



Date : April 25, 2024

Leap to Global Top 3 in AI—Semiconductor, Advanced Biotechnology & Quantum Technology

- Three major game changer technology initiatives confirmed through a plenary session of the Presidential Advisory Council on Science and Technology (PACST)
- Korea to drive 9 Key Technology Innovation Projects, aiming to “Leap to G3 in AI” and “Create a New Legend for K-Semiconductor”
- Rising as an advanced biotechnology powerhouse through digital-bio convergence and biomanufacturing innovation
- Korea to strengthen groundbreaking investments and strategic partnership to secure leadership in the quantum economy era

The Presidential Advisory Council on Science and Technology (PACST) held a plenary meeting presided over by Vice Chairman Lee Woo-il at 5 p.m. on April 25 (Thursday) at the Presidential Office in Yongsan, and deliberated and resolved three major game changer technology initiatives: AI-semiconductor, advanced biotechnology, and quantum technology.

The PACST plenary meeting is the top decision-making body in the field of science and technology, chaired by the President of Korea, and is in charge of deliberating on mid- to long-term science and technology policy and R&D budget allocation and advising on national science and technology innovation and policy directions.

* Composition of members: Chairman (President Yoon Suk Yeol), Vice Chairman Lee Woo-il, Ministers of 5 ministries (MOEF, MOE, MSIT, MOTIE and MSS), 11 advisory members, 10 deliberation members, and presidential secretary for science and technology (executive member)

AI-semiconductor, advanced biotechnology, and quantum technology are key strategic technologies that will rapidly change the global economic, social, and security paradigm amid unprecedented rapid technological changes, and are attracting attention as game changer technologies that are fiercely contested by countries around the world. So far, the government has presented the direction of national initiatives to secure technological sovereignty and lead the future market of the three major game changer technologies, and this meeting is a place for the public and private sectors to confirm the direction as a specific vision and strategy. The government has set the goal of “rising as one of the top-three major countries globally by 2030” in the AI-semiconductor, advanced biotech, and quantum technology. Under this goal, the government plans to make intensive investment in these technologies, advance the value chain for each technology that will open up a new market, and strengthen strategic cooperation with allies.

At today's meeting, Vice Chairman Lee Woo-il said, "If you are equally good at the goals and directions others are chasing, it is difficult to survive the fierce competition for the leadership." He said, "Now, it's time we take one step further from doing what we are already good at. We must become a leader and first mover who pioneers uncharted waters and finds new things that will change the future."

The main contents of the three major game changer technology initiatives confirmed at the meeting are as follows:

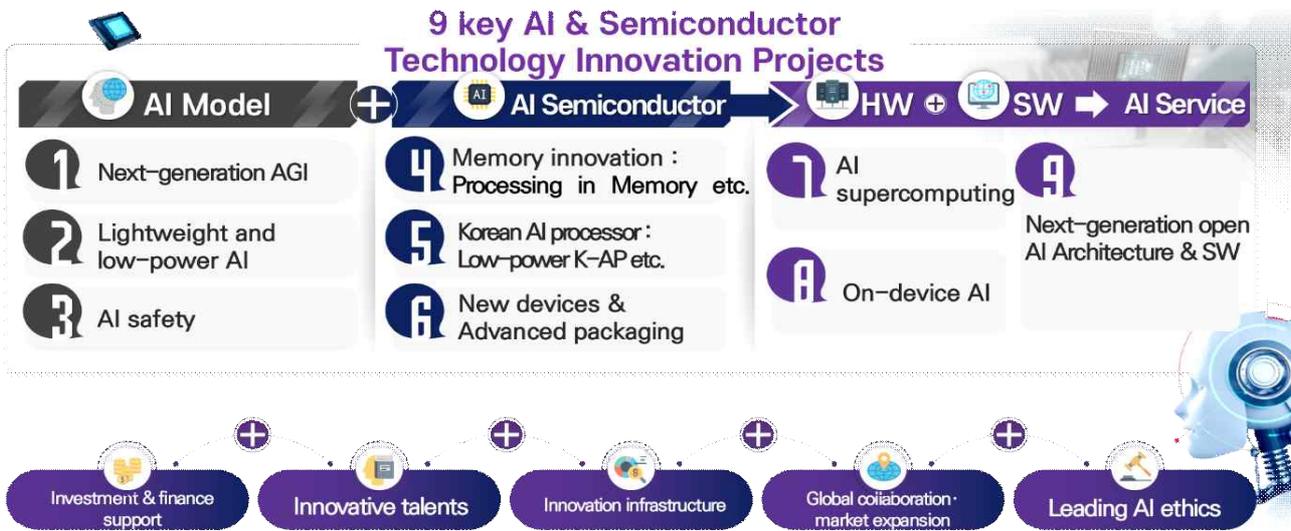
[Agenda 1] AI-semiconductor Technology Initiative

In the era where AI is the key to national competitiveness, amidst fierce global competition for leadership, Korea is driving the "AI-Semiconductor Initiative" with the goal of leaping to become one of the top three AI nations globally and creating a new legend for K-semiconductor.

The next three years are a crucial time that will determine the success or failure in the global AI war, and securing leadership in the AI era requires organic linkage and growth of the AI value chain, including AI models, AI chips, cloud, devices, and software. The "AI-Semiconductor Initiative" presents specific strategic tasks for which the government and the private sector should mobilize all of their capabilities, through the analysis of strengths and key technologies in each area of Korea's AI value chain.

Korea possesses strengths in hardware, including world-class competitiveness in the memory-chip sector and robust manufacturing capabilities. Furthermore, Korea is the third country in the world to have developed an LLM and is a nation that has established an independent AI ecosystem which boasts outstanding AI model development capabilities and top-tier AI service and cloud companies. By harnessing these strengths and mobilizing all-out national capabilities, Korea can become a leader in the future AI era. In pursuit of this, Korea aims to drive the 9 Key Technology Innovation Projects and supporting initiatives in order to bring about fundamental and bold technological innovation across the entire AI semiconductor landscape, including AI models, AI chips, and HW/SW technology ecosystems, and secure world-leading technological competitiveness.

Firstly, Korea plans to drive technological innovation in AI models in order to take the lead in AI technological supremacy by pioneering the development of specialized AIs and cutting-edge AIs in unexplored domains. This involves developing next-generation core AI technologies such as ❶ Artificial General Intelligence (AGI) surpassing the limitations of existing generative AIs, and securing ❷ lightweight and low-power AI technologies that maintain performance while consuming less energy. Ultimately, the plan is to enable the unrestricted use of AI across all devices. Additionally, Korea aims to swiftly take the lead in ❸ AI safety technologies that enable coexistence between AI and humanity while ensuring trustworthiness, such as AI cybersecurity and deepfake detection technologies.



Secondly, to take a new lead in AI semiconductor, Korea will strengthen innovation in AI semiconductor technology. By applying **4** Processing in Memory (PIM) to incorporate AI computation capabilities into memory chips, Korea aims to secure a super lead in the memory-chip field. By implementing PIM technology in DRAM and NVM (non-volatile memory), we will increase computational speed while dramatically reducing power consumption.

Furthermore, Korea will look to gain a new lead by developing **5** low-power K-AP, a Korean AI processor. We will strive to become the world's first to commercialize neuromorphic AI semiconductors that replicate the structure of a human brain. Additionally, we plan to continuously advance NPUs which have recently entered the commercialization stage.

Also, Korea will develop **6** new devices and advanced packaging technologies that can fundamentally change the paradigm of semiconductors. Through the establishment of a Lab to Fab scale-up platform, we will verify the commercialization potential and actively secure original technologies for advanced packaging, while providing stable support for innovative device development through large-scale R&D investments.

Thirdly, Korea will build a hardware and software technology ecosystem where AI and semiconductors organically converge. We will advance ⑦ AI supercomputing (K-Cloud 2.0) to enhance cloud services incorporating domestically developed AI semiconductors, and accelerate the integration of AI into daily life by developing core technologies for ⑧ on-device AI. We will develop AI semiconductors and devices to power on-device AI in environments with performance and energy constraints. Also, we will launch the K-On-Device AI Flagship Project in major industries (such as automobile, machinery, robot, home appliances and defense) to assist companies in capturing the early market. Additionally, we will strengthen support for the completion of the AI-semiconductor ecosystem by developing the ⑨ next-generation open AI architecture and software to efficiently control domestically developed AI semiconductors and enable operation in data centers and devices.

To realize the AI-Semiconductor Initiative, Korea will establish the National Artificial Intelligence Committee directly under the President's authority to consolidate the capabilities of industry, academia, research institutes, and government across the entire AI-semiconductor value chain and monitor the overall achievements of the industrial ecosystem. Furthermore, we plan to solidify Korea's global leadership in AI through the successful hosting of the AI Seoul Summit in May this year.

[Agenda 2] Advanced Biotechnology Initiative

“The Advanced Biotechnology Initiative” is a national strategy established to transform Korea from a follower to a leading country in the biotechnology sector by 2035 by leveraging the country's accumulated scientific, technological, and ICT capabilities, in response to the rapid growth of the global biotechnology market* and the heated competition for technological supremacy.

* As of 2021, the global biotechnology market size is estimated at around 2,500 trillion won, or about \$1.82 trillion, which is almost equal to the combined sales of Korea's top three export industries: \$595 billion in semiconductors, \$547.9 billion in petrochemicals, and \$1.79 trillion in automobiles.

By combining Korea's ① innovation-based technologies and ② high-quality data, this initiative strives to create ③ new service platforms and strengthen the ④ "biotechnology value chain" that are appreciated by the public. The initiative's key contents are as follows:

First, Korea will nurture digital biotechnology, a field that combines data, AI, and biotechnology, as our flagship industry. Korea will establish an integrated platform that acquires big data and dispersed biodata, including biomaterials and healthcare data. The acquired data will be processed and standardized into valuable data sets.* Korea also plans to draw a standard map of a human body's molecular structure and develop AI platforms for genes and new drugs,** strengthening the development of technologies that can enhance the use of data.

* e.g.: processed data sets on various types of cancer, new crop species or damages caused by blight and harmful insects.

** e.g.: risk prediction of mutations by coded and non-coded genomes, new drug development platform, or AI-based antibody designing.

Second, the Korean government has also set out to transform its petrochemical-based materials industry into a biotechnology-based one by promoting bio-manufacturing innovation. Korea will focus on developing core technologies in synthetic biology,* such as designing, synthesis, and high-speed screening of bio components. Additionally, Korea will establish public bio-foundries to promote automated high-speed bio-manufacturing. At the same time, Korea will foster industries related to critical materials, components, and equipment in biotechnology, covering bioprocess-based eco-friendly and high-functional materials, as well as API (active pharmaceutical ingredients) and other pharmaceutical materials.

* Six strategic technologies for synthetic biology:

1) DNA and RNA designing, 2) protein designing, 3) metabolic pathway (gene circuit) control, 4) microbial-based chemical materials, 5) animal cell-based vaccines and therapeutics, and 6) plant cell-based alternative foods and green biomaterials.

Third, Korea aims to improve the quality of life and health of its citizens with the help of innovative medical technologies based on advanced biotechnology. The government plans to support creative and disruptive research in innovation-based technologies such as epigenetics, RNA editing, and anti-aging. The government will also encourage the acquisition of advanced medical technologies* that are almost ready for commercialization or have proven commercial success in foreign countries. Korea will develop mission-oriented healthcare technologies for overcoming incurable diseases and addressing medical crises, too.

* e.g.: cell therapies (CAR-T), antibody-drug conjugates (ADC), and targeted protein degradation (TPD) technologies.

Fourth, Korea will also expand efforts to tackle global challenges commonly facing the international community, such as climate change, carbon neutrality, food shortages, and infectious diseases. To address these challenges, the government plans to strengthen its support for initiatives like bio-hydrogen and batteries, environmental cleanup, digital breeding, and developing alternative food, mRNA vaccines, and infectious disease treatments.

Furthermore, Korea will strive to foster high-caliber talent, establish industrial ecosystems, build robust infrastructure, boost global cooperation, and pursue regulatory innovations to ensure the seamless progress of these initiatives. The country aims to develop "convergent talent" by combining biotechnology with digital or engineering technology through interdisciplinary processes. The government also plans to strengthen its support for the entire lifecycle of the bio industry, from the establishment of startups to investment attraction from the private sector. Korea intends to improve its advanced biotechnology infrastructure by acquiring cutting-edge research facilities and equipment, including fully automated research labs with supercomputers. The country also seeks to enhance its research capabilities through collaboration and policy coordination with leading nations in advanced biotechnology. In addition, preemptive measures will be taken to establish legal frameworks and draw roadmaps to improve regulations on advanced emerging biotechnologies.

[Agenda 3] Quantum Technology Initiative

Quantum science and technology* are gaining limelight as a critical game-changer responsible for innovative transformations in promising industries as well as the economy, society, security landscape, and environment. Also, the technology is expected to play a pivotal role in addressing various difficult challenges. With its profound implications for national defense and security, quantum technology is being regarded as an essential core strategic technology for future national security. The Quantum Initiative outlines the key directions and strategies of the Yoon administration to prepare for the upcoming quantum era (Quantum beyond Digital).

* Quantum Science & Technology: technologies that applies quantum physical properties (including quantum entanglement and superposition) to computing, communication, sensing, etc., enabling hyper-scale, ultra-high-speed computation, ultra-reliable connections, ultra-precision measurement, and more.

Although the field of quantum science and technology is showing rapid growth, it has yet to enter a commercialization stage. Therefore, based on the advanced industrial and IT capabilities accumulated over the years, Korea can be considered well-positioned to lead the technological trajectory of quantum science and technology and has significant opportunities and potential to create new innovations.

With this understanding, the government has outlined nine priority technologies under the "Quantum Initiative" to strategically prepare for the quantum era, leveraging our strengths in the following three pillars: technologies to catch up rapidly (core quantum technologies); technologies to lead the world (quantum engineering); and technologies and fields (utility and services) to explore new markets.

Firstly, based on Korea's accumulated scientific technologies and ICT capabilities, we will actively secure the following core quantum technologies to rapidly catch up with leading countries: 1) Quantum processors (QPU) that serve as the foundation of quantum computers; 2) Quantum algorithms and

software (SW) for addressing industrial and academic challenges; 3) Quantum network, including quantum internet for quantum device connections and next-generation quantum cryptography that ensures unbreakable encryption and invulnerability to eavesdropping; 4) Quantum sensing technologies such as GPS-free navigation sensing, ultra-high-resolution imaging, etc.

Secondly, based on the country's semiconductor and manufacturing capabilities, Korea presented the following quantum engineering technologies that will lead the world in the future: 5) Quantum materials, components, and equipment for measuring and controlling quantum states; 6) Quantum device and process technologies for designing and manufacturing core devices of quantum processors; 7) Digital-quantum hybrid technology for the complementary integration and utilization of supercomputers and quantum computers

Thirdly, the Korean government outlined the following as the fields we must pioneer in preparation for the future industrialization era: 8) Quantum killer applications that generate innovative use cases and services of quantum science and technology across various fields; 9) Quantum artificial intelligence (AI) for efficiency enhancement in machine learning, etc.

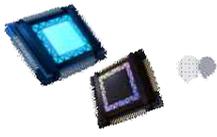
To secure these priority technologies, the government aims to:

- ▲ Increase the 2025 budget for quantum science and technology to double the allocation of 2024, and enhance the strategic research and development (R&D) through flexible and stable financial support;
- ▲ Secure core researchers in the field of quantum science and technology through support for junior researchers and attraction of global talent;
- ▲ Establish open quantum research hubs to consolidate research capabilities;
- ▲ Create a foundation for global cooperation with advanced countries at the national level and enhance joint research support with leading global universities;
- ▲ Strengthen the quantum ecosystem through the expansion of infrastructure such as quantum fabs, foundries, and testbeds, as well as support for industrialization.

Furthermore, for the systematic and strategic support of quantum science and technology in the future, the government is committed to:

- ▲ Establish a Quantum Strategy Committee with the Prime Minister as chairman, consisting of representatives from relevant ministries, private sector experts, etc.;
- ▲ Operate a constant communication channel between the research-public-private sectors;
- ▲ Facilitate quantum dialogues with major leading countries.

In conclusion, through the Quantum Initiative, the government aims to elevate the level of quantum science and technology to over 80% of its potential by 2030, up from the current 65%. Additionally, by the same target year, the initiative seeks to expand the number of companies that supply or utilize quantum technologies from around 80 (as of 2022) to 500, thereby further accelerating core technology development and market creation.

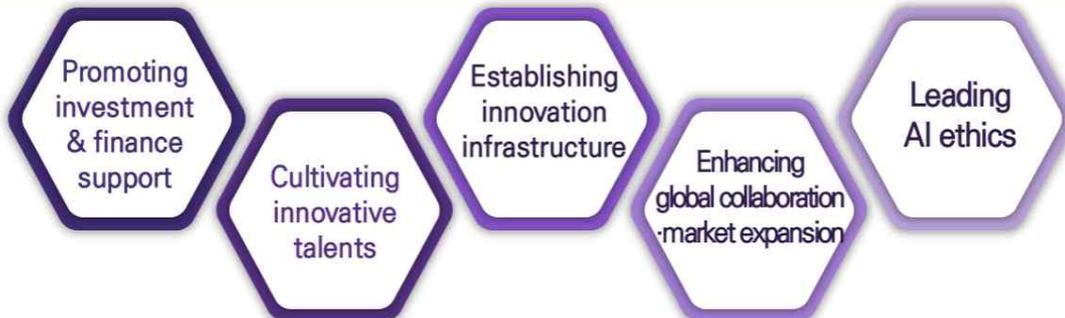


Leaping into AI Global top 3, Create a New Legend for K-Semiconductor

9 key AI & Semiconductor Technology Innovation Projects

Leading AI technology hegemony	AI Semiconductors Super-Gap & New-Gap	AI & Semiconductors HW-SW Tech. Ecosystem
<p>01 Next-generation AGI</p> <ul style="list-style-type: none"> ☑ Multimodal AGI ☑ Data-Centric AGI ☑ Causal AI 	<p>04 Memory innovation : Processing in Memory etc.</p> <ul style="list-style-type: none"> ☑ HBM-PIM, LPDDR-PIM ☑ NVM-PIM ☑ AI custom Memory 	<p>07 AI supercomputing</p> <ul style="list-style-type: none"> ☑ K-Cloud 2.0 ☑ Cluster Computing HW Technology ☑ Hyperscale Model Training & Inference SW
<p>02 Lightweight and low-power AI</p> <ul style="list-style-type: none"> ☑ Ultra-lightweight & High-performance sLLM etc ☑ Ultra Low Power AI Algorithm 	<p>05 Korean AI processor : Low-power K-AP etc.</p> <ul style="list-style-type: none"> ☑ Next-generation NPU ☑ Neuromorphic Processor ☑ Chiplet-SoC 	<p>08 On-device AI</p> <ul style="list-style-type: none"> ☑ Field-specific AP ☑ Standalone AI device
<p>03 AI safety</p> <ul style="list-style-type: none"> ☑ Explainable AI ☑ Bias removal ☑ AI-Cybersecurity Technology ☑ Deepfake detection 	<p>06 New devices & Advanced packaging</p> <ul style="list-style-type: none"> ☑ Intelligent New device platform ☑ Barrier-Breaking future semiconductor devices ☑ Advanced packaging core technologies 	<p>09 Next-generation open AI Architecture & SW</p> <ul style="list-style-type: none"> ☑ AI semiconductors-optimized System SW ☑ HW-Cognitive SW

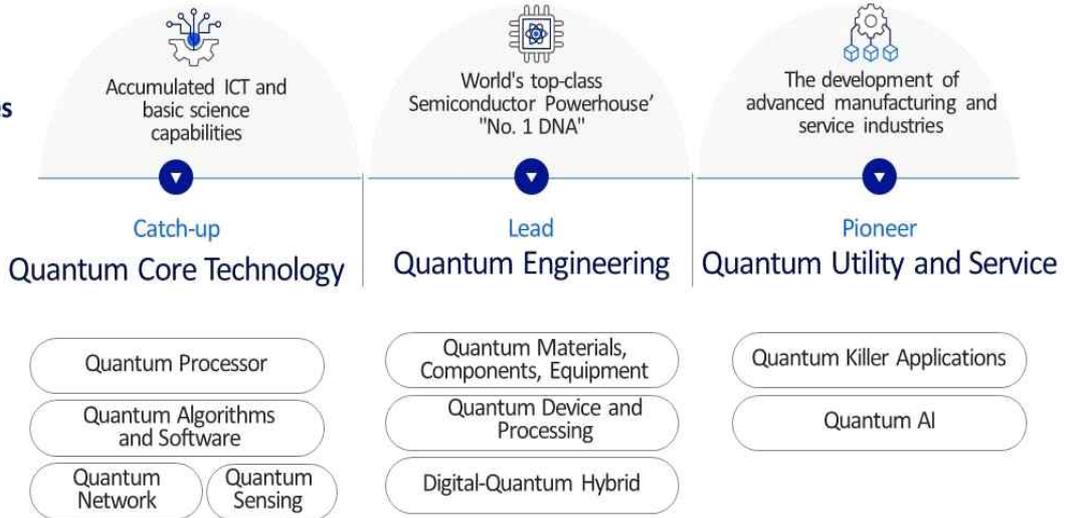
Key Strategic Pillars



<p>Vision</p>	<p>To Emerge as a Global Biotechnology Superpower by 2035</p> <ul style="list-style-type: none"> To secure the status of a leading country in advanced biotechnology. To promote biotechnology as the country's core industrial technology following semiconductors To contribute to addressing global challenges such as the population aging, food shortage, and climate change 																			
<p>Overall direction</p>	<p style="text-align: center;">Strengthen the biotechnology value chain</p> <p>Strengthen the 'biotechnology value chain' that can create next-generation 'service platforms' and realize 'practical values' by combining 'innovation-based technologies' with 'high-quality data'</p> <div style="text-align: center;"> <pre> graph LR A[1 Innovation-based technology] -- "+" --> B[2 High-quality data] B -- "→" --> C[3 Service platform] C -- "→" --> D[4 Practical value] </pre> </div>																			
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<p>Strategies</p>	<p style="text-align: center;">Regulatory improvement jointly led by the government and the private sector</p> <p>Pursue regulatory improvements to meet global standards throughout the entire lifecycle from R&D to technology commercialization</p>	<p style="text-align: center;">Pan-ministerial collaboration involving industry, academia, research institutes, and hospitals</p> <p>Establish and operate various consultative bodies, including those for biotechnology and healthcare data platforms</p>	<p style="text-align: center;">Strengthened global networks and collaboration</p> <p>Jointly acquire 'super lead' in technologies' and respond to technology blocks and bio-security issues.</p>																	

QUANTUM beyond Digital

9
Priority Technologies



4
Promotion Strategies



Governance



Expected Outcomes

