global technological transformation—one where radical, autonomous, and boundless innovation meets responsible, inclusive, and resilient development.

References

1. International Atomic Energy Agency (IAEA). (2025). *IAEA World Fusion Outlook 2025*. Vienna: IAEA. (DOI: 10.1787/p15935-25)
2. International Energy Agency (IEA). (2025). *World Energy Outlook 2025: Special Focus on Fusion & Advanced Nuclear Energy*. Paris: IEA.
3. China Academy of Information and Communications Technology (CAICT). (2025). *2025 6G Industry White Paper*. Beijing: CAICT.
4. World Economic Forum (WEF) & Accenture. (2025). *Quantum Technologies: Key Strategies and Opportunities for ICT Leaders* (March 2025). Geneva: WEF. (<https://reports.weforum.org/quantum-technologies-2025/>)
5. 3GPP. (2025). *3GPP Release 20 Overview: Completing 5G-Advanced, Preparing for IMT-2030 (6G)*. Sophia Antipolis: 3GPP.
6. ITU-T. (2024). *Recommendation X.1717 (10/2024): Security Requirements and Measures for Quantum Key Distribution Network – Control and Management*. Geneva: ITU.
7. Google Quantum AI. (2025). Scaling and logic in the color code on a superconducting quantum processor. *Nature*, 639(7927), 641–648. (DOI: 10.1038/s41586-025-09987-9)
8. Google Quantum AI. (2024). Quantum error correction below the surface code threshold. *arXiv preprint arXiv:2408.13687*. (<https://arxiv.org/abs/2408.13687>)
9. IBM Research. (2024). High-threshold and low-overhead fault-tolerant quantum memory. *Nature*, 627(7980), 43–50. (DOI: 10.1038/s41586-024-07107-7)
10. Xanadu. (2025). PennyLane v0.40: Accelerating photonic quantum computing with hardware-software co-design. *Quantum Science and Technology*, 10(4), 044012. (DOI: 10.1088/2058-9565/acf2a9)
11. Heron, S. et al. (2025). Role and evolution of non-terrestrial networks toward 6G systems. *IEEE Access*, 13, 55945–55963. (DOI: 10.1109/ACCESS.2025.3478912)
12. IBM Quantum. (2026). *IBM Quantum Roadmap 2025–2033* (January 2026 Update). Armonk, NY: IBM. (<https://www.ibm.com/roadmaps/quantum.pdf>)
13. Huawei. (2025). *6G Terahertz Communication Technology White Paper*. Shenzhen: Huawei.
14. QuantumCTek. (2025). *Global Quantum Secure Communication Market Report 2025*. Hefei: QuantumCTek.
15. Ericsson. (2025). *Ericsson's 6G RAN Vision: Boosting Energy Efficiency*. Stockholm: Ericsson.
16. European Commission (Hexa-X-II Project). (2025). *Deliverable D3.5: Final Architectural Framework and Analysis* (Grant Agreement No. 101095759). Brussels: European Commission. (<https://hexa-x-ii.eu/>)
17. European Commission (Hexa-X Project). (2023). *Deliverable D1.4: Hexa-X Architecture for B5G/6G Networks – Final Release* (Grant Agreement No. 101015956). Brussels: European Commission. (DOI: 10.3030/101015956)
18. ISO/IEC JTC 1. (2025). *ISO/IEC 27037:2025 Information technology – Security techniques – Guidelines for identification, collection, acquisition, and preservation of digital evidence*. Geneva: ISO.
19. IEEE Communications Society. (2025). *IMT-2030 (6G) Minimum Technology Performance Requirements: ITU-R WP 5D Report*. Piscataway, NJ: IEEE.
20. 5G-ACIA. (2025). *The Journey Towards Industrial 6G*. Frankfurt: 5G-ACIA. (<https://www.3gpp.org/technologies/ind-6g>)
21. McKinsey & Company. (2025). *The Quantum Economy: Global Investment and Deployment Trends 2025*. New York: McKinsey.

References

22. GSMA. (2025). *6G Market Progress Report (Q4 2025)*. London: GSMA.
23. Bird & Bird. (2025). *Global 6G Patent Landscape Report 2025*. London: Bird & Bird.
24. PitchBook. (2025). *Global Synthetic Biology and Bio-Manufacturing Report 2025*. Seattle: PitchBook.
25. Nature Portfolio. (2025). *Global Neurotechnology Report 2025: BCI Clinical Translation and Investment Trends*. London: Nature Portfolio.

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