National Science and Technology Development Plan

（2021–2024）

（Approved Version）

May 21, 2021
Yuan-Tai-Ke-Letter No. 1100009078

Contents

Chapter 1. Introduction

According to the Fundamental Science and Technology Act, the government must present a blueprint describing the visions, strategies and status of science and technology development. The government must also formulate a National Science and Technology Development Plan based on the consensus and conclusions reached at the National Science and Technology Conference, taking into consideration the nation's developmental trends, the needs of society, and the goal of balanced regional development. This Plan shall serve as a basis for formulating science and technology policies and promoting scientific and technological research and development. For this reason, the Executive Yuan held the 11th National Science and Technology Conference in December 2020. The Conference was focused on the vision for Taiwan in 2030 — "Innovation, Inclusion, and Sustainability," which aims to use innovative thinking, incorporate technologies for solving problems in all industries, formulate preemptive strategy for the development of key technologies, and integrate the six core strategic industries to strive toward becoming a country that excels in innovation. With Inclusion at the core, the vision addresses the needs of different generations, populations, and domains, deepens the care for local society, enriches the diversity of local culture, and creates a safe, diverse, and inclusive society. In response to the sustainable development goals (SDGs) of the United Nations, the science and technology development strategies for economic growth, social development, and environmental protection are promoted to create a co-existing, prosperous, and sustainable society.

To strengthen balanced regional development, the government aims to upgrade and promote the six core strategic industries based on the 5+2 industry innovation plan by integrating the advantages of science parks to shape Northern, Central, and Southern Taiwan into characteristic industry clusters. Besides, the government strengthens ties to local demands and the integration of the capacity of industries, academia, and research institutes. Furthermore, the government assists science parks to cultivate talented professionals in industrial technology and promote local employment to generate the critical mass that drives the development of regional economy. In the future, science parks will continue to connect local businesses, bolster the advantages of regional industries, and cooperate closely with local governments to promote the development of regional economy and industries and boost local prosperity. The National Science and Technology Development Plan (2021–2024) (hereafter referred to as "the Plan"), based on the direction of national development and needs of society, is outlined below.

1.1. The Direction of National Development

The drastic changes in the global economy, vigorous science and technology development, ongoing economic conflict between China and the United States, and the impact of the COVID-19 pandemic on daily life have accelerated the restructuring of global supply chains and changed the world economy and technological development trends. The Global Competitiveness Report Special Edition 2020, published by the World Economic Forum (WEF) on December 16, 2020 recommended that the economic revival and transformation of countries in the post-pandemic era must emphasize building a new economic model that embraces the innovation of new technologies, the inclusion of diverse populations, and the sustainability of the environment.

Major countries are responding to global changes by actively investing in future key industries and implementing new technological development policies to improve the country's competitiveness. For example, the National Science Foundation (NSF) in the U.S. proposed 10 technology focus areas in May 2020 — artificial intelligence and machine learning; high performance computing, next generation semiconductors, quantum computing and information systems; robotics, automation, and advanced manufacturing; natural or anthropogenic disaster prevention; advanced communications technology; biotechnology, genomics, and synthetic biology; cybersecurity, data storage, and data management technologies; advanced energy; and materials science.

To overcome the trade bottleneck resulting from ongoing dispute with the United States, China has proposed its future technology development strategies in the 14th Five-Year Plan, which aims to strengthen the domestic base to become a self-reliant technological and manufacturing powerhouse. The Plan targets advanced scientific areas, including artificial intelligence, quantum information, integrated circuits, neuroscience and brain-inspired research, genetics and biotechnology, clinical medicine and health, and deep sea, deep space, and polar exploration.

In face of the COVID-19 pandemic in 2020, South Korea adopted the stance that failure to respond in a timely manner may harm the country in the future. Against this backdrop, the Korean New Deal: National Strategy for a Great Transformation was introduced in July 2020 as a strategy focused on promoting the "Digital New Deal," "Green New Deal," and "Stronger Safety Net." The Deal aims to support the country's recovery from the pandemic crisis and adapt to structural changes in the economy and society by actively developing a diverse array of technologies, such as big data application, next-generation networks, smart healthcare, smart schools, digital management, green energy, green buildings, and eco-friendly transportation.

As part of the technology development strategy for the post-pandemic era, Singapore unveiled its national budget in February 2020, allocating S$8.3 billion for the development spanning research areas including biomedical technologies, information and communications technology (ICT), smart science and research, and new energy, among other focus areas of the smart economy. The objective was to develop advantages for Singapore in global technology and innovation economy in the post-COVID-19 era.

To meet the future demands of society and industries in response to the rapidly changing world economy, demographic structure changes, and the rise of new technologies, Taiwan will be based on the foundations of the 5+2 Industrial Innovation Plan and the advantages of semiconductor industry to develop next-generation core technologies to enhance critical influence across the world. These development initiatives will focus particularly on the six core strategic industries, namely digital and information industry, national defense and strategic industry, cybersecurity industry, green and renewable energy industry, medical technology and precision health industry, and strategic stockpile industry. Another focus will be on Cross-Agency Strategic Research Programs such as Sustainable Big Data Platform for Precision Health, cybersecurity excellence, the Angstrom Semiconductor Initiative, beyond-5G satellite communication, and the digital transformation and service plan of small and medium enterprises (SMEs) using the cloud technology.

1.2. The Society's Needs

To collect opinions across the board and keep abreast of the society's needs, the Plan aims to gather the questions, comments and opinions of expert scholars, opinion leaders,

civic representatives, and the general public through group meetings by topics, general strategy review meetings, legislator's consultation meetings, and regional preparatory meetings. The section below introduces the four major aspects of the opinions collected, including talent cultivation and value creation, research and foresight, economy and innovation, and secure society and smart living. The opinions will serve as the basis for ministerial departments to develop and propose measures to reinforce the connection between science and technology policies and the needs of all sectors of the society.

1.2.1. Talent cultivation and value creation

The key opinions on this aspect are grouped into three categories: efforts to recruit and retain talent should be strengthened continuously; talent cultivation should focus on future trends and needs of industry; lifelong learning should be fully adapted to changes in population structure. Detailed descriptions are provided below.

1.2.1.1. Efforts to recruit and retain talent should be strengthened continuously

Given the trends of globalization, technologicalization, and accelerated industrial changes, global competition for talent is fierce and the demand for local outstanding talent is increasing sharply. Because of the industrial development and salary competitive disadvantage in Taiwan, foreign professionals working in Taiwan accounted for only 0.29% of the nation's total workforce at the end of 2019, which is considerably lower than that of Singapore, Hong Kong, and other adjacent Asian countries. Furthermore, Taiwan's employment laws and regulations, such as the Employment Service Act, can no longer support the demands of a digital era. In the future, the Taiwan government should adequately loosen laws and regulations for foreigner employment. In response to the trends of an aging population and low birth rates, the government must also propose how to strengthen the cultivation of female researchers, to devise mechanisms to attract foreign professionals to live and work in Taiwan, and to help overseas Taiwanese acclimate to the employment market in Taiwan.

1.2.1.2. Talent cultivation should focus on future trends and industrial needs

Changes in demographic structure and constant innovation in artificial intelligence (AI), robotics, and biomedical technologies will impact and transform the daily practices of industries and workplaces. In view of this trend, we must contemplate how many industries are adequately equipped to support talented scientific researchers. In the future, the government must address the future needs of key industries in Taiwan, and adopt mechanisms and models such as curriculum reform, cross-industry collaboration, novel digital talent cultivation, and competency-based certification to cultivate technologists with professional competency, digital literacy, and cross-disciplinary innovation skillsets. In addition, deeper ties among industry, academia, and the research community are required to strengthen knowledge–action integration so that cultivated professionals can become more competitive internationally, making them more employable by industries or startups.

1.2.1.3. Lifelong learning should be fully adapted to changes in demographic structure

The vigorous science and technology development will accelerate occupational changes in the future. Ministerial departments across the government develop their own learning platforms in accordance with policy requirements, which leads to discrepancies in learning progress and learning journey records. To facilitate public use of these platforms, ministerial resources must be unified to build an integrated lifelong learning information platform. With this integrated platform, everyone can keep track of their skill learning progress, which will help them to choose courses that hone their interests or skills; encourage them to join learning communities that allow the sharing of learning resources or experiences; increase sustainable learning and promote social engagement; and satisfy the needs of middle-aged and elderly people to achieve lifelong learning and continuously contribute to society.

1.2.2. Research and Foresight

The key opinions on this aspect are grouped into four categories: Future technology development strategy should be built on the advantages of Taiwan; basic research should be fortified for stronger scientific research capacity; industry–academia–research collaboration should be reinforced continuously for accelerating technological groundwork; and risk assessments and data management should be improved to reduce negative impacts. Detailed descriptions are provided below:

1.2.2.1. Future technology development strategy should be built on the advantages of Taiwan

National science and technology policies are relevant to the nurturing, accumulation, and innovation of scientific research capacity and to the effective resources allocation. Currently, science and technology budgets are allocated to a wide range of projects, including basic research, application and technical development, industry assistance, product commercialization, and other R&D projects involving upstream, midstream, and downstream technologies, as well as talent cultivation, environmental construction, and systems management and improvement. To utilize resources effectively in the face of globalization and fierce competition in innovation, it is necessary to think about Taiwan's future competitive advantages in technology, draw on its advantages over existing industries, develop mid- to long-term science and technology policies that reflect the socioeconomic situation and needs of the country, and outline strategic research areas in Taiwan. These policies must implemented through a comprehensive science and technology policy decision-making system.

1.2.2.2. Basic research should be fortified for stronger scientific research capacity

Basic research is the foundation of a country's scientific research capacity. The application of basic research outcomes exerts a profound influence; however it is often difficult to predict and takes a long time to put into practice. Enterprises are therefore not keen to invest in basic research because they expect returns in the short- to med-

term for the benefit of their business. Therefore, only the government is able to secure investment and wait for opportunities in the interests of the public, which indicates the importance of basic research and subsequent development of industrial technologies. In addition to securing budgets for basic research, the government must contemplate how to design the incentive mechanism to encourage the private sectors to invest in original and innovative R&D, bolster the basic research capacity of Taiwan, and invest in the development of advanced technologies in early stages in line with international standards to strengthen the core competitiveness of industries.

1.2.2.3. Industry–academia–research collaboration should be reinforced continuously for accelerating technological groundwork

Global turmoil and rapid changes in society has brought up more complicated issues and challenges that need to be addressed through cross-disciplinary collaboration. Diverse policies and approaches are currently available to facilitate industry–academia–research collaboration. However, limited economies of scale, and the lack of integrated and communication mechanisms, and the lack of industrial R&D and innovation, have resulted in inflexibility between R&D processes and translation of R&D outcomes. Then, this situation subsequently influences the overall effectiveness of cooperative efforts and innovation initiatives. In the future, we should identify directions for problem solving, establish short-, mid-, and long-term plans, develop effective mechanisms for the implementation of technological research planning and resource integration to accelerate the commercialization of innovative technologies and create greater value for industry and society.

1.2.2.4. Risk assessment and data management should be enhanced to reduce negative impacts

New technologies are essential to countries in the contemporary era. Various key technologies and disciplines are closely related. The industrial application of critical technologies is only possible if it is integrated with information or data from different disciplines. The government should develop comprehensive open data and application mechanisms, while ensuring both data privacy and security, so that various information and data may be used in research and development. However, the integration of information between ministerial departments and corresponding legal frameworks still requires further improvement. In the future, the government should continue to retrofit and develop the hardware facilities and infrastructures, accelerate data circulation and streaming, and formulate risk management strategies accordingly to improve governmental services and innovation capacity to build a smart government.

1.2.3. Economy and innovation

The key opinions in this aspect are grouped into four categories: the development niche for industrial transformation and upgrading should be based on the advantages of Taiwan; the research and development of recycled materials should be intensified to drive a circular economy; diversity, stability, and future prospects need to be taken into account when making energy policies; and the environment for innovative startups should be improved to accelerate the promotion of a startup economy. Detailed descriptions are provided below:

1.2.3.1. The development niche for industrial transformation and upgrading should be based on the advantages of Taiwan

The rapid development of advanced technologies around the world brings changes to traditional single-industry supply chains and how industries innovate. Industries require stronger capabilities to conduct precise cross-disciplinary R&D and achieve industrialization more quickly. Although Taiwan is equipped with world-leading ICT infrastructure, the country is slow to respond to the rapid transformation of digital industries because of shortcomings in relevant industrial technologies and applied innovation. The COVID-19 pandemic in 2020 not only dramatically impacted industries but also changed the behavior of consumers, which created new challenges for business operations. Ministerial departments and government agencies should use the advantages of Taiwan as a niche to establish specific industrial development directions that can serve as guidance for the industries to speed up the process of upgrading and transformation.

1.2.3.2. The research and development of recycled materials should be intensified to drive a circular economy

Waste recycling policies implemented by Taiwan's government have been effective. Taiwan's waste recovery rate is over 58% and ranks third in the world. To achieve a circular economy in which industrial development runs parallel to environmental protection, circular applications across various industries, including circular energy resources, circular equipment, circular agriculture, circular plastics, circular designs, circular buildings, and carbon cycles causing climate warming, are problems that warrant immediate attention and solution. Pollution prevention technologies must also be developed to address the environmental impact as a result of the introduction of new technologies. In the future, the government should increase efforts to develop technologies for resource recycling and material sustainability, improve the efficiency of the circular use of resources, prolong the lifecycle of resources, and promote the transformation of industries in Taiwan.

1.2.3.3. Diversity, stability, and future prospects need to be taken into account when making energy policies

Taiwan, relies on imports for 98% of its energy, which leaves the island vulnerable to changes in international energy supply and energy price fluctuations. However, the development of renewable energy involves multiple professional specializations and thus relies on cross-disciplinary assistance and collaboration. Numerous problems must be addressed. For example, energy development is constrained by natural conditions, and potential energy investors are limited. The government has already created a comprehensive roadmap in its energy transitioni policies that mainly involves photovoltaic systems and offshore wind farms. If these energy systems can be successfully developed, Taiwan will become an exporter of low-carbon technology, and can create economic benefits from carbon reduction, and expand domestic demand to promote the sustainable development of resources.

1.2.3.4. The environment for innovative startups should be improved to accelerate the promotion of a startup economy

Scientific research capacity is crucial for a country's future competitiveness, and the country's competitive advantages to a large extent depend on the effective translation of scientific research results, the development of innovative technologies into specific new products or services, and the creation of value for industries, the economy, and society. Currently, the shortage of venture capital still persists, and cross-ministerial collaboration and promotion is therefore required. Meanwhile, tech startups in Taiwan are not capable of using scientific research technologies effectively as an impetus for expanding the international market. Professors who are also entrepreneurs are still a minority. We should learn from advanced countries and encourage the commercialization of technologies. Therefore, ministerial departments must continue to improve the entrepreneurial ecosystem with application of academic expertise and research results to accelerate the promotion of a startup economy.

1.2.4. Secure society and smart living

The key opinions on this aspect are grouped into four categories: Efforts and capacities to prevent COVID-19 should be enhanced continuously to improve responsiveness; the cybersecurity industry chain should be improved to reinforce cybersecurity protection; urban disaster resilience should be enhanced in response to climate change; and public services should be digitized to improve the effectiveness of policy implementation. Detailed descriptions are provided below:

1.2.4.1. Efforts and capacities to prevent COVID-19 should be enhanced continuously to improve responsiveness

COVID-19 has spread worldwide since the first outbreak in 2019, causing an constant increase in the number of confirmed cases and deaths around the world. Although governments in different countries have introduced policies to combat COVID-19, the extent of the pandemic leads to a major impact, drastically changing the way people live and threatening the economy of a nation and the health of its people. In Taiwan, policies for tackling the COVID-19 pandemic cover the following aspects: status monitoring, border control and testing, community prevention, preparedness of medical supplies and other necessities, and health education campaigns. All these aspects require an extensive inter-ministerial communication mechanism and real-time information integration, coupled with digital technologies for greater accuracy and timeliness, so that the COVID-19 response capacity can be effectively enhanced and the health of the people can be assured.

1.2.4.2. The cybersecurity industry chain should be improved to reinforce cybersecurity protection

As the Internet of Things, 5G networks, and AI technologies mature, the application of autonomous systems, such as cloud services, autonomous vehicles, unmanned aerial vehicles, and smart healthcare becomes popular. As these will be integrated with ubiquitous Internet technologies, privacy infringement and unprecedented

cybersecurity challenges will probably increase. “Lone-wolf” security hackers will likely be replaced with hacker groups, which often launch attacks systematically. The cybersecurity risks of key infrastructures and supply chains are thus increasing daily, and the general cybersecurity protection mechanism requires further reinforcement. However, Taiwan still has a shortage of cyber security talent and there is still plenty of room for improvement in terms of R&D capacity to cybersecurity. These issues need to be addressed before Taiwan can transform into a secure and smart country.

1.2.4.3. Urban disaster resilience should be enhanced in response to climate change

Climate change is a huge challenge that the world must confront together. Extreme climate events will become more frequent. The resilience of infrastructures to climate change must be strengthened. For example, Taiwan has put in place an array of policies and actions to become a nuclear-free country and actively invested in energy transition to achieve a targeted power mix of “20% renewables, 50% natural gas, and 30% coal.” However, the types and structures of energy facilities resulting from such energy transition will be more sensitive to climate change, which implies that climate change scientific research and technology development, coping strategies, and green infrastructures still require further improvement. Owing to its location, Taiwan is vulnerable to various disasters. Approximately 73% of its population is exposed to the risk of three or more natural disasters, such as droughts, earthquakes, and typhoons, as these happen considerably more frequently in Taiwan than in other parts of the world. Therefore, new technologies must be introduced to strengthen the early warning systems, disaster prevention, and disaster resilience of major cities in Taiwan.

1.2.4.4. Public services should be digitized to improve the effectiveness of policy implementation

A densely populated city characterized by a crowded living environment, traffic congestion, and air pollution brings more complex challenges to city management. Meeting basic everyday needs (e.g., smart transportation and housing), building an age-friendly environment (e.g., the implementation of long-term care policies and the development of geriatric care and nursing mechanisms), and creating a network environment suitable for future generations are all factors affecting the livelihood and development of the people. An issue crucial to city management is how to identify and use technologies that can solve local problems best to improve quality of life, and to facilitate industrial development. In addition, technology compentency can help to bridge the urban–rural gap and balance the resources distribution equality, to assistrural areas to mitigate labor shortage problems in health care, education, and public services. In summary, the Plan is a continuation of the government’s major policies and development direction and aims to meet the society’s needs in an effort to realize the vision for Taiwan in 2030: Innovation, Inclusion, and Sustainability. To increase the depth and breadth of science and technology policies, 21 ministerial departments and agencies have collectively developed a systematic strategy focusing on four aspects of needs: Meeting industry needs for talent by strengthening the cultivation of competitive talent and encouraging lifelong learning; meeting the need for greater scientific research capacity by investing in R&D of strategic technologies and enhancing research performance for society’s wellbeings; meeting the need for industrial transformation by promoting digital innovation and sustainability; and meeting the need for safer and

more secure living by providing public health care and bolstering the resilience of society.

Chapter 2. Status and Review of Current National Science and Technology Development

2.1. International Trends

The WEF forecasts that digital transformation will add US$12 trillion to the global economy by 2030, prompting major countries to invest in the research and development of digital technologies, which has driven the transformation of production models. From the end of 2019 through to 2020, the COVID-19 pandemic has affected both daily life and economic activity, spurring a series of developments in the areas of remote learning and healthcare systems, contactless e-payment systems, cloud and big data applications, next-gen computing technologies, artificial intelligence (AI), and automated production models. Countries around the world are facing the challenges arising from changes in population structure. The population of people aged 65 years or older is projected to exceed 1 billion by 2030, representing 11.7% of the global population, which is the structure of an aging population. Therefore, precision medicine, telehealth, and smart living systems have garnered increased attention. Since the United Nations established Sustainable Development Goals (SDGs) in 2015, fostering environmental, economic, and social prosperity has become the focus of national development. Under this trend, governments worldwide are adopting development strategies that center on renewable energy industries, next-generation energy sources, eco-friendly buildings, and environmentally friendly production models. In doing so, innovative thoughts are generated to develop new technologies that not only ensure the well-being of people of all age groups but also create a smart, resilient, and sustainable society. An overview of the technological trends of major countries is provided below, with examples taken from the technological development of the United States, mainland China, European Union (EU) countries, South Korea, Japan, Singapore, and Israel.

2.1.1. The United States

The United States has spared no effort in cultivating the field of new technologies to maintain its global competitive advantages. Since 2018, the country has actively promoted the development of AI. In June 2019, the U.S. government released the "National Artificial Intelligence Research and Development Strategic Plan: 2019 Update," highlighting long-term research in AI technologies aimed at maintaining the country's global leadership in AI. In February 2020, the White House Office of Science and Technology Policy published the "American Artificial Intelligence Initiative Year One Annual Report," providing an overview of the American Artificial Intelligence Initiative based on policies implemented by the U.S. government over the past year, including investment in AI research and development, unleash AI resources, and innovation and development. In January 2021, the White House announced the creation of the National Artificial Intelligence Initiative Office, which adopts strategic thinking to comprehensively review the national-level effect of AI on the future economic and national security of the United States. At the end of January 2021, the National AI Initiative Act of 2020 was then passed as part of the National Defense Authorization Act of 2021, providing a legal status to national strategic thinking on the adoption of

AI and thus highlighting that AI technologies are integral to the federal government's efforts in ensuring its global leadership in AI.

Regarding the development of next-generation technologies, the 10-year National Quantum Initiative (NQI) act was signed into law at the end of 2018, providing a program to engage in the research and development of quantum communications, quantum computing, and high-precision quantum sensing. In addition, the United States devoted US$74 million in February 2020 to the development and implementation of energy efficiency building techniques and systems to improve the energy efficiency of the U.S. buildings and structures, thus ultimately achieving the objective of energy sustainability.

2.1.2. Mainland China

Mainland China has often referred to its reliance on imported technologies, specifically key technologies from the United States, as "qia bozi" or stranglehold problems. To overcome this trade issue, the Chinese Academy of Sciences suggested in September 2020 that the country needs to take the lead in deploying the technological research and development of high-speed computing systems, advanced material applications, and next-generation core technologies, so as to support industrial upgrading and improve the well-being of its people.

On November 3, 2020, the Chinese government released the "Proposals of the Central Committee of the Communist Party of China on Formulating the 14th Five-Year Plan for National Economic and Social Development and Long-term Goals for 2035." Based on the 2035 vision, the 14th Five-Year Plan outlines the formulation of the direction for national economic and social development. The Plan also discusses the key strategic industries to be promoted in the future, including high-end next-generation information technology, biotechnology, new energy, new materials, high-end equipment, new energy vehicles, green environmental protection, aerospace, marine equipment, and other advanced technologies. The ultimate goal of the Plan is to achieve technological self-reliance, enhance the technological capabilities of enterprises, develop strategic emerging industries, and accelerate the digital development of industries.

2.1.3. European Union

The EU released an article titled "Shaping Europe's Digital Future" in February 2020, unveiling its ideas and actions for a digital transformation that works for all, and presented the "White Paper On Artificial Intelligence - A European Approach to Excellence and Trust and European Data Strategy," which were set as its two major foundations for further development. This reveals that the EU values the industrial and social applications of AI and is focusing on the development of the network security and data management involved in telecommunications.

In June 2020, the EU released the Digital Economy and Society Index (DESI) as part of a review of its advances in digital technologies, such as next-generation network development, public digital literacy, corporate digital applications, and digital public services, in major European countries. This report provided an overview of the economic and social impact of digital technologies on EU countries. by reviewing the potential in the development of new technologies including blockchain, high-performance computing, and quantum technologies.

Regarding environmental sustainability, to achieve climate neutrality by 2050, the EU has worked tirelessly with countries worldwide to achieve the zero-pollution goal of the Paris Agreement. On July 8, 2020, the European Commission presented the EU Strategy for Energy System Integration and the EU Hydrogen Strategy. These strategies will pave the way toward a more efficient and interconnected energy sector to achieve the twin goals of a cleaner planet and a stronger economy.

2.1.4. South Korea

In response to the global technology trend, the Presidential Advisory Council on Science and Technology in South Korea convened the 12th national review meeting and approved the long-term plan formulated by the Ministry of Science and ICT, "Future Strategies of Science and Technology for 2045: Challenges and Tasks of the Future and Transformation of Science and Technology Policies," setting forth the long-term technology goals and directions of South Korea for 2045. The Plan outlines four visions of the future: a healthy and safe society, a rich and convenient society, a fair and reliable society, and being a nation that contributes to mankind. The Plan serves as the basis for a series of technological developments, including new environmental protection technologies, precision medicine, AI application, next-generation automobile technologies, blockchain, quantum computing, next-generation network communications, aerospace technologies, deep sea technologies, and innovative applications of fundamental science.

In face of the COVID-19 pandemic, which severely impacted the economic and social structures of South Korea, the country introduced the "Korean New Deal: National Strategy for a Great Transformation" in July 2020 as a strategy focused on promoting the "Digital New Deal," "Green New Deal," and "Stronger Safety Net." The Digital New Deal aims to promote the economic development and industrial transformation of South Korea by using the concept of digital innovation, which is focused on data, networks, and AI to create new digital products and services. Affected by the notion of combating COVID-19, South Korea rigorously develops "untact" industries, digital education infrastructure, and the digitalization of social overhead capital. The Green New Deal is based on the concept of environmental and ecological sustainability, and aims to prompt the South Korean economy and society to actualize a low-carbon and eco-friendly production model while also fostering green industries. The focus areas of this deal include green transitioning of infrastructures, low-carbon and decentralized energy supply systems, and innovation in the green industry. The Stronger Safety Net deal emphasizes the inclusion of cross-disciplinary talents, attempts to build a stronger and tighter employment and social safety net, and supports the fostering and job training of individuals required for the development of a digital and green economy. The Korean New Deal sets the groundwork for South Korea to adapt to the aforementioned structural changes and to have steadyfast development in the post-COVID-19 era.

2.1.5. Japan

In a 2019 expert meeting, the Japanese government decided to include the "Quantum Technology Innovation Strategy" as a priority area for research and development alongside AI and biotechnology, among other national strategic technologies. Japan aims for industries, government, and academia to collaborate to comprehensively promote the development of quantum technology, setting the year 2020 as Japan's "the First Year of Quantum Technology."

In response to the revolution of next-generation communication technology brought about by digital technology trends, the Ministry of Internal Affairs and Communications hosted an expert meeting on April 7, 2020 and released the "6G Comprehensive Strategy" for 2025 and strategic goals for key technologies to actively deploy next-generation communication technology.

Japanese government concluded amendments to the Science, Technology, and Innovation Basic Plan, which includes a 30 trillion yen (approximately NT$8 trillion) investment in research and development over the next 5 years, at the Integrated Innovation Strategy meeting held on January 19, 2021. The government is also determined to promoting basic research on innovation in science and technology and research relating to low-carbon technologies.

Concerning environmental sustainability, on October 26, 2020, the Prime Minister of Japan, Mr. Yoshihide Suga, established the goal of achieving net zero carbon emissions in Japan by 2050. The Japanese government also indicated that it will boost investments in the development of the next generation of advanced batteries for electric vehicles, with the aim of increasing the use of electric vehicles and reducing greenhouse gas emissions.

2.1.6. Singapore

Digital technology trends profoundly influence the way people live and engage in economic activities. Singapore's government introduced the "Smart Nation 2025" plan in 2014, which aims to develop cloud and IoT technologies, virtual/augmented reality applications, digital education and healthcare systems, AI applications, automation, and big data technologies. The plan also emphasizes digital finance as the focus of deeper development. In 2019, Singapore committed S$9.8 billion to launch the "Research Innovation Enterprise 2020 Plan," with the goal of deploying four technology domains: advanced manufacturing and engineering, health and biomedical sciences, urban solutions and sustainability, and services and digital economy. In February 2020, Singapore made plans to focus the development of its smart economy on biomedical technologies, ICT, smart scientific research, and new energy, to facilitate the development of smart technology in the post-COVID-19 era. The goal was to anchor its position as the Global-Asia node of technology, innovation, and enterprise. In May, Singapore allocated more than S$500 million from the S$33b Fortitude Budget, the 4th package of COVID-19 relief measures, to support the digital transformation of businesses. Specifically, eligible businesses including food service providers, hawker centers, and retailers that were impacted by the social distancing measure, can receive a subsidy if they adopt e-invoicing as well as e-commerce solutions.

2.1.7. Israel

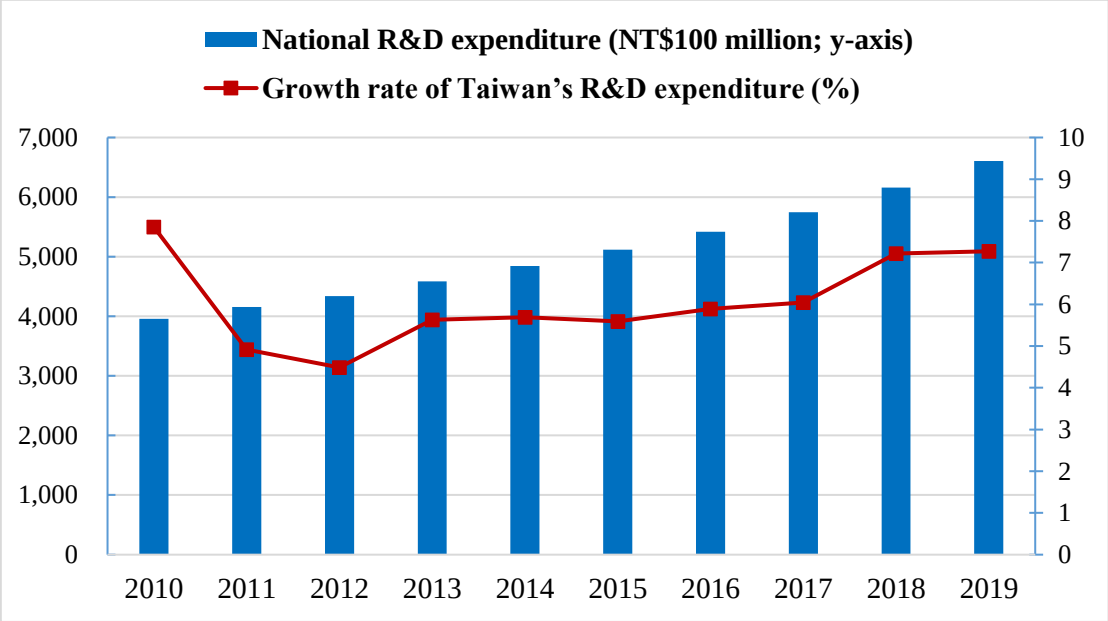
Israel unveiled its national AI plan in November 2019. According to the plan, the government will invest US$289 million to US$580 million a year to develop AI technology applications over a 5-year period. The total investment is estimated to be US$2.893 billion. In the same year, the Israeli government launched a national initiative to promote the development of quantum computing technology. It will invest US$360 million in a 5-year period. The national plan will focus on basic research on quantum computing, discuss the possibility of future development, and then slowly set the national quantum technology development goals that will make Israel a pioneer in global quantum computing research.

2.2. Current Science and Technology Development Status and Results

2.2.1. Current Science and Technology Development Status

2.2.1.1. The Economic Aspect of Research and Development

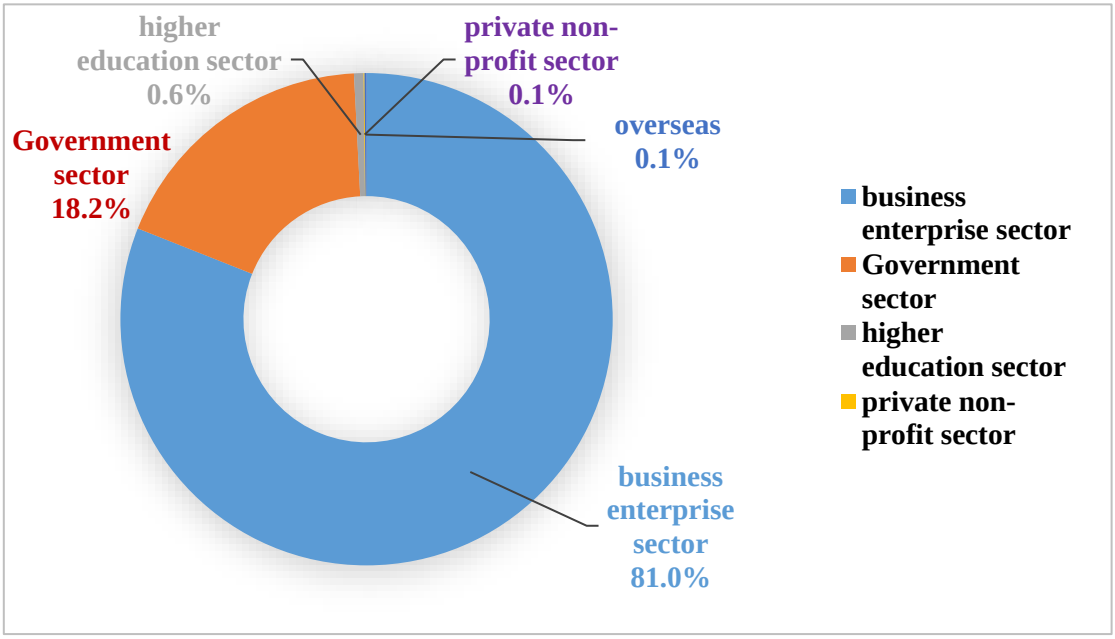
An overview of Taiwan's R&D expenditure over the past decade (Figure 1) shows that the public and private sectors in Taiwan have been extremely active in terms of innovation and R&D activities. Taiwan's R&D expenditure throughout 2010 amounted to NT$395.9 billion, which rose to NT$660.8 billion in 2019, growing annually at an average of 6.1%. The magnitude of growth over a 10-year period reached 66.9%, indicating that both public and private sectors in Taiwan are paying increased attention to R&D investment to secure the competitiveness of industries in Taiwan.



Data source: Indicators of Science and Technology, 2020, organized by the Science & Technology Policy Research and Information Center (STPI).

Figure 1. R&D expenditure and growth rate trends

The business enterprise sector is the main source of funding for R&D activities. This phenomenon is consistent with that of other developed countries around the world and indicates that the R&D capability of private sectors in Taiwan is improving. In 2019, the business enterprise and government sectors accounted for 81% and 18.2% of national R&D expenditure, respectively (Figure 2).



Data source: Indicators of Science and Technology, 2020, organized by the STPI.

Figure 2. Source of R&D expenditure

The distribution of Taiwan's R&D expenditure by types of R&D shows that R&D expenditure was primarily on "technological development." In 2019, expenditure on technological development, applied research, and basic research amounted to NT$464.7 billion (70.3%), NT$150 billion (22.7%), and NT$46.1 billion (7.0%), respectively. Although Taiwan's expenditure on different types of R&D projects has increased in recent years, the significant increase in expenditure on technological development caused a reduction in the percentage of expenditure on basic research and applied research (Table 1).

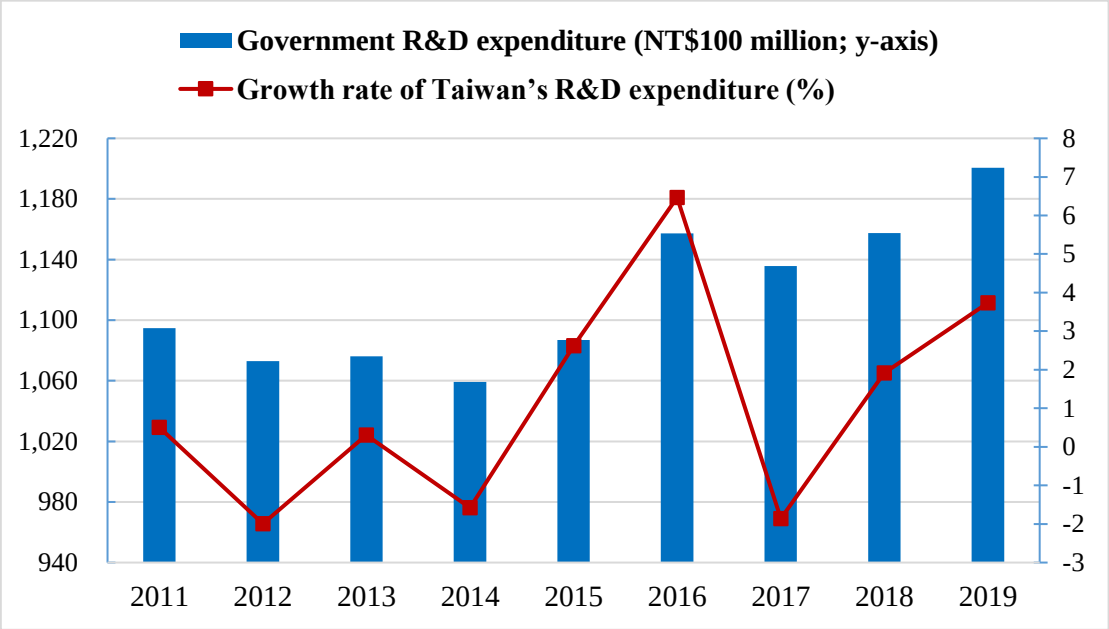
Table 1. R&D expenditure by type of R&D

Unit: NT$100 million

Year	Basic Research		Applied Research		Technological Development		Total	
	Amount	%	Amount	%	Amount	%	Amount	%
2015	472	9.2%	1,181	23.1%	3,463	67.7%	5,116	100.0%
2016	468	8.6%	1,242	22.9%	3,707	68.4%	5,418	100.0%
2017	466	8.1%	1,309	22.8%	3,970	69.1%	5,745	100.0%
2018	449	7.3%	1,414	23.0%	4,296	69.7%	6,160	100.0%
2019	461	7.0%	1,500	22.7%	4,647	70.3%	6,608	100.0%

Data source: Indicators of Science and Technology, 2020, organized by the STPI.

In recent years, the government has injected more resources into national defense and aviation R&D, leading to a steady increase in the R&D expenditure of the government sector, which exhibited a positive growth for 3 consecutive years from 2017 to 2019 (Figure 3). In 2019, the R&D expenditure of the government sector totaled NT$120.1 billion, up 3.7% compared to the previous year.



Data source: Indicators of Science and Technology, 2020, organized by the STPI.

Note: Government R&D expenditure refers to national R&D expenditure funded by the government sector.

Figure 3. Government R&D expenditure and growth rate trends

The central government allocated total budgets of NT$108.3 billion, NT$121.8 billion, and NT$119.9 billion for the development of science and technology (S&T) in 2017, 2018, and 2019, respectively (Table 2).

Table 2. The S&T budgets of government agencies for 2017–2019

Unit: NT$1000

Agency	2017 Budget	2018 Budget	2019 Budget
Ministry of Science and Technology	45,679,775	45,821,050	47,698,593
Ministry of Economic Affairs	35,069,573	36,317,364	35,946,721
Academia Sinica	11,460,763	11,674,471	11,390,397
Ministry of Education	1,905,970	4,750,994	4,861,839
Ministry of Health and Welfare	5,268,296	4,998,637	4,811,853
Council of Agriculture	4,683,264	4,425,968	4,486,933
Ministry of Culture	1,202,469	1,884,372	2,196,543
Ministry of Transportation and Communications	1,229,303	1,292,497	1,749,431
Ministry of the Interior	764,988	2,214,392	1,544,354
National Development Council	519,387	996,899	922,728
Ministry of Finance	282,695	845,178	653,736

Agency	2017 Budget	2018 Budget	2019 Budget
National Communications Commission	321,762	705,035	630,032
Atomic Energy Commission	796,848	740,983	601,143
Department of Cybersecurity	60,000	378,423	515,875
Environmental Protection Administration	185,573	393,268	481,864
Ministry of Justice	204,085	289,210	315,462
Ministry of Labor	238,491	223,331	208,598
Council of Indigenous Peoples	190,870	192,000	205,680
Ministry of National Defense	157,000	176,100	158,900
Ocean Affairs Council	-	-	129,820
National Palace Museum	52,500	121,538	108,070
Directorate-General of Personnel Administration	79,979	56,232	57,970
Financial Supervisory Commission	-	15,270	48,939
Academia Historia	5,000	45,850	40,296
Board of Science and Technology	38,981	40,293	39,793
Department of Information Management	18,000	31,400	38,866
Veterans Affairs Council	-	-	25,000
Directorate-General of Budget, Accounting and Statistics	24,961	15,622	15,072
Transportation Safety Board	-	-	8,241
National Audit Office	-	-	3,053
Ministry of Foreign Affairs	-	-	1,900
Aviation Safety Council	9,131	8,479	-
Public Construction Commission	5,979	5,126	-
Civil Service Protection and Training Commission	2,600	2,600	-
Control Yuan	5,200	-	-
Hakka Affairs Council	58,000	-	-
Total	110,521,442	118,662,582	119,897,702

Data source: Annual performance evaluation and review of government S&T development programs, organized by the STPI.

Note:

1. S&T development budgets of each government agency are based on the legal budgets for S&T and forward-looking infrastructures.
2. The legal budget of the Ministry of Economic Affairs included a petroleum and energy fund, which was NT$3,816,400,000 NT$4,887,000,000, and NT$4,857,000,000 in 2017, 2018, and 2019, respectively.
3. The legal budget of the Ministry of Science and Technology included the cross-agency S&T development funding program, as well as the national S&T development fund to support the balance. In 2017, 2018, and 2019, the cross-agency S&T fund was NT$3,954,841,000, NT$3,055,596,000, and

NT$2,084,005,000, respectively, and the national S&T development fund to support the balance was NT$1,649,000,000, NT$3,149,000,000, and NT$2,220,000,000, respectively.

4. The agencies were ranked according to their legal budget for 2019.

Taiwan's R&D expenditure as a percentage of gross domestic product (GDP) has remained consistently higher than the average expenditure of member states of the Organization for Economic Co-operation and Development (OECD). In 2018, the R&D intensity of Taiwan was 3.35%, which was lower than that of Israel (4.94%) and South Korea (4.53%) but higher than that of mainland China (2.14%), Germany (3.13%), Japan (3.28%), Sweden (3.32%), and the US (2.83%).

Table 3 shows that the R&D expenditure of Germany and the United States as a percentage of their GDP was not particularly significant; however, the S&T results of both countries have received worldwide recognition, which indicates that the amount of R&D expenditure is only one of the factors influencing a country's R&D performance. The efficiency with which R&D funds are used and the designs of management and evaluation mechanisms are equally important.

Table 3. Comparison of the R&D expenditure of various countries as a percentage of GDP

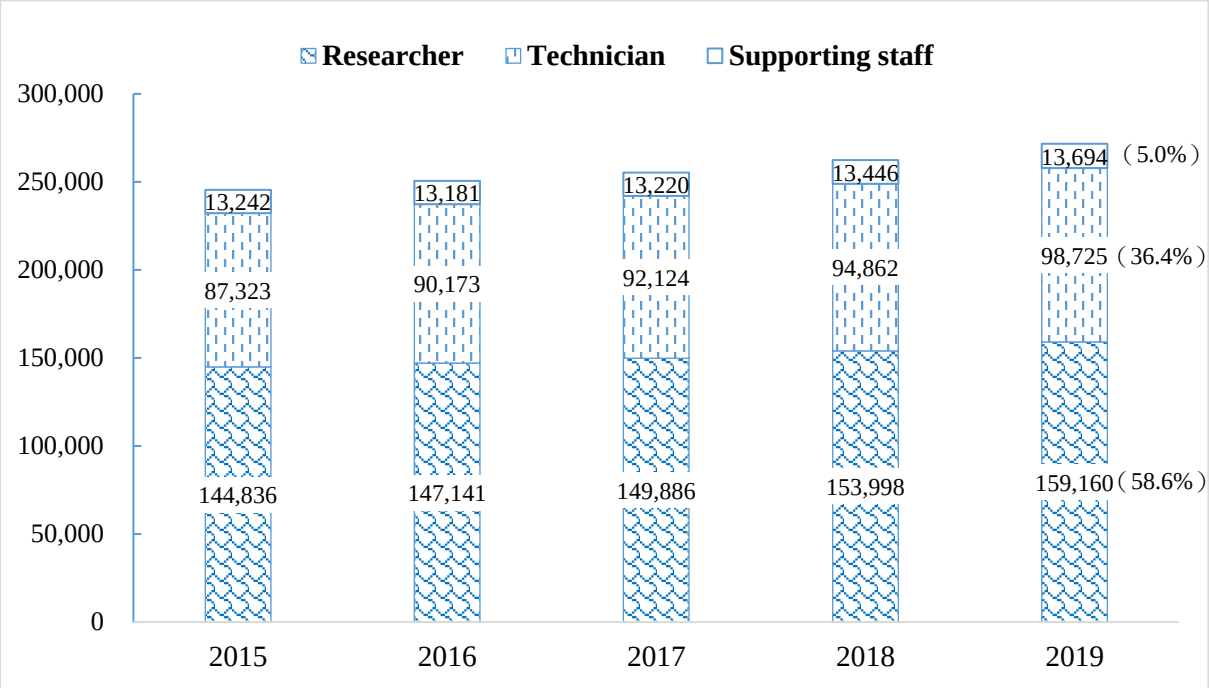
Unit: %

Year	Taiwan	Mainland China	Germany	Israel	Japan	South Korea	Sweden	The United States	Average of OECD Countries
2012	**2.96**	1.91	2.88	4.16	3.21	3.85	3.23	2.68	2.28
2013	**3.00**	2.00	2.84	4.10	3.31	3.95	3.26	2.71	2.30
2014	**2.98**	2.02	2.88	4.17	3.40	4.08	3.10	2.72	2.32
2015	**3.00**	2.06	2.93	4.27	3.28	3.98	3.22	2.72	2.31
2016	**3.09**	2.10	2.94	4.51	3.16	3.99	3.25	2.76	2.30
2017	**3.19**	2.12	3.07	4.82	3.21	4.29	3.36	2.81	2.34
2018	**3.35**	2.14	3.13	4.94	3.28	4.53	3.32	2.83	2.38

Data source: Organized by the STPI. Data for Taiwan were sourced from the Indicators of Science and Technology, 2020, and data for other countries were obtained from Main Science and Technology Indicators (2020/01), OECD.

2.2.1.2. R&D Workforce

In 2019, the R&D workforce in Taiwan comprised approximately 271,579 individuals, an increase of 3.5% compared to the previous year. The annual average growth rate between 2015 and 2019 was 2.5%. The R&D workforce in Taiwan was composed mainly of researchers, followed by technicians. In 2019, there were 159,160 researchers (58.6%), 98,725 technicians (36.4%), and 13,964 supporting staff (5.0%) (Figure 4).

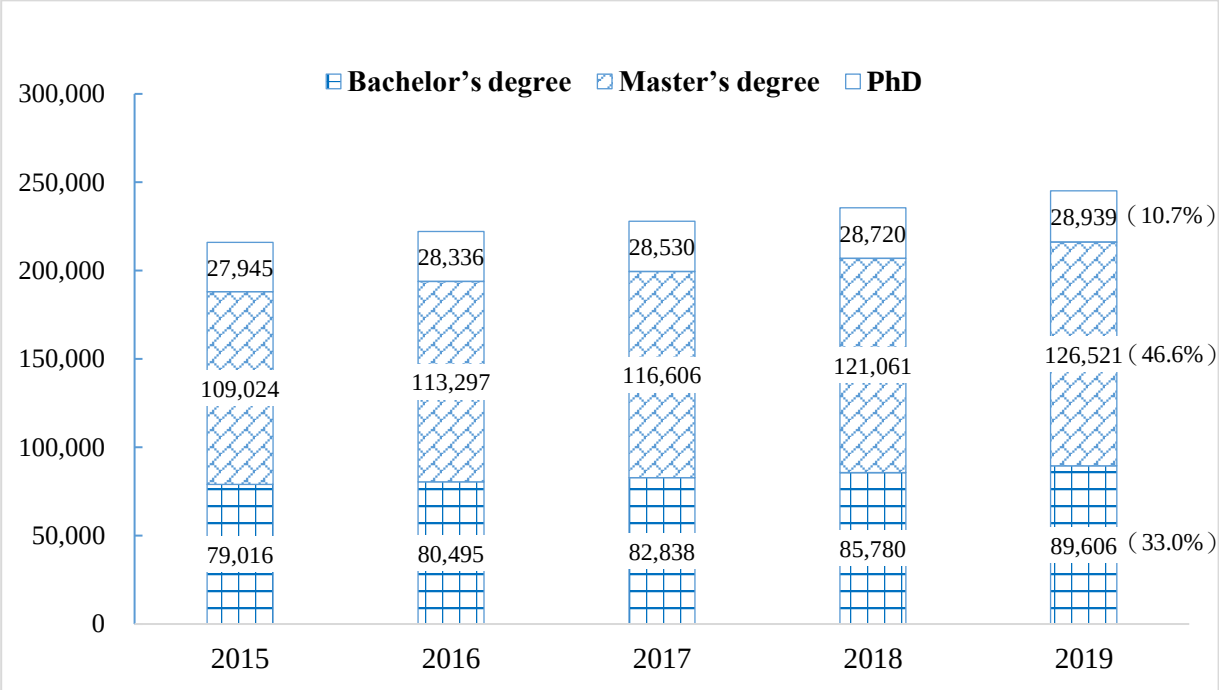


Data source: Indicators of Science and Technology, 2020, organized by the STPI.

Note: Unit is full-time equivalents (FTE; person-years).

Figure 4. Index of Taiwan's R&D workforce

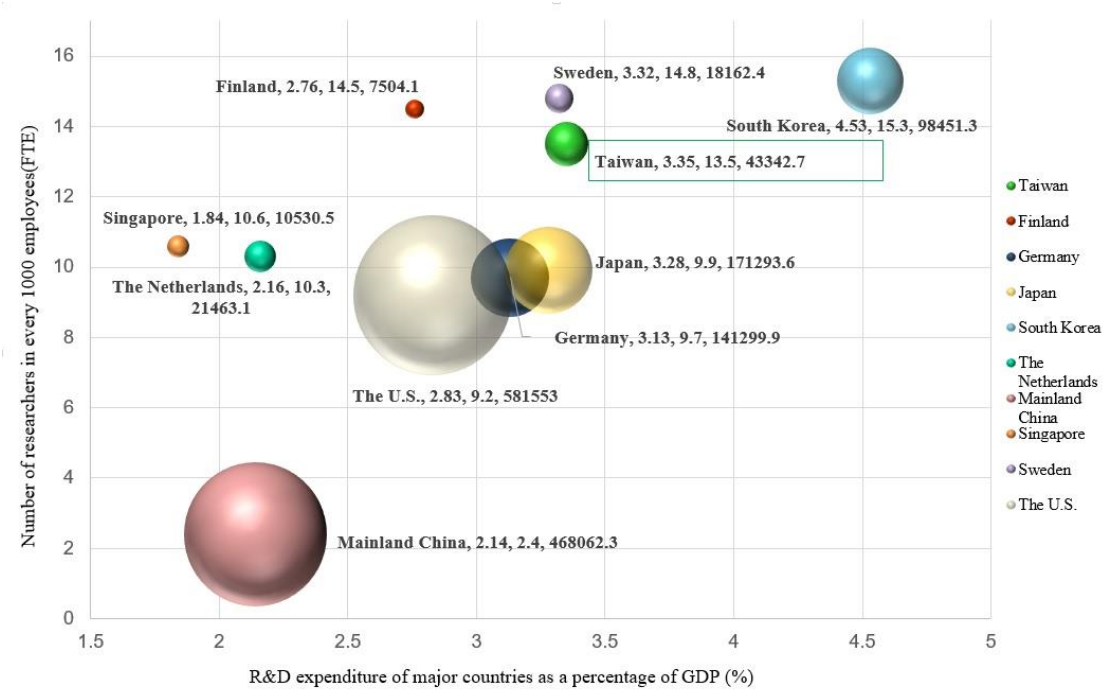
In terms of academic qualifications, most of the R&D personnel in Taiwan have a master's and PhD degree. In 2019, 46.6% of R&D personnel had a master's degree, an increase of more than 17,000 person-years and 2.2 percentage points compared to 2015. In addition, there were 28,939 R&D personnel with a PhD degree in 2019, accounting for 10.7% of the total R&D personnel, which represented an increase of 994 person-years and a decrease of 0.7 percentage points compared to 2015. These results show that Taiwan's national innovation system is characterized by high-caliber R&D professionals and more than 57% of these professionals are holders of a postgraduate degree. Compared to countries such as Singapore and the Netherlands, Taiwan has a sufficient pool of R&D professionals. This status quo is related to the expansion and popularization of higher education in Taiwan (Figures 5 and 6).



Data source: Indicators of Science and Technology, 2020, organized by the STPI.

Note: Unit is FTE (person-years).

Figure 5. Taiwan's R&D personnel by academic qualifications



Data source: Indicators of Science and Technology, 2020, organized by the STPI.

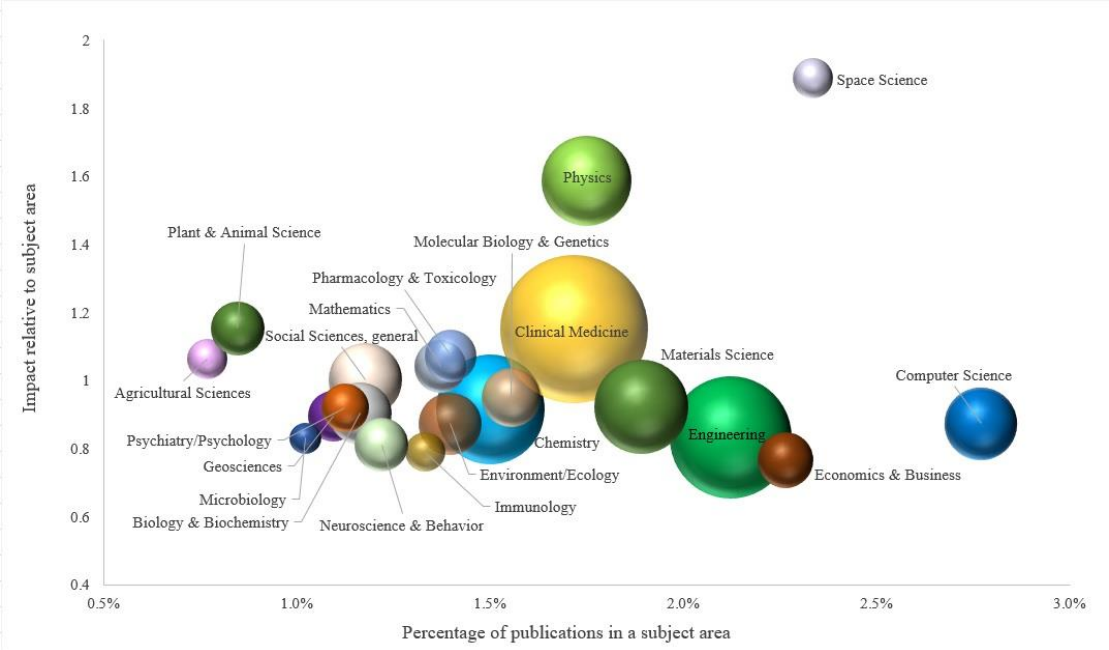
Note:

1. Bubble chart represents total R&D expenditure (adjusted for PPP; unit: US$1,000,000)
2. Data year: Except for the number of researchers in every 1000 employees, the data year was 2017 for the US, and 2018 for all others.

Figure 6. Comparison of the R&D expenditure and R&D workforce of different countries

2.2.1.3. R&D Activities

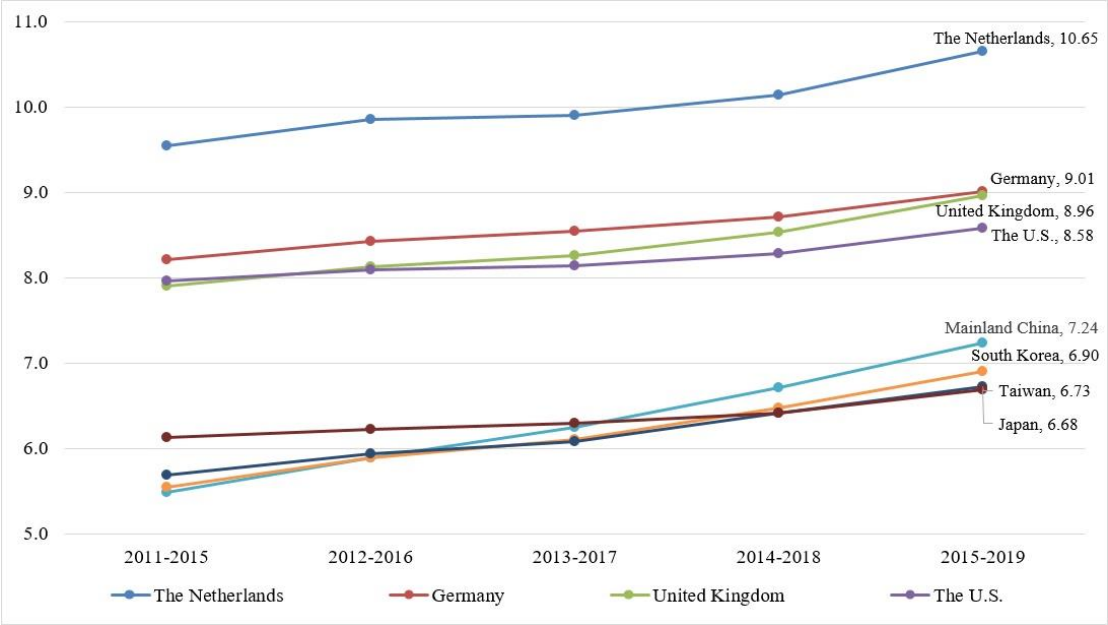
As mentioned earlier, Taiwan has been extremely active in terms of R&D and innovation activities. The results of related R&D activities are also reflected in the output of academic journal publications. The review of Taiwan's performance in journal publication is focused mostly on relative impact rather than on a discussion of the number of journal publications. In terms of individual domains, Taiwan's impact relative to the subject areas of space science, physics, plant and animal science, clinical medicine, and agricultural science was above the global average of 1 (Figure 7). A subsequent analysis of citations per publication in the Science Citation Index Expanded (SCIE) shows that Taiwan exhibited continuous improvement in citations per publication. Although Taiwan's performance falls behind that of the United Kingdom and the U.S., it is slowly catching up to South Korea and Japan (Figure 8).



Data source: InCites, Clarivate Analytics (2021/01), organized by the STPI.

Note: The bubble chart shows the total number of publications in each subject area, the x-axis represents the percentage of publications in a subject area relative to the world, and the y-axis represents the citations of each of Taiwan's publications relative to the global average, with 1 indicating that they are comparable.

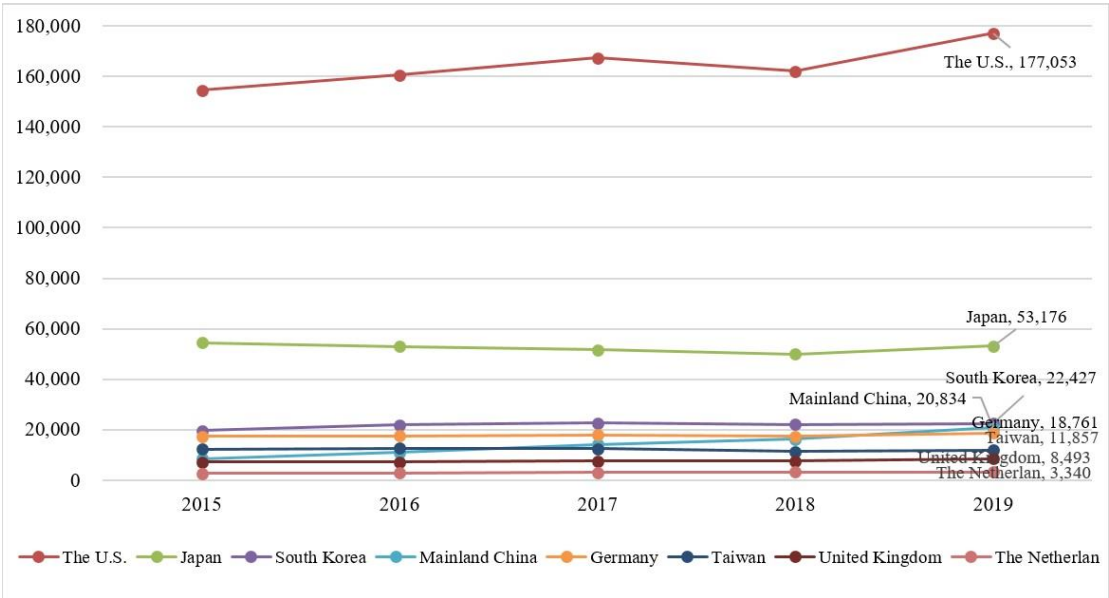
Figure 7. Journal publications in different subject areas between 2015 and 2019



Data source: Indicators of Science and Technology, 2020, organized by the STPI.

Figure 8. Citations of each publication in SCIE

Regarding patent performance, Taiwan ranked 6th globally in terms of total patents in the United States Patent and Trademark Office (USPTO) in 2019. Taiwan has consistently maintained this ranking in recent years (Figure 9). Although the number of patents can be used to measure the output of innovation and R&D activities, this measure cannot reflect the difference in quality and value of the patents held by various countries.



Data source: Indicators of Science and Technology, 2020, organized by the STPI.

Figure 9. Number of utility patents in the USPTO held by Taiwan and other countries

In the WEF Global Competitiveness Report 2019, Taiwan ranked 12th worldwide among 141 countries, moving up one rank compared to the previous year. Taiwan ranked 4th in the Asia Pacific, behind Singapore (1st), Hong Kong (3rd), and Japan (6th), but ahead of South Korea (13th), Malaysia (27th), and China (28th) (Table 4).

With respect to the innovation ecosystem, the National Development Council indicated that Taiwan ranked 4th in the category of innovation capability in 2019 primarily because the country performed exceptionally well in terms of patent applications, the state of cluster development, R&D expenditure as a percentage of GDP, and international co-inventions. Taiwan ranked 20th in the category of business dynamism, increasing its rank compared to the previous year (Table 5).

According to the International Institute for Management Development (IMD) 2020 World Competitiveness Yearbook, Taiwan's overall competitiveness improved considerably from 16th in 2019 to 11th. Taiwan dropped to 17th for economic performance but moved up in the rankings for the other three indicators. Specifically, its ranking for government efficiency, business efficiency, and infrastructure improved three positions to 9th, two positions to 12th, and four positions to 15th, respectively (Table 6).

Table 4. WEF 2019 Global Competitiveness ranking

Country	2018	2019	Difference
Taiwan	13	12	+1
Singapore	2	1	+1
Hong Kong	7	3	+4
Japan	5	6	-1
South Korea	15	13	+2
Malaysia	25	27	-2
Mainland China	28	28	0

Data source: WEF, The Global Competitiveness Report 2019, organized by the STPI.

Note:

1. The WEF began adopting the Global Competitiveness Index 4.0 (GCI 4.0) in 2018; therefore, rankings cannot be compared with those of previous years.
2. The WEF did not release a Global Competitiveness Report for 2020 because of COVID-19.

Table 5. Taiwan's rankings for the pillars and index components of the WEF 2019 Global Competitiveness report

Index	2019	2018
Global Competitiveness Index	12	13
1. Enabling Environment		
(1) Institutions	24	25
(2) Infrastructure	16	22
(3) ICT adoption	11	13
(4) Macroeconomic stability	1	1
2. Human Capital		
(1) Health	24	27

Index	2019	2018
(2) Skills	23	21
3. Market		
(1) Product market	14	18
(2) Labour market	15	16
(3) Financial system	6	7
(4) Market size	19	20
4. Innovation Ecosystem		
(1) Business dynamism	20	21
(2) Innovation capability	4	4

Data source: WEF, The Global Competitiveness Report 2019, organized by the STPI.

Note:

1. The WEF began adopting the GCI 4.0 in 2018. The GCI 4.0 comprises four index components and 12 pillars. The WEF report provided rankings for only the pillars, not the four index components.

Table 6. Taiwan's rankings according to the IMD World Competitiveness Yearbook

Factor	2016	2017	2018	2019	2020	Position Changes from 2019 to 2020
Overall Ranking	14	14	17	16	11	+5
Economic Performance	15	12	14	15	17	-2
Government Efficiency	9	10	12	12	9	+3
Business Efficiency	16	15	20	14	12	+2
Infrastructure	19	21	22	19	15	+4

Data source: IMD World Competitiveness Yearbook 2020, organized by the STPI.

2.2.2. Effectiveness of Policies Implemented in Taiwan in Recent Years

Policy planning and policy implementation of various government departments are closely related to each other. Strategies must be planned in the correct direction to produce fruitful outcomes from S&T development. The National Science and Technology Development Plan is crucial for the planning and implementation of key policies in Taiwan and is strongly associated with the S&T policies enforced by various government departments. The outcomes of R&D development are also representative of the effectiveness of a policy. In the following sections, the achievements of Taiwan's S&T policies are reviewed based on the four key goals of the National Science and Technology Development Plan (2017–2020): revive economic dynamics through innovation; develop robust smart living technologies and industries; foster and recruit talent with diverse career paths; and enhance the innovation ecosystem for research and development.

2.2.2.1. Revive economic dynamics through innovation

(1) Develop an innovative and digital economy

The government prioritized consumer experience and development opportunities, created a brand new cluster of the sensing technology industry, and successfully added value and promoted service industry with new technologies. Besides, the government created an ecosystem of cross-border ASEAN e-commerce, and actively promoted international mobile payment services to make payments more convenient for the general public.

(2) Link regional innovation to boost the momentum of industrial growth

The government forged stronger intergovernmental ties between central and local governments, consolidated the policy consensus of industries, academia, research institutes, and central and local governments, built an intergovernmental platform for regional industry collaboration, and introduced institutional R&D capacity to facilitate innovation in regional industries.

(3) Create a friendly environment for innovative startups

The government combined new forms of research centers linking industries, academia, and research communities and promoted the translation of R&D products of academic and research institutions into commercial products or business opportunities. The government helped startups to quickly acquire funds by adopting an expedited review approach. Thus far, 46,726 cases of credit guarantee loans in the amount of NT$86.9 billion have been approved through this approach.

Given the changes in the international economic and trade situation and accelerated restructuring of the global supply chain, Taiwan still needs to establish industrial development advantages, encourage the value-added transformation of general production models, promote a circular economy, accelerate energy transition, refine the entrepreneurial ecosystem that is driven by academic and research achievements, and achieve an unprecedented industrial revolution while ensuring circular sustainability.

2.2.2.2. Develop robust smart living technologies and industries

(1) Introduce robust health care laws and technologies

The government amended the “Regulations Governing the Application or Use of Specific Medical Techniques, Examinations, or Devices,” to include cell therapies that have low risk and high safety. The government integrated more than 96 million sets of food-safety-related data into the five principal components of the Food Cloud System, which is used to effectively keep track of high-risk vendors and product lists.

(2) Enhance disaster-prevention technologies to mitigate disaster impacts

The government promoted the development of a national soil monitoring system and disaster prevention database, strengthened the collection of data and intelligence during a disaster response period, and provided information on disaster prevention and rescue operations most appropriate to decision makers. To safeguard the life and

property of Taiwanese citizens, the government tested its Public Warning Cell Broadcast Service by sending out test messages to residents living in areas that are at high risk of landslides and river flooding. The success rate of this service was 100%.

(3) Develop green technologies to create a sustainable society

The government integrated electronic industries, built a circular system in which different industries co-exist symbiotically, developed innovative business models, and produced a circular economic benefit of NT$388 million per year.

Extreme climate and new technology are exerting an impact on the living environment. Using smart technology is still necessary to build a healthcare system, enhance the capability of the cybersecurity industry in Taiwan, improve disaster early warning systems and management, deploy next-generation network infrastructure, meet the future needs of society, and improve the well-being of all citizens.

2.2.2.3. Foster and recruit talent with diverse career paths

(1) Foster interdisciplinary talent for the digital economy

The government followed closely the needs of industries in Taiwan (i.e., the number and types of talent they need for the digital economy) and promoted training programs for interdisciplinary digital talent. These programs included the development and application of smart robots, big data analytics, digital manufacturing, digital services, and IoT technology.

(2) Reinforce training for industrial technological practitioners

To supply the pool of talented professionals required for industrial upgrading, the government organized training programs for practitioners that work in the following industries: smart machinery, biotechnology and pharmaceuticals, renewable energy, IoT, IC design, image displays, cybersecurity, and digital content and materials.

(3) Recruit and retain international top talent

The government amended the “Draft of Research Supplements for Faculty Members of Public Universities and Colleges” to reinforce the retention of high-caliber professionals such as professors; launched the “Perfect Taiwan’s Environment for Retaining Talent” program to create a living environment that is friendly to and convenient for foreign professionals.

In response to population structure changes, the government still needs to strengthen Taiwan’s competitiveness in international talent recruitment, deploy talent for industrial development, and create a learning environment that meets the needs of people of different generations to enrich Taiwan’s human capital of Taiwan.

2.2.2.4. Enhance the innovation ecosystem for research and development

(1) Improve S&T policy planning

The government followed closely the needs of industries in Taiwan (i.e., the number

and types of talent they need for the digital economy) and promoted training programs for interdisciplinary digital talent. These programs included the development and application of smart robots, big data analytics, digital manufacturing, digital services, and IoT technology.

(2) Adjust regulations and supporting measures for S&T development

The Fundamental Science and Technology Act has been amended to allow public research institutions to flexibly use income derived from R&D results, to outline mechanisms for information disclosure and management of conflicting interests, and to allow government-approved research institutions to receive income derived from technology transfer.

(3) Encourage participation and exchange in international research and development activities

The government participated in the development of a world-class research facility platform for high-energy experimental research and was invited to participate in the phase-2 high granularity calorimeter project. To build an environment that facilitates international collaboration and internationalization, the government engaged in research and development collaboration with New Southbound countries and constructed research centers to strengthen talent training and exchange.

Facing new trends in technology, Taiwan should deploy strategic technologies and increase the benefits of R&D achievements. These still require continuous improvements to decision-making systems for S&T policies, preemptive development of cutting-edge technologies and basic industrial technologies, accelerated industrialization of research and development results, completion of various risk warning mechanisms derived from new technologies, and fulfillment of Taiwan's needs for research and development capacity.

2.3. Current Challenges

In response to global technology trends arising from the advancement of science and technology, Taiwan continues to foster research and development talents in Taiwan, builds basic research capability, enhances the momentum for economic development, and ensures the well-being of citizens. It is also necessary to review the current development gap and keep abreast of S&T potential, to gather opinions from different experts in the hope to achieve values of innovation, inclusion, and sustainability. Furthermore, it is also necessary to put emphasis on the creation of value for enhancing competitiveness in talent cultivation and talent recruitment, to promote the development of visionary research, to create an innovative economic model and a secure society that embraces smart living, and to take progressive steps to deploy key strategies. Based on these objectives, Taiwan may encounter challenges in the following four dimensions:

2.3.1. Talent and Value Creation

The imbalanced population structure and fierce competition for international talents have widened the talent shortage gap in Taiwan. In addition, global integration and technological changes have led to dramatic changes in the way we work, and increased

individual needs for diverse skills. Challenges in this dimension are summarized below.

2.3.1.1. The environment for talent cultivation and talent recruitment

Countries around the world are competing fiercely for talented professionals. Taiwan lacks a friendly mechanism for talent flow between academia and industries. In addition, higher education institutions in Taiwan are not sufficiently internationalized and seldom participate in international research collaboration. Existing laws and regulations of Taiwan cannot support the talent requirements of a digital economy era, and social innovation and development is lacking a foundation of cultural and technological literacy.

2.3.1.2. The cultivation of industrial talent

Facing rapid change in industries, talents need to improve their workplace skills constantly. Under the heavy use of digital technologies, and semiconductors, and the increasing demand for medical technology, it is urgent to have cross disciplinary talents to for talents shortage. In response to the innovation and transformation of industries and digital technology trends, the academic community must be given additional reinforcement to increase its capacity for industry–academia collaboration and talent cultivation.

2.3.1.3. The diversification of lifelong learning

Independent and lifelong learning is important because technologies are changing how people work and the skills they need to do their job. However, the learning needs of people cannot be easily met because the complete progress and trajectory of physical learning and digital learning cannot be recorded.

2.3.2. Scientific Research and foresight

Digital technologies, AI, regenerative medicine, and other innovative technologies have transformed our way of life. Global economic and trade changes and the development of new technologies have compelled industries to address these changes. Challenges in this dimension are summarized below.

2.3.2.1. Strategic deployment of technological resources

Systems for supporting decisions relating to S&T policies are not sufficiently agile or effective. The review of S&T development plans should be based on comprehensive perspectives and more valid evidence. S&T plans should strengthen systematic management and evaluation systems and establish mechanisms for tracking and assessing mid- to long-term benefits. In addition, Taiwan is lagging behind competitor countries and international average because it lacks sufficient funding for basic scientific research.

2.3.2.2. Basic research capacity

In the face of rapid technological development and changes, it is necessary to deploy researches on strategic areas and cutting-edge technologies. In addition, to develop excellent research to increase international visibility is required as well.. The diversifying needs of society necessitate interdisciplinary collaboration; however, interdisciplinary research collaboration in Taiwan must be strengthened and relevant talent must be cultivated.

2.3.2.3. Industry–academia–research collaboration links

There are different policy approaches for industry–academia–research collaboration, but a mechanism to integrate and communicate these approaches is lacking. An innovative industry–academia–research linking model should be established, and the roles of institutions in such a collaboration should be strengthened. The opportunity for growth in the domestic market is limited; therefore, technology startups should enhance international connection.

2.3.2.4. Assessment of technology risks and data management

Increased use of technologies in everyday activities has exposed infrastructures and the systems they operate to more risks. The causes and consequences of these risks must be assessed, and corresponding strategies to manage these risks must be developed. Technological innovation and development are strictly regulated by existing laws, which greatly limits the degree of freedom with which data can be used and shared. Therefore, open data applications and mechanisms require further improvement.

2.3.3. Economy and Innovation

Mature technologies are speeding up the innovation and transformation of industries. However, extreme weather and energy shortages are adversely affecting environmental sustainability. We must therefore develop distributed energy systems and renewable energy. Cross-disciplinary innovation accelerates scientific research and the creates of opportunities for industries. Challenges in this dimension are summarized below.

2.3.3.1. Digitalization of industries and the digital economy

Industries in Taiwan are not developing innovative models fast enough to keep pace with the rapid development of cutting-edge technologies. Industries must strengthen the integrated application of ICT software and hardware. Increasing Cybersecurity threats, insufficient industrial input and resources, incomprehensive innovative digital support systems of key industries, and the capability to apply financial, agricultural, architectural, cultural, and transportation technologies are all challenges that need to be addressed.

2.3.3.2. Circular economy and environmental sustainability

The promotion of industrial circular applications must be accelerated to facilitate both economic growth and environmental sustainability. We must also refine waste

conversion technologies, improve the entire green supply chain (from design to manufacturing and consumers), initiate the innovation, research, and development of recycling technologies and key materials, turn the circular economy into an industry while applying a more circular approach to industrial processes, and support the core strategic industries of Taiwan.

2.3.3.3. Renewable energy

Issues relating to the use of renewable energy (e.g., laws and supporting measures, the capability to test and verify key components, and safety concerns for massive deployment) must be addressed by contemplating how to expand domestic demand, increase the scheduling flexibility and resilience of electric grid systems, and ensure that renewable energy is developed without compromising efforts to conserve the environment and ecology or disturbing the balance of the natural habitats of wild animals.

2.3.3.4. Startup economy

Although entrepreneurship within academic communities has been fortified, there is still room for improvement. The government has introduced angel funds for business startups, but private investments remain insufficient. Opportunity for growth in the domestic market is limited. Stronger ties with the international market must be established to facilitate the growth of business startups.

2.3.4. Secure society and smart living

Aging population and fierceing escalation of disaster risks experts the need to be self-sufficient and to safeguard the health and safety of the people. The rapid penetration of new technologies is changing the way people live. Challenges in this dimension are summarized below.

2.3.4.1. Healthcare

A comprehensive epidemic prevention strategy is essential to achieve instant crisis response. Ineffective treatments and unnecessary medical expenses should be reduced to improve healthcare efficiency. Elderly people and people living in rural areas can not access to healthcare resources easily. Cross-ministerial food safety management information integration capabilities and management systems must be strengthened to implement farm-to-table management. Enhancing biomedical research and optimizing project application procedures are also required.

2.3.4.2. ICT security

The fast-growing digital economy is constantly introducing new forms of cybersecurity threats. As a result, the government and industries will eventually need more R&D talent and measures for safeguarding national cybersecurity, and a deeper and extensive general cybersecurity joint defense mechanism is required. Taiwan cannot otherwise

advance toward the goal of becoming a smart country.

2.3.4.3. Secure homeland

Climate change will generate a wide range of influences, and Taiwan is under constant threat of composite disasters. We must establish a comprehensive proactive response measure; reduce the hazards of chemical substances by engaging in continuous green chemistry innovation and adopting risk management practices and reduce the potential impact that existing energy facilities have on the environment to safeguard our homeland and keep it clean. The gathering of intelligence on environmental changes requires further improvement, and more intelligent approaches should be adopted to respond to these changes. Because society is advancing continuously, public security and the effectiveness of judicial systems must be improved and enhanced further with the aid of technology.

2.3.4.4. Smart living

Cities are overpopulated; age-friendly environments and quality of life in cities require further improvement. The network environment must also be improved because the rise of digital governance is forcing public services to be digitalized, thereby increasing people's need for advanced IoT applications.

2.4. Future Prospects

To meet the future needs of Taiwan, the government must create a human-centered smart society driven by digital technologies innovation build a diverse environment that is inclusive of people from different cultural backgrounds, ethnic groups, and generations; promote a sustainable homeland that is renewable, pollution-free, smart, and resilient, and endeavor to realize the vision for Taiwan in 2030—Innovation, Inclusion, and Sustainability. This section details the directions along which the four dimensions of talent and value creation, scientific research and foresight, economy and innovation, and secure society and smart living will be promoted in the future.

Regarding talent and value creation, we will strengthen interdisciplinary collaboration and increase the flexibility of talent cultivation to create an environment that is effective for talent cultivation and talent recruitment. We will expand the global reach of higher education institutions to attract foreign students to study in Taiwan; improve regulatory measures to enhance Taiwan's competitiveness in international talent recruitment; and deepen cultural and technological literacy to encourage social innovation and development. To strengthen the cultivation of industrial talent, we will meet the competency requirements of industries by training professionals to develop vocational and specialized skills; support industrial development by cultivating national interdisciplinary talents; and encourage industry–academia collaboration to cultivate strategic areas industrial talents. With the goal of promoting diverse lifelong learning, we will develop smart education, encourage autonomous and adaptive learning, and strengthen cross-agency collaboration to promote multiple lifelong learning of all ages.

Regarding scientific research and foresight, we will improve the management of S&T plans and develop agile and effective decision support systems for S&T policies to make use of resources in strategic areas. The allocation of resources will be optimized

to secure basic research projects and deploy strategic scientific research projects. To strengthen basic research capacity, we will observe future development trends, focus on strategic key research areas, and reinforce interdisciplinary basic research to start a new era of scientific research. To forge deeper industry–academia–research ties, we will coordinate cross-agency resources to build a new base for advanced R&D and innovation and to encourage needs-oriented R&D collaboration. We will fine-tune our technology risk assessment and data management practices to mitigate social risks and impacts, and perfect our data management mechanisms to create an innovation-friendly environment.

Regarding economy and innovation, we will expand the scope of application of smart technologies to develop smarter industries and revive the digital economy; nurture industries to transform innovatively; strengthen cybersecurity measures by developing multidisciplinary solutions to global cybersecurity threats; establish digital support systems and verification sites; increase the effectiveness of industry clusters; and integrate state-of-the-art digital technologies to develop a diverse range of cross-disciplinary smart applications. To build a circular economy for environmental sustainability, we will strengthen information analysis and innovative business models; facilitate the sustainable development of industries; improve resource recycling technologies; increase the benefits of reusing resources; and promote the establishment of circular technology and key material innovation R&D centers to support the core strategic industries of Taiwan. We will develop high-efficiency, smarter key technologies to increase the sources of renewable resources; increase our potential for renewable energy development while lowering operational costs; construct a demonstration site integrated with innovative models; connect resources to promote the clustering of industries; transform Taiwan into an Asia-Pacific node of green energy; and increase the resilience of electric grid systems by adopting smart grid systems to ensure the stability of electrical power systems that use power grids and a large amount of renewable energy. We will encourage the entrepreneurial commercialization of scientific research results to revive the startup economy; incubate potential tech startups; strengthen cross-agency support for business startups; improve the entrepreneurial investment environment; and integrate industrial and international resources to help startup companies to grow.

Regarding secure society and smart living, we will formulate a comprehensive policy to safeguard the health of our people in the event of public health crisis; develop precision health and medical care to improve public well-being; use technologies to promote smart health and telecare; and introduce novel and smart technologies to improve food hygiene and safety. We will build a comprehensive cybersecurity defense systems to improve cybersecurity and ensure that data are used securely. We will strengthen the application of adaptation technologies to create a secure homeland; reinforce early warning responses to disasters; improve the management of chemical substances to build a green chemistry environment; develop nuclear decommissioning technologies to become a green sustainable society; develop smart environmental technologies to achieve urban resilience; and use technologies to enforce laws, thereby enhancing the effectiveness of the judicial system. To support smart living, we will make people’s living spaces smarter, build an age-friendly environment, introduce smart public services to enhance government efficiency, and set up a next-generation network environment to lay the foundation for Taiwan’s smart living infrastructure.

Chapter 3 Goals and Vision

Focusing on the future needs of Taiwan, we adopted multiple channels, virtual and physical, to collect the opinions of various sectors, evaluated the actions that should be taken, and consulted different sectors' representatives, and consoldidatd comments to reach a consensus on S&T development. Ministries and agencies across the government worked together to establish key strategies and measures, which encompass the following four goals and response actions.

Goal 1: Refine the Talent Cultivation Environment and Create Competitive Advantages for Talent Recruitment

Actions for achieving this goal include the following: Implement the internationalization of higher education and boost the flow of industry, academia, and research talents to increase the flexibility of talent cultivation schemes, in the hope to establish an environment in which talent is effectively recruited and cultivated to enrich the human capital of Taiwan. Support regional industrial development by cultivating talent with innovative, technological, and specialized skills to bolster Taiwan's competitiveness in talent recruitment. Meet the learning needs of different generations at every stage of their career and increase adults' participation in learning to help everyone keep pace with technology.

Goal 2: Improve the Research and Development Ecosystem and Allocate Resources for the Development of Pioneering Technology

Actions for achieving this goal include the following: Improve the S&T development plan governance mechanism, reinforce the decision support system for S&T policies, and enhance the effectiveness of R&D resource input. Consolidate the foundation of scientific research, develop advanced scientific and industrial basic research preemptively, address major social challenges through interdisciplinary and cross-agency collaborative research, and increase the value and social influence of basic research. Forge industry–academia–research collaboration, accelerate the application and industrialization of scientific research results, activate the innovation ecosystem in which innovation in local industries and society are encouraged to promote the digital transformation and upgrading of industries. Enhance the risk assessment mechanisms required when new technologies are applied, reduce technological risks, and build a friendly regulatory environment that facilitates S&T development, innovation, and application to foster stronger national scientific research capacity.

Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation

Actions for achieving this goal include the following: Establish the advantages of

Taiwan in industrial development, raise the awareness of every industry regarding the value of smart technologies to promote product value addition, transformation, and upgrading, and strengthen the cybersecurity of Taiwan to ensure the secure development of the digital economy. Continue to reduce waste at the source and recycle and reuse waste resources, develop a high-performing model for resource recycling and reuse, and turn waste into resources to achieve a win-win outcome for industrial development and the environment protection. Implement a comprehensive energy transition policy, strengthen the development of renewable energy, and create an energy transition environment that enables the balanced management of energy, environmental protection, and the economy in Taiwan. Promote commercialization of university-based research results, encourage the businesses to invest in startups, and to connect to the world in the hope to build the ecosystem of the campus and to revive the startup economy.

Goal 4: Enhance Smart Living Capacity and Realize a Secure Society

Actions for achieving this goal include the following: Use smart technologies to build a needs-oriented healthcare system that provides accessible and affordable public health and medical resources to improve the health and well-being of everyone in Taiwan. Strengthen the cybersecurity awareness of government agencies, businesses, and citizens in Taiwan and establish a world-trusted cybersecurity system and industry chain to transform Taiwan into a resilient and secure smart country. Apply new technologies and tools to improve early warning systems and disaster management, reduce the use of chemicals that are hazardous to the environment and health, and use technologies to improve the quality of the overall environment and strengthen public security. Establish a foundation for next-generation network infrastructures based on a human-centered concept, build an age-friendly environment, and adopt smart public service systems to create a resilient network society.

Achieving these goals can boost the development of talent, scientific research, industries, and society. Through early deployment, we can meet the four needs of Taiwan: the need for industrial talent, the need for scientific research capacity, the need for industrial transformation, and the need for a secure society, which not only meet the expectations of citizens but also conform to the UN sustainable development goals, thereby realizing the vision for Taiwan in 2030—Innovation, Inclusion, and Sustainability.

Chapter 4. Strategies and Important Measures

Goal 1: Refine the Talent Cultivation Environment and Create Advantages for Talent Recruitment

1.1. Create an environment that facilitates talent cultivation and recruitment

1.1.1. Strategy 1: Enhance the a flexible strategy for cultivating interdisciplinary talents

1.1.1.1. Encourage university–research institutes collaboration and loosen talent cultivation collaboration regulations

Research institutes can bridge industry and academia to translate academic research results into industrial applications. Research institutes conducts industry analysis and future deployment on key technologies, and a universities conduct frontier and academic researches. Such collaboration facilitates the integration of both parties and avoids broken chain issues. Faculty members intending to apply for patents are advised to cooperate with research institutes as early as possible to increase the applicability and excludability of patents. Research institutes can work with universities to conduct courses to cultivate high-caliber professionals. Research institutes and universities can co-host graduate programs to cultivate R&D talents with a doctorate degree or above, and conduct research and development as well.

1.1.1.2. Loosen restrictions on the employment and flow of industry–academia–research talents, increase system flexibility, adjust salary structure, and improve incentive programs for talent retention

(1) Introduce relevant projects to encourage universities to develop flexible strategies for talent recruitment and set an example for other universities

(2) Formulate flexible salary regulations and hire outstanding talents from industries, academia, and research institutes

I. Develop a sound salary structure for faculty members by short-term (3-year) pilot program first, with the support from Ministry of Education (MOE) and Ministry of Science and Technology (MOST) to allocate budgets for flexible salary schemes.

II. Assist universities to use funds from the Higher Education Sprout Project and implement a differentiated flexible salary structure based on the focus of development (as a guide for universities to input resources, the flexible salary structure adopted by each university should meet the minimal disbursement requirement stipulated by the MOE to ensure the effective adoption of the university's flexible salary).

III. Ensure that faculty members who are committed to industry–academia–research collaboration in key subject areas can receive flexible salary support at a certain rate, and have the MOE provide additional subsidies to support universities in increasing the range and quota of flexible salaries within the university.

1.1.1.3. Strengthen the interdisciplinary transition of high-ranking talents and enhance the employment of PhD talents

To address the number of PhD students decrease and the employment problems they face, we encourage PhD graduates to work in industries; step up efforts to encourage industries to provide job vacancies to PhD students and grant scholarships to cover their tuition. Through internship programs offered during their course of study, PhD students can help enterprises to solve their problems.

1.1.1.4. Promote mechanisms for talent cultivation and industry–academia collaboration in strategic areas

The government aim to legislate the "National Key Fields Industry-University Cooperation and Skilled Personnel Training Innovation Act"; guide national universities to establish research institutes that specialize in strategic areas of national interests; cultivate high-level science and technology professionals; grant research institutes the flexibility to conduct organizational, personnel, financial, equipment asset, talent development, and procurement operations so that industries, government agencies, and academic communities can participate in these operations together.

1.1.1.5. Cultivate female scientific researchers

(1) To encourage universities to create a gender-friendly interdisciplinary learning environment where female students are given more opportunities to study male-dominated courses, in 2021, the MOE added policy guidance to the Higher Education Sprout Project, encouraging universities to actively promote interdisciplinary courses. Under one of key policies, "train students to use and apply programming languages," the MOE reminds universities that they are advised to guide non-ICT students to take programming design courses. They should also gradually improve gender equality within these courses, create positive and gender-equal learning environments and opportunities, and provide sufficient learning resources and related counseling programs. The goal is to provide more support for universities to develop relevant strategies to increase the number of female students studying science and engineering.

(2) When planning the Phase-2 Higher Education Sprout Project (2023–2027), the MOE will assess the feasibility of including the goal "strengthen female

scientific researchers" as a key performance indicator of main research projects, for example, universities with lower female faculty members ratio need to hire STEM female faculty prior to other areas or to increase the number of female students studying science and engineering. To encourage female students to specialize in STEM, the comprehensive plan will include training mechanisms, assistance programs, and environmental aspects to facilitate the effective transition of female students or women into the field of science and technology, improve the "leaky pipeline" phenomenon, and create a female-friendly academic environment.

1.1.2. Strategy 2: Expand the global reach of higher education institutions

1.1.2.1. Transform higher education and improve scholarship and reward mechanisms for students

(1) Authorize universities to allocate student enrollment quotas in accordance with national policies, and reserve 30% PhD students quota and 20% of master students quota to authorize universities (or the President of the university) to allocate in accordance with major national policies (e.g., 5+2 industries, AI and IoT industries, semiconductors, cybersecurity, food safety, and Southeast Asia) and the development direction of the university.

(2) Increase scholarship budgets for international students to attract young foreigners to study or learn Mandarin in Taiwan.

1.1.2.2. Combine strengths and promote the internationalization of higher education

(1) Encourage double degree programs for STEM related areas to attract foreign students to study STEM programs in Taiwan

I. Encourage double degree programs for STEM related areas so that when international students graduate from Taiwanese universities with a double degree, they can apply for exemptions to the 2 year work experience and salary requirements through the foreign and overseas Chinese student scoring mechanism and work in Taiwan.

II. Attract foreign students to study STEM-related programs in Taiwan. For STEM-related programs, recruit students from New Southbound countries, Hong Kong, and Macau, overseas Chinese students, and foreign students to study in Taiwan; recruit international students to study industry-oriented master and PhD programs in STEM; and introduce more incentives to attract foreign students to study STEM-related programs in Taiwan.

(2) Encourage domestic universities to forge international ties, recruit international students and foster international talents through international collaboration, and indirectly enhance overall teaching and research quality.

(3) Help university departments/colleges with excellent international ratings on the Essential Science Indicators or Quacquarelli Symonds World University Rankings to increase their international talent cultivation capacity and visibility.

(4) Attract outstanding foreign graduate students and research personnel to study and conduct research in Taiwan; or, for foreign scholars who obtained a PhD degree in Taiwan but work for a teaching or research institution in their home country, provide a reward program that will entice them to visit Taiwan, conduct research in Taiwan, or teach in Taiwan.

(5) Focus on international exchange programs to connect to and attract world-class talent, and provide a stable source of funding through exchange programs to encourage students to study abroad, thereby increasing the global mobility of students.

1.1.2.3. Acquire international scientific research resources to strengthen international research exchange

(1) Actively participate in international advanced scientific research collaboration programs to foster stronger R&D capacity

I. Join world top-tier scientific research teams or participate in important multilateral research projects such as the EU's Horizon Europe initiative, develop cutting-edge technologies, increase the strength of Taiwan's R&D capacity, and strive to become a key member of international collaboration research communities.

II. Encourage universities and scientific research institutions to work with international partners implement cooperative projects, voluntarily organize multinational research projects, visits, and conferences, and accumulate international scientific research resources through bilateral or multilateral agreements.

III. Cooperate with international universities or research institutes to cultivate top R&D talents, expand international exchange and partnering communities, invite world-class experts to visit Taiwan, and encourage domestic PhD students, faculty members, and research personnel to increase their visibilities in the international academic community by participating in international collaboration programs (e.g., study abroad, attend international conferences, publish papers in international journals, or participate in research projects and teacher collaboration programs).

(2) Connect Asian scientific research networks and expand the spillover effect of Taiwan's strengths

In response to the rise of political and economic powers in Asian regions, we will take the advantage of the strengths of Taiwan and scientific research results; offer training programs that assist Southeast Asian countries and emerging Asian countries to cultivate talents with expertise in S&T development; maximize the spillover effect of Taiwan's scientific research capacity to forge stronger cooperative relationships between Taiwan and other Asian countries; and enhance the global influence of Taiwan's scientific research, which secures our competitiveness in scientific research and also enables us to attract regional talents, and continue to encourage multi-faceted collaboration and exchange to create a mutually beneficial

outcome.

1.1.3. Strategy 3: Improve supporting measures for talent recruitment

1.1.3.1. Promote amendments to the Act for the Recruitment and Employment of Foreign Professionals

To quickly and comprehensively loosen the regulations and restrictions for foreigners who engage in professional work or seek employment in Taiwan, the NDC enforced the Act for the Recruitment and Employment of Foreign Professionals (hereafter referred to as "the Act") to lower the visa, work, and residency requirements and optimize insurance, tax, and retirement benefits for foreign professionals. The Act was implemented on February 8, 2018 and has produced favorable results as of the end of 2020. Specifically, 1,945 Employment Gold Cards have been issued to foreign special professionals. Going forward, the NDC will coordinate with relevant ministerial departments to recommend and assist foreign professionals and special professionals to apply for an Employment Gold Card. NDC will promote the Act through different channels such as the Internet and experience exchange activities, and make plans to further loosen and adjust relevant regulations so that the purpose of the Act (to recruit international talent) can be effectively achieved.

(1) Recommend and assist applications for Employment Gold Card

Coordinate with relevant agencies to recommend and help foreign professionals and special professionals to apply for an Employment Gold Card, and provide consultation services to assist with the application procedure.

(2) Increase publicity

Increase the publicity of the Act by organizing seminars or experience exchange activities, distributing promotional materials, and maintaining a designated website and Facebook group: Gold Card Family in Taiwan.

(3) Increase efforts to loosen and adjust regulations

Continue to coordinate with agencies to further loosen and adjust relevant regulations, and collect opinions about the Act from experts in Taiwan and abroad, which can serve as the basis for regulatory amendments or policy planning.

To enhance the recruitment and employment of foreign professionals and enforce laws that make living and working in Taiwan easier for foreigners, the NDC is currently in the process of amending the Act to achieve a complete legal framework for talent recruitment in Taiwan. The amendments are focused on the following directions:

(4) Loosen work conditions

Loosen the conditions for foreign professionals to work in Taiwan, attract more top-tier international talents to Taiwan, and allow fresh graduates from the world's top 500 universities to seek a job in Taiwan without the current criterion of 2 years' work

experience; and allow not only English teachers but also foreign subject teachers at primary or high school to be employed in Taiwan in response to Taiwan's 2030 bilingual policy.

(5) Loosen permanent residence regulations

Shorten the residency requirement for foreign special professionals applying for permanent residency from 5 to 3 years; shorten the continuous residency requirement for foreign students who earn a master's or doctorate degree in Taiwan by 1 to 2 years.

(6) Optimize welfare and benefits

Loosen and optimize National Health Insurance requirements and extend tax breaks. The 6-month waiting period to qualify for National Health Insurance will be waived for foreign special professionals or foreign senior professionals who employ others or operate their own businesses, as well as for their dependents, and tax breaks for foreign special professionals will be extended from 3 to 5 years.

1.1.3.2. Reinforce measures for supporting foreign nationals to live and work in Taiwan

(1) Strengthen the "Contact Taiwan" service platform of the Ministry of Economic Affairs (MOEA), integrate related ministerial resources, provide foreigners with information (including information about dependents, visas, residency, and living conditions) and online services that allow them to make inquiries with real people, and establish one-stop service platform.

(2) Improve the online application platform for foreigners intending to work in Taiwan and simplify the application and review procedures for foreigners intending to live and work in Taiwan. The "Foreign Professionals Online Application Platform" established in 2018 accepts applications for Employment Gold Cards. We are planning to introduce the Employment PASS Card and Entrepreneur Visa in 2021.

(3) Encourage young overseas Chinese students living in Europe, the U.S., and other developed countries to come to Taiwan to participate in a short-term diverse study programs or internships, enhance interactions with industries, academia, and research institutes, and increase global publicity about Taiwan's strengths in talent cultivation.

1.1.4. Strategy 4: Deepen literacy in the humanities and technology

1.1.4.1. Create an interdisciplinary teaching environment and cultivate innovation talents for future society

(1) Develop interdisciplinary teaching models and flexible mechanisms for higher education institutions

The government will provide project funding and guide universities to develop interdisciplinary teaching models for grand challenges and establish regional

alliances or teaching resource centers. We will also encourage schools to develop innovative teaching practices and interdisciplinary community management mechanisms for teachers, transform existing curriculum structures to promote the knowledge output of teachers, and foster talent with interdisciplinary innovation skills.

(2) Promote deeper and more innovative general education

The government will strengthen the regional development and resource sharing in general education by designing and sharing high-quality curricula; improve the competency of teachers; design suitable general education curricula based on students' attributes such as needs, competency, interests, and subject areas; and facilitate cross-school study channels and credit transfers for more effective education.

(3) Cultivate talent in the humanities and social sciences, and talent with technological foresight

The government will fund higher education sectors to develop the environment and mechanisms necessary for fostering prospective talent with skills in the humanities, social sciences, and technology; cultivate interdisciplinary teachers with specializations in both research and teaching; research and develop frontier methods, materials, plans, and aids; promote international teaching exchanges; and train students in the humanities and social sciences with visions for future, and cultivate talents with the capabilities of knowledge innovation, knowledge integration, and knowledge application capabilities.

1.1.4.2. Enhance public science literacy and foster popular science professionals

(1) Organize popular science activities and promote a new way of thinking from the perspective of the humanities and technology

Through the Taiwan Science Exploration Fair, which is directed by the MOE using the resources of national museums, science bases, schools, local governments, and private sectors, the "Taiwan Science Festival" is held every year to foster interest in science, improve affinity for science, and enhance the well-being of the people. Competitions, science markets, science demonstrations, and a series of other popular science activities (e.g., scientific questions related to everyday life, data analysis and reasoning, results exploration, and presentation) are organized to foster scientific narrative capability and creativity and to enhance the scientific knowledge and research capabilities of citizens.

The MOST continues to promote a wide range of popular science activities, including educational material R&D, DIY, exhibitions, and lectures in the hope to create vivid and memorable science experiences for the public. While journeying through major events in the history of science and the culturally rich background and characters involved, the public are prompted to think about the past and present, and recognize the power of science and its profound influence on every critical moment of history.

(2) Promote the public understanding and support through science popularization and promotion plans

The MOST supports popular science through various promotional plans such as organizing popular science activities, producing science films, and publishing science articles. Activities with digital value are promoted through the "Sci-Tech Vista" platform. In future, audio and visual popular science resources for audiences of different age groups will be produced to encourage the public to understand and support science. The MOST will also promote citizen science by encouraging the public to participate in scientific discussions and research to, increase their trust and interest in science.

(3) Cultivate talents with expertise in the translation of popular science knowledge through the promotion of large-scale programs

By launching the "Industry–Academia Collaboration Program for the Promotion and Production of Popular Science Products," the MOST encourages academia to collaborate with media companies at home and abroad to produce audio and video products that promote popular science and in turn foster talent with skills in making and producing popular science audio/video materials. The MOST also funds to organize large-scale events to foster talents in science-themed exhibitions. In future, the MOST will not only encourage academic to engage in popular science and enhance their translation skills, but also continue to assist industries using different media materials to translate sciences. Through this dual-track cultivation approach, the MOST intends to promote the capacity of science communication.

(4) Cultivate and strengthen the pool of talent in the humanities and social sciences within universities and colleges in Taiwan through cross-agency collaboration

The government will implement the "Benchmark Program of Humanities and Social Sciences for Universities and Colleges," continue to improve research capacity in the humanities and social sciences, cultivate talents in the humanities and social sciences, enhance the visibility in international academic research community, and propose research results that contribute to the society.

1.1.4.3. Integrate elements of the arts and humanities to inspire talented interdisciplinary researchers

(1) Promote basic research and development in humanities, arts, and technologies and build an interdisciplinary collaboration and innovation model

The integration of the humanities, arts, and technologies is inevitable trend at the era of massive digital technology applications. To support interdisciplinary research and train interdisciplinary researchers, we plan to collect opinions from academic community and promote interdisciplinary projects integrating the humanities, the arts, and technologies. We will consider various topics and reinforce the R&D and innovation capacity of researchers with interdisciplinary specializations in the humanities, the arts, and technologies, thereby bolstering national competitiveness.

(2) Optimize the environment friendly for the development of humanities, the arts, and technologies

Based on Taiwan Contemporary Culture Lab (C-LAB), the government will encourage the innovative application and interdisciplinary integration of cutting-edge technologies, catalyze the development of a novel cultural site, and encourage the production and presentation of experimental projects.

(3) Accelerate the upgrading of cultural innovation applications

We will conduct art innovation technology researches, and introduce the verification of cultural innovation technologies exhibitions/performance. Besides, we will invite industries and academia to cultivate interdisciplinary talents together through R&D or exhibitions and performances. Furthermore, we will research to develop cultural innovation technology modules to be used as a medium for fostering creativity in technology-based art, and apply the medium at the innovative experimental sites in Taiwan to promote and upgrade the industry–academia R&D collaboration.

1.1.4.4. Reinforce cultural preservation and promote the application of innovative services

(1) Strengthen the development of Taiwan's native culture and its content and utilize information on the raw materials of local culture

We will encourage the use of local cultural materials, innovative technologies, visualization techniques, and new media characteristics to produce creative works that are native to Taiwan; improve the ability to self-produce audio and video materials; and transform technology, marketing and business models to develop innovative convergent services, thus expanding the application value of intellectual property through diverse applications.

(2) Increase the openness, promotion, and accessibility of cultural data, guide industries to establish access privilege mechanisms, and encourage citizens to use open data to create derivative value-added applications and close the cultural gap.

(3) Encourage the application of digital technology, combine it with local cultural characteristics and other creative elements, and use them in theaters, galleries, museums, and other forms of exhibitions; and expand the scope of application to commercial activities, large-scale events, celebratory events, and other fields, for interdisciplinary conservation and integration in order to promote the development and transformation of culture and the arts.

1.1.4.5. Build a consensus on social innovation and create a sustainable society

(1) Organize national seminars on the empowerment of social groups during which different communities interact with each other to identify core problems and innovative solutions.

(2) Use the resources of the Social Innovation Lab to collect case studies and real-life examples of social innovation activities in Taiwan, and work with local organizations to improve public understanding of social innovation.

1.2. Improve industrial talent cultivation

1.2.1. Strategy 1: Cultivate competent talents that meets the needs of industries

1.2.1.1. Link universities and colleges to develop customized talent cultivation programs through industry–academia collaboration

The government will use the platform for talent cultivation through industry–academia collaboration and the cross-agency collaboration platform for labor supply and demand, keep abreast of the development trends and talent demands of S&T industries, link vocational schools to develop customized talent cultivation models, and strengthen industry–academia collaboration, talent cultivation, and connections with the workplace.

1.2.1.2. Enhance the links between professional courses and the practices of S&T industries

The government will launch reforms in vocational education curriculum for cultivating the next generation of specialized professionals in response to future industry needs; integrate the paths of skills training, and adjust teacher qualifications, courses, equipment, practical training, and practical learning programs; review the professional and practice subjects for professional groups in junior and senior high schools; and forge stronger links between professional courses and the practices of S&T industries.

1.2.1.3. Establish a regional base for vocational talents and skill cultivation

The government will build a regional base for vocational talents and skill cultivation; integrate resources from schools, industries, and business corporations; establish production line training programs, course development programs for industry–academia collaboration, and teacher training programs; and introduce customized industry–academia collaboration programs or special classes.

1.2.1.4. Initiate professional training courses on digital technology

The government will invite private training organizations (e.g., universities and colleges, industrial (business) groups, non-profit organizations, and occupational training institutions) to organize professional training courses related to digital technology, which will facilitate industrial development. The government plans to subsidize a portion of the training expenses of in-service workers to encourage their participation, build up their human capital, and enhance their competitiveness.

1.2.1.5. Plan a professional competency identification system for industries based on the competency criteria of industrial talents

We will plan a professional competency identification system for industries based on the competency criteria of industrial talents, encourage enterprises to train the talents they need and provide them with training opportunities, and encourage students to obtain certifications to increase employability and improve technical skills and digital transformation capabilities before their transition into the workplace.

1.2.1.6. Enhance female re-employment and improve the workplace environment for women

We will organize different employment-oriented occupational training courses based on regional industrial development and employment market requirements by using self-owned resources and the resources of training departments to help women improve or develop employability skills and encourage them to join the workforce; support measures for protecting the health of mothers in the workplace by creating a friendly working environment for mothers, thereby promoting re-employment; provide professional industrial training courses to improve the (re)employability of women and help them to understand the abilities needed for industrial development; and urge business owners to provide flexible workplace measures for women to help them fulfill their different roles and tasks.

1.2.2. Strategy 2: Cultivate talent in national strategic areas

1.2.2.1. Build a reserve of interdisciplinary digital talents in response to the digital economy and new forms of industrial development

(1) Invite prestigious universities to train high level R&D experts and engineers in the hope to increase the pool of ICT digital talent by 10%.

(2) Deepen the implementation of faculty-combined courses related to the digital innovation of industries in professional areas through interdisciplinary micro-degree programs or new digital talent training models, and train non-ICT students to develop digital ICT capabilities.

(3) Encourage graduates and workers to develop secondary skills in digital ICT through the open university diverse training model.

(4) Encourage talents of national talent development policies and national strategic areas for further study in Taiwan and abroad; encourage universities to flexibly adjust study time limits, credit requirements, and teaching models through course designs, and initiate pilot programs that fit the above mentioneders.

1.2.2.2. Nurture frontier semiconductor interdisciplinary talents

In order to develop new generation semiconductor materials, IC systems, advanced manufacturing and testing technologies for the next decade, more interdisciplinary semiconductor talents will be required. It is therefore crucual to attract talents in basic sciences such as physics, chemistry, and mathematics to join semiconductor-related projects; and integrate research institutes and industries resources to complete the semiconductor industry chain in Taiwan, thereby fueling the power of semiconductor clusters.

1.2.2.3. Cultivate biomedical and industrial product innovation and entrepreneurial talents with international perspectives and the ability to integrate multiple disciplines

We will promote to connect with renowned foreign universities or institutions on biomedical translation products, select candidates to receive training overseas and develop local training mechanisms, and provide training on aspects that are crucial to product development (e.g., translation, laws, intellectual property and negotiations, and marketing and business planning) to nurture domestic interdisciplinary talents in biomedical product commercialization and innovative entrepreneurship.

1.2.3. Strategy 3: Provide interdisciplinary training to cultivate talents in industrial innovation

1.2.3.1. Foster industrial innovation and R&D capacity

The government encourages academia to work with industries to provide training opportunities for prospective PhD students, during which students can learn to apply theory in practice while working in the industry, enhance their knowledge of patents and trade secret protections, and adopt R&D models for addressing industrial issues. We will also train students through industry–academia collaboration to inject R&D capacity into the industry and transform students into a competent driver of industrial development; subsequently, we will inject industrial funds to support the research work of research institutions, focus on the industrial application of academic research results, minimize the theory-practice gap, and develop industrial innovation and R&D capacity.

1.2.3.2. Launch internship programs for students to work in industries

We will improve industry internship programs, which are based on the innovative and professional talent training needs of industries and require universities to match students to prominent industries that offer attractive career prospects for them; combine all types of industry–academia collaboration talent development plans so that students can enter the workforce, conduct researches, and enhance and accumulate practical experiences during the course of their study, all of which will help them to adapt to a fast-changing society and technology trends and meet the talent needs of industries and markets.

1.2.3.3. Encourage university faculty and research personnel to engage in industry–academia collaboration

We will develop ministerial measures related to industry–academia collaboration, project resources, and industry–academia collaboration reward mechanisms to encourage university faculty and research personnel to commit to industry–academia collaboration, practical application and technology R&D, talent development, and entrepreneurial ventures; guide schools to develop incentive programs (e.g., loosen restrictions on the income received by teachers through industry–academia collaboration programs) that will motivate teachers to engage in industry–academia

collaboration so that teachers' R&D work can drive industrial innovation;
and urge industries to participate in universities' innovation and R&D initiatives to generate synergies that will facilitate industry–academia collaboration, which in turn contributes to industries by supplying them with outstanding talents and R&D results, thereby forming reliable and dependable long-term collaborative relations and win-win situations for both parties.

1.2.3.4. Guide universities and colleges to develop general education courses for interdisciplinary innovative talents with international links

Guide universities and colleges to develop general education courses for interdisciplinary innovative talents with international links to enhance students' comprehensive knowledge and leadership and to develop the multidisciplinary talents needed in key industrial areas.

1.3. Promote diverse lifelong learning

1.3.1. Strategy 1: Promote the development of smart education

The government will adopt technologies to develop smart education, assist learners from childhood through to adult education to learn independently and adaptively and, ultimately, achieve lifelong learning. The following five dimensions are recommended for this strategy:

1.3.1.1. Motivate and encourage students to become independent learners

The government will establish and introduce digital learning models that are suitable for students' independent learning; observe schools' continuing use of digital learning platforms, and analyze and adjust assistance methods; and urge students to make use of digital learning channels to learn basic subjects more effectively and foster the ability to learn independently throughout their lifetime.

1.3.1.2. Nurture professional teachers on science and technology education

The government will integrate technology-related courses in preservice teacher education to train teachers to develop the ability to use digital teaching practices and adaptive learning platforms; encourage teachers to participate in empowerment workshops and lecture training; strengthen teachers' support systems and networks; and transform teachers' teaching practices to those that guide students to learn adaptively.

1.3.1.3. Provide learning support to students such as learning devices and resources

The government will encourage public–private collaboration to prioritize supplying

learning aids to students who are competent, willing to learn, and go to schools in rural areas; and develop digital instructional materials combined with cloud services to integrate AI systems to support the content services of independent learning platforms.

1.3.1.4. Bridge diversified education and the paths for transitioning to higher education

The government will implement a non-formal education certification system and promote the exchange of formal and non-formal education activities; encourage universities to preferentially adopt and recognize non-formal learning outcomes through strategic alliances; subsidize a portion of the tuition fees of students with special circumstances (e.g., ethnicity, culture, financial status, and physical and mental conditions) to encourage lifelong learning and alleviate parents' financial burden and students' learning stress.

1.3.1.5. Enhance the digital knowledge and skills of adults

The rapid development of digital technology has made life easier; however, the inability to use technologies in everyday life may make life difficult and even cause social alienation. Therefore, suitable learning methods and channels for adult learners should be designed to teach them basic digital applications and skills and shorten the digital gap.

1.3.2. Strategy 2: Promote diverse learning for all age groups

An age-friendly learning account is a concept of lifelong learning to meet the learning needs at different stages of a person's career. Cross-agency collaboration is required to establish learning accounts for promoting independent adaptive learning. The following four dimensions are recommended for this strategy:

1.3.2.1. Establish cross-platform authentication mechanisms

In response to the advent of the digital learning era, government and private sectors are devoting resources to building digital learning sites or platforms and providing heterogeneous and different learning resources based on users' needs. Nevertheless, to promote a friendly environment for technological applications, simplify authentication procedures when users log into different platforms, and take safety into consideration, digital learning platforms should be combined with the Citizen Digital Certificate, Taiwan Mobile Identity Service (TAIWAN FidO or TW FidO), National Health Insurance (NHI) card, or dual-certificate verification (which is the NHI card number plus Household Registration number; a physical card is not required) mechanisms, thereby creating a user-friendly environment.

1.3.2.2. Provide personal learning records

An age-friendly personal learning account involves the MOE's lifelong learning concept. Ministerial departments have provided learning-related platforms for the general public, although information is relatively spread out. We will therefore combine

the account with My Data, which is a cross-agency and cross-business integrated information system developed by NDC. My Data is a people-oriented digital service established using personal data authorized for use by a third party. It provides a one-stop portal to governmental services and offers convenient and efficient service procedures. By using this platform, users can make inquiries into their personal learning account and access personal learning information from different agencies and systems.

1.3.2.3. Recommend personalized learning contents

Different age groups have different development needs in terms of education and learning. For example, young learners are preparing for higher education and social experience. Young adults are preparing for employment, re-employment, job transfers, or entrepreneurial ventures, at which point occupational education is extremely important and requires collaboration with enterprises to design practical courses that meet the competency criteria. Young adults also need to learn parenting skills. Middle-aged to elderly adults emphasize social involvement and self-realization. My Data should be used as a medium for providing a one-stop integrated information recommendation service to help learners of varying age groups, such as students, job seekers, workers, middle-aged adults, and elderly adults, to choose either micro-degree courses or systematic courses depending on their learning needs, select the interests or skills they would like to cultivate, and effectively utilize learning resources to achieve personal development.

1.3.2.4. Increase applications for job searching and continuing education

Once the age-friendly personal learning account is established, governmental learning platforms can be used to accumulate and register learning records, which include a person's learning progress in formal education, resume, qualifications, and licenses, as well as non-formal lifelong learning progress. Thus, users can build and manage their learning base without worrying about having to preserve printed records. They can also apply for digital certificates as needed, which serve as a reference for further education, employment, or job interviews. By using the government's learning resource recommendation service and encouragement mechanisms, job-seeking learners can develop competence through systematic courses, which will help them to develop their career. Middle-aged and elderly learners can join learning communities to share resources or collaboration results, which will increase learning sustainability and promote social engagement. Thus, the needs of learners of varying age groups for lifelong learning and continued contribution to society can be met.

Goal 2: Improve the Research and Development Ecosystem and Allocate Resources for the Development of Pioneering Technology

2.1. Make use of resources in strategic areas

2.1.1. Strategy 1: Build a decision support system for S&T

2.1.1.1. Improve the methods of formulating S&T plans and review mechanisms

The government will encourage ministries to implement mid- to long-term plans to meet urgent innovation needs; review and plan scientific research projects that need to be cultivated; and use the plans as the basis for ministries to develop S&T budget policies after the Executive Yuan reviews the plans upon submission and agrees to accept for filing.

2.1.1.2. Strengthen the management of key policies and S&T plans and implement tracking and evaluation of mid- to long-term benefits and information

The government aims to build mechanisms for managing key policies and S&T plans; leverage expert knowledge to ensure that plans are aimed at achieving the target benefit; assist with the identification, translation, and trends analysis of scientific research results; submit strategic and competitive national mid- to long-term S&T policies for observation and recommendation, which are expected to enhance the effectiveness of the plans and progressively improve cross-ministerial collaboration; and adopt a mid- to long-term benefit tracking and evaluation mechanism, whereby ministries track and evaluate benefits and the MOST and BOST of the Executive Yuan provide guidance and assistance, review the ministries' evaluation methods and results, and recommend subsequent improvement measures. The MOST and BOST can also screen for important plans or key projects, which are then submitted for evaluation.

2.1.1.3. Improve the data management of S&T plans and establish an agile and professional decision support system

The government will complete the establishment and linking of databases related to S&T plans, including platform development, data collection and preservation, and classification and coding; keep complete track of information on S&T plans, and provide a comprehensive summary of R&D performance and highlights for better communication with society. Furthermore, data, models and knowledge will be integrated into a smart data analysis tool for professional interpretation to quickly produce decision information and provide quantified evidence-based strategic recommendations to effectively enhance decision quality.

2.1.2. Strategy 2: Outline strategic areas of scientific research

2.1.2.1. Develop a system for funding basic scientific research

The government will comprehensively review the funding mechanism for basic scientific research, maintain a specific ratio and growth of the funding limit for basic research, improve the infrastructure required for S&T development, ensure that basic research funding is not affected by political changes, and maintain a long-term and stable source of research funding.

2.1.2.2. Implement strategic plans on material topics

The government will use a top-down approach to implement strategic plans that address material topics such as society, economy, and industry competitiveness to respond to the socioeconomic trends and national needs, outline the key layouts of Taiwan's scientific research, set explicit targets, and strengthen the implementation of management and evaluation.

2.1.2.3. Formulate scientific research development strategies based on future mid- to long-term needs

The government will envision future societal problems and needs by using innovative thinking, reinforce the planning of mid- to long-term layouts and scientific research strategies, and invite domestic and foreign experts with international perspectives to provide professional advice on different aspects based on the current global views on scientific research development. We will also respect the professional autonomy of academic communities, encourage the diversification of academic development, and invest in ground-breaking research that meets the long-term development needs of Taiwan. Furthermore, the government will mobilize resources for needs-oriented applied research and enhance the innovation capacity of industries while keeping the sustainable innovation of industries in mind. We will vigorously invest in needs-oriented research resources, effectively link upstream, midstream, and downstream industries by drawing on a robust innovation prospect and environmental infrastructure, and shift our focus from "technological development" to "applied research" and then strive toward "basic research" to enhance the innovation capacity of industries in original technologies and create core competitiveness in high-value products.

2.1.2.4. Mobilize different ministries to jointly strengthen national defense scientific research capability and cultivate national defense talent

The government will launch the "Academic Research Center," conduct an inventory of Taiwan's national defense scientific research capacity, draw up a blueprint of technological development pathways, integrate the units that need national defense technologies, formulate the direction of national defense technology research, promote the progress of Taiwan's national defense technology, and assemble groups of experts to train high-caliber talent to implement the domestic production of military aircrafts

and ships, thereby driving the upgrading of Taiwanese industries.

2.2. Foster stronger basic research capacity

2.2.1. Strategy 1: Preemptively identify key feature areas

2.2.1.1. Initiate long-term scientific research development and create advantages and strengths in response to future societal needs

The government will formulate the key focus areas of Taiwan's innovative technological research and development with due consideration of the social, economic, and environmental challenges facing Taiwan and the research capacity and advantages of industries, academia, and research institutes in Taiwan. The vigorous development of quantum technologies in recent years has prompted countries worldwide to invest large amounts of resources into R&D initiatives. Because quantum computers are much more powerful than traditional computers, future quantum technologies will generate a massive impact on cybersecurity, industries, finance, and national defense. Facing the advent of the new quantum era, we will accelerate efforts to improve our quantum technology capabilities to prepare for upcoming changes, thus enabling Taiwan to continue playing a key role in the future quantum era after its global success in the semiconductor industry.

2.2.1.2. Optimize the core infrastructure facilities and services of scientific research

The government will optimize and upgrade cutting-edge research core facilities and technological integration service platforms, provide facility services for the research and development of next-generation pioneering technologies and key technologies, and expedite the development of new manufacturing processes, new products, and new services. We will leverage the years of experience of Taiwan's academic and research communities in manufacturing and producing advanced materials. We will also support outstanding scientific researchers to conduct the research and development of advanced instruments and testing technologies, and promote self-assembly capability for scientific equipment to speed up the development of advanced materials and optimize the application of these materials.

2.2.1.3. Establish Excellence research centers to bolster Taiwan's competitiveness in the global academic community

The government will guide comprehensive universities with multifaceted global competitiveness to adopt international standards relating to the development of key characteristic research; provide assistance to major universities and research institutes in accordance with key national issues as well as their teaching practices, R&D capabilities, and development focus to help them develop world-class key Excellence research centers that emphasize the academic value of professional disciplines, encourage ground-breaking research projects, and propose innovative ideas and solutions to address societal and academic material problems; in terms of implementation, we will adopt regular review mechanisms, mobilize resources and

merit-based funds, and pursue global visibility and influence with the goal of becoming the global node of academic research.

2.2.1.4. Deploy advanced pioneering industrial technologies

To satisfy the needs of industries for innovative development, we will commit to the development of cutting-edge technologies that meet future market needs; initiate early deployment of innovative and value-added industrial technologies that have the potential for development; mobilize enterprises to produce strategic products, services or industries during the future industrial development process; and accelerate the integration of industrial R&D initiatives with the international market to gain a leading advantage.

2.2.2. Strategy 2: Integrate the challenges and material topics of different disciplines

2.2.2.1. Strengthen the incentives for interdisciplinary collaboration and encourage interdisciplinary research

The government will tackle the challenges and obstacles in interdisciplinary collaboration and integration by designing and implementing research projects and promotional programs that provide collaboration incentives and accommodate the research culture of different subject areas; and aggressively reinforce long-term investments in interdisciplinary-integrated basic research and facilitate the integration and collaboration of interdisciplinary basic research on atomic science and technology, which is expected to create a new scientific research layout for Taiwan. We will also plan the implementation of a “Humanities and Social Science Research Program,” which involves integrating the research capacity of interdisciplinary talent to conduct research or develop new research areas on innovation issues and cultivating outstanding scholars and researchers to produce ground-breaking research results that will exert a far-reaching impact.

2.2.2.2. Promote interdisciplinary research that focuses on societal needs and reinforce the integration of the humanities, science and technology

The government will encourage the formation of interdisciplinary research teams comprising scholars with expertise in S&T development, the humanities, social sciences, economy, and policymaking to address issues concerning the needs and characteristics of local societies in Taiwan, the lifestyle changes derived from technological applications and anthropogenic activities, and changes to human behavior, cognitive models, and rules regarding socioeconomic operations. We will integrate scientific knowledge and innovative technologies to provide systematic solutions based on scientific evidence, jointly solve problems that are urgent and important to Taiwan, and seek solutions through interdisciplinary and cross-departmental collaboration to convert knowledge into actions to address the needs of society.

2.3. Forge deeper industry–academia–research ties

2.3.1. Strategy 1: Promote advanced R&D and innovation across different sectors

2.3.1.1. Facilitate the transfer of talented students and technologies and develop 5+2 innovative industries and key regional industries

The government will focus on the development of 5+2 innovative industries and key regional industries, solicit support from universities, industries, local governments, and various ministries to facilitate the transfer of student talent and technologies for industrial applications.

2.3.1.2. Strengthen industry–academia–research collaboration and encourage different S&T sectors to engage in innovation

The government will encourage FinTech innovation science parks, financial institutions, and university FinTech research centers to form strategic alliances with stronger industry–academia–research ties and introduce innovative financial services. We will also mobilize private sources to foster FinTech talent and promote the innovation dynamic of financial markets.

2.3.1.3. Build a regulatory environment that facilitates innovative entrepreneurship

The government will continue to review and relax laws to provide a friendly legal environment for the development of innovative entrepreneurship. Guidelines for providing teachers with resources to offer innovation and entrepreneurship courses and for schools to provide startup registration sites will be established to encourage key members to use R&D results to launch startups or research service companies.

2.3.1.4. Loosen laws and regulations regarding scientific research, entrepreneurship, and technology transfer and loosen restrictions on teachers' roles in foreign startup companies and shareholding structure

The commercialization of research results is necessary for academic and research institutes to assist industries with S&T innovation and development. To maximize the benefit of loosening rules about the commercial activities of research personnel and to link with the international market, we should loosen the restrictions on teachers who work for national universities or above and concurrently hold related positions in foreign companies for the purpose of scientific research as well as the restrictions on the maximum shareholding ratio for foreign startups. The relaxation of such restrictions can help researchers serving national universities or above to gain international R&D and entrepreneurial experience, which would boost the S&T innovation and

development of Taiwan, promote the industrial application of government-funded research results, and assist with the fostering of more local R&D talent and elites.

2.3.2. Strategy 2: Linking industries, academia, and research institutions for stronger innovation capability

2.3.2.1. Promote global research and industry alliances and integrate the innovation capacity of regional industries and academia

The government will develop the key technologies of the six core strategic industries through industry–academia collaboration by tapping into the existing foundations of 5+2 innovative industries to improve Taiwan's industry competitiveness. The government also encourages industries and academia to build long-term stable cooperative relationships, foster high-ranking industrial talent, and increase the willingness of benchmark enterprises to invest in Taiwan. The government will centralize the capacity and resources of local academia and research institutes by building a cluster of regional industries; introduce industrialized professional teams and capacity to accelerate industry–academia collaboration in technology transfer to aid the upgrading of industry clusters. Finally, the government will enhance the benefits of diversified exchange by linking with international markets and resources to promote the innovation and upgrading of Taiwanese industries and bolster the global competitiveness of Taiwan.

2.3.2.2. Build industry–academia–research platforms and increase the value of the research results achieved by research institutes

The government should strengthen the intermediary role of collaborate institutions in the relationship between schools and enterprises to fortify industry–academia–research ties; integrate six core strategic industries with 5+2 innovative industries to reinforce key topic research that strengthens the competitive advantages of industries and boosts industry–academia–research collaboration between different schools and research institutes; and share experimental equipment, technical experts, and networks of connections, among other resources, to accelerate the development of innovative interdisciplinary integrated service platforms that feature the value-added capacity of research institutes, build long-term partnerships between industries, academia, and research institutes, and implement the social application of scientific research results.

2.3.2.3. Encourage research institutes to build bridges between enterprises and schools, forge stronger industry–academia–research ties, and promote innovative entrepreneurship

To promote industry–academia–research ties and encourage innovative entrepreneurship, the government should support the intermediary role of research institutes in the relationship between schools and enterprises. In the context of schools, research institutes could identify and explore R&D technologies that meet industrial needs and build a long-term window of contact as the communication channel among industries, government, academia, and research institutes. In the context of enterprises,

research institutes corporate institutions could explore related technologies based on the actual needs of industries and engage in interactive exchanges with academic institutions through match-making activities to precisely match technology results. By leveraging their strengths (e.g., market sensitivity, strong connections with industries, and specialized facilities for technological R&D), research institutes could assist schools with providing value-added services such as technology upgrading, patent application, site verification, prototyping, and entrepreneurial guidance to accelerate the industrial application of technological research results. Additionally, the government should commit to high-value innovative R&D and derived startups, encourage research personnel to apply their research results in industries, tap into the bridging and translation functions of research institutes, and boost the diversification of industry–academia collaboration and startup development.

In addition, the government also need to (1) leverage the capacity and industrial experiences of research institutes to accelerate the commercialization of R&D results through the translation of basic research results (e.g., the government could combine the capacity of clinical research and basic research and conduct value-added research on local medicinal ingredients and Chinese medicine formulas to promote the industrial application thereof); and (2) realize the tangible collaboration between research-type research institutes and different ministries to achieve output industrialization.

2.4. Strengthen S&T risk assessment and data management

2.4.1. Strategy 1: Strengthen S&T risk assessment

2.4.1.1. Develop infrastructure risk assessment and application technologies

The paralysis of social functions due to the collapse of large-scale infrastructure can be avoided by assessing the risk impact of new technologies on infrastructure systems and the infrastructure as a whole, determining the causes and consequences, and providing the results as reference for the government to formulate corresponding risk management strategies. Taiwan has greatly improved the performance of its nuclear power plants and risk response capabilities, thanks to more than 30 years of experience in applying risk assessment technologies to nuclear power plants. Taiwan has also successively applied risk assessment technologies to natural gas terminals and power distribution infrastructure. In other words, we have sufficient theoretical foundation and practical experience to develop technologies for assessing the risks of new technologies.

2.4.1.2. Develop risk assessment for new technologies

Natural disasters are still frequent around the world. Taiwan’s nuclear power plants have been operating for some time. We need to assess the abilities of safety elements, including the structures, systems, and components that ensure the safe operation of nuclear power plants, to maintain their designed functions during natural events, and we also need to boost the development of risk analysis technologies for nuclear power plants in Taiwan. Currently, Taiwan’s nuclear power facility has entered the decommissioning transition phase. The decommissioning of nuclear power facilities involves multiple areas of specialization, such as civil structure, electrical power,

machinery, and water chemistry. Once a facility enters the decommissioning phase, the nuclear material must still be kept in the reactor core for some time. Given these special circumstances, we need to develop a tool to assess the decommissioning risks and to improve our ability to analyze risk events to ensure that facilities are safely decommissioned.

2.4.1.3. Develop an independent assessment model and analyze potential scenarios, changes in greenhouse gas emissions, and the status of achievement targets

The government plans to convert information related to reduction policy plans, which are proposed by each ministry in accordance with the Greenhouse Gas Reduction and Management Act, into quantitative data, which is the format required for the assessment model, to analyze the strategic measures adopted by each ministerial department. By applying the long-term energy alternative planning model, the government aims to analyze the ministries' mid/long-term development trends, the effectiveness of carbon reduction plans, strategies for revising and strengthening desired targets, and the challenges and difficulties facing Taiwan. The government will also establish a dietary model for Taiwanese nationals, increase the ratio of domestic food production and domestic food spending, and analyze the effectiveness of this model on carbon reduction. The government will assess the long-term (2050) structural changes and emissions of sectors in Taiwan, such as energy, industry, real estate, transportation, and agriculture, as well as the long-term development visions and potential impact on economic transformation, energy transition, and social transformation.

2.4.2. Strategy 2: Improve data management mechanisms

2.4.2.1. Construct a privacy-protected data infrastructure environment

Building a privacy-protected data infrastructure environment is necessary to provide stable data services and promote the wide circulation and effective use of governmental data to achieve the goal of turning Taiwan into a smart country and an innovative economy. Specific approaches include continuing to develop de-identification technologies and encryption technologies, building server rooms that meet international ISO standards, and reinforcing the physical security control mechanisms and the network communication security environment of these server rooms, while also creating an environment for permanently storing data and backups.

2.4.2.2. Construct a data infrastructure environment that ensures both compliance and convenience

To create a sound infrastructure environment for Taiwan's smart government development, this sub-strategy is aimed at improving the government's data management environment for handling data transfer and data release tasks. The plans are as follows:

(1) Promote open data and data reuse

The government will strengthen the government's open data release and reuse mechanisms, maximize the amount of open data, improve the value and quality of released datasets, transform data formats into structured data, open-format data, machine-readable data, and application programming interfaces, and adopt a transparent decision-making mechanism to increase the scope of data provision and continue to release highly applicable data; establish principles regarding the sharing of governmental data and authorization regulations; and encourage private sectors to participate in the provision of innovative and value-added data services to effectively promote data circulation and reuse.

(2) Empower the general public to personalize their digital services

The government will promote the autonomous use of personal data by allowing the general public to download their personal data independently or authorize government agencies to provide their personal information to third-party service providers to obtain precise personalized services. The MyData mechanism, which was established by the NDC, provides a diverse range of digital ID verification and online consent functions while ensuring that personal data and privacy are protected. Members of the public can independently download their personal data from government agencies or use digital files instead of paper certificates to apply for counter services, or they can provide online consent to the use of personal data to access specific services.

Currently, personal data and privacy protection and management measures have been established for the MyData platform. To refine these measures, we will follow international practices and continue to strengthen the protective mechanisms of MyData so that data, which are stored in governmental systems, can be conveniently and safely returned to the hands of the general public for reasonable use. We will also improve the platform to simplify the application procedures for the general public and deliver innovative public services.

(3) Develop a flexibly scalable channel for exchanging data securely across different agencies

To provide a secure and trusted data exchange environment for government agencies, the NDC plans to complete the T-Road system, a cross-agency data transmission channel, by the end of 2020 and establish data exchange standards and security regulations to provide government agencies with a secure environment for data transmission. The security of T-Road will be protected by using exclusive network segments to access T-Road, using a data center to set up a centralized network export for data transmission, and also building a T-Road cybersecurity protection zone to block malicious cyberattacks. Finally, a data security connection channel will be established to ensure that all the data being transmitted are encrypted and sealed by government certificates and to keep the transmitted data confidential. Thus the transmission security of the T-Road platform is ensured by a multi-leveled protection scheme. Regarding data protection, the NDC complies with the ISO27701 guideline regarding personal data management, and commissions an impartial third party to conduct a data protection impact assessment on T-Road, identify the privacy risks involved in the operating procedures of T-Road, and measure, manage, and respond to the impacts of the risks to ensure that relevant operations are in compliance with personal data protection laws and to fulfill our responsibilities under the Personal Data Protection Act.

Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation

3.1. Speed up the smartization and digital transformation of industries

3.1.1. Strategy 1: Strengthen smart applications for greater tenacity

3.1.1.1. Build smart supply chains to increase the tenacity of supply chains

Industries in Taiwan have a firm foundation in semiconductor and ICT technologies, which can not only facilitate the research and development of new generation technologies and expand the scope of digital applications, but also strengthen the tenacity of supply chains, promote the cross-disciplinary collaboration of different industries and technologies, further expand the scope of digital technology applications, and lead the innovation and transformation of global industries.

First, we must take advantage of the strengths of semiconductor industries in Taiwan, support domestic materials and equipment manufacturers to enable them to produce key materials and equipment, and reinforce the ecosystem of advanced manufacturing industries, through which a complete cluster of semiconductor industries can be established to improve the self-sufficiency of Taiwan in the production of semiconductor equipment and materials.

Second, we must develop global smart supply chain management systems to respond to the effects of international situations such as the US-China trade war, technology disputes, and COVID-19 on the global supply chain structure and to the need to restructure diversified and regional supply chains. Moreover, we should also promote the demonstration and application of smart supply chain management to assist small and medium manufacturers to integrate smart supply chain systems.

By digitalizing the semiconductor ecosystem and industry chains, we can expect to continuously promote industrial digitalization, digital transformation, and innovative applications at home and abroad and to secure Taiwan's global position in the next-generation supply chain. In doing so, Taiwan can become a key base that is indispensable to the development of next-generation ICT, continuously strengthen a smart supply chain that extends across multiple countries, and subsequently build a tenacious supply chain comprising industries from Taiwan and around the globe through the flexible collaboration between large and small enterprises in Taiwan and overseas.

3.1.1.2. Deepen the integration of software and hardware technologies to accelerate the digitalization and digital transformation of industries

(1) Initiate ICT development, increase the depth of software and hardware integration, and develop innovative application solutions

We will implement the research and development of technologies related to next-generation ICT; assist industries to accelerate the adoption of 5G, AI, and IoT

applications and platform collaborations; deepen software and hardware integration capabilities of the manufacturing industry; and motivate Taiwanese enterprises to develop and upgrade to Industry 4.0. We should also integrate technological elements into different stages of a service process based on global trends and the needs of society to create more sophisticated service contents and catalyze the development of applicable innovative service models and solutions. Finally, we should link the two-way collaboration between manufacturing and service sectors to guide industrial innovation and transformation.

(2) Use cloud platforms, digital tools, and big data analytics to aid industrial upgrading and transformation

We will integrate software and hardware technologies (e.g., IoT, AI, 5G, cloud platforms) based on the transformational needs of commercial service sectors such as retail, hospitality, and logistics; develop smart commercial service application plans (e.g., customer relationship management, bricks and mortar intelligence analysis, online food ordering and checkout, smart storage and transportation services); assist service operators to optimize existing service and operating processes; and develop new products/new services/new channels/new business models/new shop types through the collection, extraction, analysis, and sharing of business operation data.

3.1.1.3. Speed up integration with international smart application standards and develop key measurement and testing technologies

(1) Participate in the development of international standards and measurement technologies for 5G, IoT, and other smart applications and assist industries in acquiring international competitive advantages

We will integrate the capacity of industries, academia, and research institutes; participate in the development of international standards as well as meetings on measurement technology and important international conferences to provide relevant technology contribution; and expand the global influence of Taiwan in related areas to consolidate the international competitive niche of industries.

(2) Accelerate the reconciliation of international standards in related areas and develop key measurement and testing technologies in response to the digitalization needs of industries

We will continue to reconcile and update standards related to key emerging industries in Taiwan to promote the international integration of domestic industries; develop key testing and measurement technologies required by 5G, semiconductor, and smart manufacturing industries; improve measurement tracking and quality testing systems; and assist industries to make progress in product development and enhance their competitiveness to satisfy industrial needs.

3.1.2. Strategy 2: Improve cybersecurity systems through international integration

3.1.2.1. Introduce industrial cyber risk classification and address the cybersecurity needs of industries

Previous cyberattacks on manufacturing industries showed that small and medium enterprises (SMEs) invested too little in cybersecurity protection, whereas large, well-funded enterprises are unaware of where to begin. We recommend integrating international cybersecurity standards and the procurement needs of large international companies to build cybersecurity maturity and risk level mechanisms, which will help businesses to identify cybersecurity gaps and risks, prompt industry leaders and suppliers to reinforce cybersecurity systems, enable industries to understand risk level and improvement needs, and subsequently compel suppliers and manufacturers to fortify their cybersecurity capacity as a response to the cybersecurity requirements of international procurement.

For example, in 2019, the Taiwan Semiconductor Manufacturing Company adopted third-party cybersecurity indicators and completed the cybersecurity assessment of 9 suppliers and improved 12 potential cases of cybersecurity vulnerabilities.

3.1.2.2. Encourage cybersecurity alliances to create solutions and test innovative systems

The solutions adopted by domestic companies that independently develop cybersecurity systems mostly involve expansion into a niche market based on industry scale. Although the solutions can meet customization needs, they cannot satisfy the needs of general customers, who require a one-stop service platform to purchase protection. In 2018, the Industrial Development Bureau of MOEA established a cybersecurity integrated service platform called Security Platform as a Service (SecPaaS), in which more than 51 domestic companies that independently develop cybersecurity systems participate. We recommend using this platform as the basis to develop solutions targeting the two major areas of Taiwan's competitive industries, such as smart manufacturing and smart healthcare. Through collaboration with public associations, buyers and system integration operators are encouraged to propose topics, call for proposals from around the world, and attract domestic and overseas startups and SMEs to participate in developing application solutions and promote international output. Companies are also encouraged to cooperate with domestic semiconductor manufacturers and Semiconductor Equipment and Materials International (SEMI) to propose international semiconductor cybersecurity standards and improve the overall cybersecurity capacity of the cybersecurity industry.

3.1.2.3. Introduce joint defense feedback mechanisms for a more tenacious cybersecurity system

Cyberattack methods are constantly changing, but a single malware tool poses the greatest harm to similar systems and the same industry in a short period. Therefore, the government should connect the leading cybersecurity operators in the cybersecurity industry, agree on a standard cybersecurity data exchange format, and gradually establish an industrial data collection platform and cybersecurity incident reporting mechanism. Only by establishing a cross-domain interface model and assisting cross-industry operators to quickly integrate intelligence and solutions can we minimize the damage and prevent problems before they occur.

3.1.2.4. Make Taiwan the global hub of cybersecurity innovation and integrate international systems

The government recommends improving Taiwan's international cybersecurity brand image by, for instance, adopting the single brand of Cyber Taiwan Pavilion to integrate international cybersecurity clusters (e.g., the Netherlands). The government also recommends assisting domestic cybersecurity operators to penetrate the overseas market by using multinational Proof of Concept (POC) verification. In addition, the government plans to assist domestic ICT industries to keep abreast of international cybersecurity standards and the procurement needs of large companies; integrate the capacity of Taiwan's cybersecurity industry; develop IoT products featuring security functions; leverage Taiwan's strengths in ICT manufacturing to attract international cybersecurity startups to cooperate with us and move their base to Taiwan; and enhance the advantages of domestic ICT industries by increasing the value of cybersecurity, thereby creating an impetus that boosts cybersecurity innovation in Taiwan.

3.1.3. Strategy 3: Improve sites to optimize the environment for industrial innovation

3.1.3.1. Improve the digital transformation and service functionality of science parks to drive software and hardware integration and industrial innovation

(1) Launch infrastructure and smart application solutions for the development of digital economy, optimize the investment environment of science parks, and create smart sustainable science parks

The government will launch the software and hardware infrastructures required for the development of digital industries; develop a new ecosystem of digital economy transformation services; entice global high-tech and strategic industries to establish advanced manufacturing and R&D centers; accelerate the clustering of new industries; and speed up the use of smart technologies to expand value-added application of related data platforms and improve the digital management system of science parks, thus creating smart sustainable science parks.

(2) Build new tech co-creation and matching platforms to improve startup development

The government will develop co-creation and matching platforms for new technologies such as AI; reinforce the introduction of startup businesses that facilitate the promotion of software and hardware integration and application development; encourage cross-border innovation to promote the digital transformation of industries; and support the smart and high-value development of industries.

3.1.3.2. Motivate R&D teams of academic institutions to invest in smart manufacturing, software and hardware integration, and technology upgrading

The government should deepen the mid- to long-term plans for smart manufacturing technologies; conduct research and development of smart manufacturing, software and hardware integration, and technology upgrading through the R&D teams of academic institutions; guide academic research institutes to apply advanced technologies to issues that meet industrial needs; and encourage academic research institutes to verify their R&D results and industrial collaboration to facilitate industrial upgrading and transformation.

3.1.3.3. Build a smart technology verification site and promote the practical application and diffusion of research results

To apply solutions in practice, we aim to encourage academic research institutions to select pilot verification sites for R&D results and targets of industrial collaboration. Facilities in existing sites/institutions will be activated and upgraded to create an environment where integrated development and solutions can realistically be implemented and tested to guide academic research institutes to apply advanced technological applications to issues that meet industrial needs and address the problems in industrial practices, thereby assisting industries to transform and upgrade. In addition, based on mid- to long-term needs in 2030, we plan to integrate smart frontier technologies such as AI chips, 5G communication, smart displays, digital twins, autonomous vehicles, and sensors; assist innovative companies in Taiwan to conduct technical and service verification of different technologies, new products, and new applications; identify the prerequisite environmental conditions and gaps through verifications based on the perspectives of product, service, and business model development; and connect related industry value chains to applicable companies to assist domestic innovation companies to enter the new blue-ocean market of smart technology in advance.

To continuously promote the digital transformation of industries, the government will implement the digital streaming and AI application of suppliers of small and medium manufacturing industries; assist small and medium business service providers to use cloud platforms, digital tools, and big data analytics; and in turn develop innovative application solutions. Subsequently, key industry leaders such as manufacturing and commercial service providers will be integrated to create application demonstration sites where software and hardware technologies (e.g., IoT, AI, 5G) will be adopted to implement the local development and real-life application of smart technologies.

Regarding the overall business service sector, the government will target retailers, hospitality, and logistics service sectors to identify business problems and customer service needs, and then bring technology companies together to solve the identified problems. The government will cooperate with business service providers to establish diverse verification sites and adopt smart applications, such as collecting digital footprints to promote precision marketing, analyzing consumer data to make business decisions, or integrating digital information to overcome store pickup restrictions and allow access to smart storage and transportation services. These will then be provided to technology companies to verify their technology or business models. Meanwhile, the government will assist technology companies to accumulate practical experiences and benefit-related data and create opportunities for domestic and overseas business expansion.

3.1.4. Strategy 4: Achieve virtual and physical integration for a wider scope of interdisciplinary application

3.1.4.1. Integrate resources to build a sound environment for financial innovation

(1) Adjust financial laws and regulations

The government should accelerate adjustments to financial laws through FinTech innovation experimentation mechanisms, trial service measures, and continued dialog with innovators. The government will also promote the R&D and application of various new financial business models and technologies to enhance the effectiveness of financial services.

(2) Improve cross-border and cross-disciplinary collaboration platforms for financial services

The government will increase the service resources of FinTech Space, provide FinTech startups co-working spaces and counseling resources, establish corporate laboratories and digital sandbox platforms, and encourage cross-border collaboration and cross-disciplinary resource integration to facilitate the development of innovative financial services.

(3) Encourage financial institutions to introduce open banking services

Financial institutions are encouraged to voluntarily introduce open banking services based on their business strategies and needs, providing that they respect market mechanisms and development, and to make plans to gradually introduce open banking services in progressive stages, such as “open data inquiry” as Stage 1, “consumer information inquiry” as Stage 2, and “transaction information” as Stage 3. Deeper collaboration between banks and FinTech companies will be promoted to maximize benefits for customers. Therefore, ministries can collectively discuss aspects about sharing open data so that the general public can conveniently access everyday services on their smartphones in the current digital era.

(4) Expand international markets and strengthen international collaboration

The government will organize FinTech exhibitions or forums to help domestic business operators to extend their global presence and introduce international FinTech solutions. We should also participate in Global Financial Innovation Network (GFIN) activities to assist business operators to identify new business opportunities and promote cooperative coordination with international financial supervisory agencies.

3.1.4.2. Increase the digitalization of agriculture and promote the transformation of production and marketing strategies

Smart production is the use of human–machine systems to increase productivity. For smart production, a geographic information system (GIS) and other decision modules for big data analysis of spatial information will be constructed to achieve high-quality precision production, and an intelligent group cultivation model will be adopted to increase production efficiency. Therefore, for field operation, greenhouse operation, and agricultural processing machines, we plan to conduct an inventory of agricultural needs (e.g., the need to save manual labor and to use automated, digital, and smart

applications); review related technology or R&D results to identify gaps in key technologies; and engage in interdisciplinary technology matching to promote industrial applications through agricultural machinery communities and exchange activities. Thus, the high-value development of agricultural machinery industries can be facilitated to achieve the synergy of reducing production and manufacturing costs and bolstering industrial competitiveness. Additionally, we will strengthen the development and application of biosensor monitoring and IoT technologies and achieve smart production management through growth condition data analysis systems, environmental control strategies, and data, to implement smart agricultural production management and smart logistics.

The government will establish an ecosystem of digitally transformed agriculture, develop an ecosystem of agricultural clusters, and expand and support the diverse development of innovation needs in the areas of agriculture through the development and demonstration of vertical agricultural applications. By building agricultural production and marketing digital transformation platforms, counseling and matching services and agriculture transformation cloud will be provided for farmers to digitally transform their services and initiate digital industry alliances. The government will combine the public and private business models of agricultural machinery innovation to accelerate the digital transformation of agricultural sites, with top companies guiding contract customers to acquire large orders from international companies. The government will integrate domestic and foreign e-commerce platforms to strengthen sales and use the success of alliance partners to attract more companies to join the platform. Finally, the government will use technologies to support the digital upgrading of contract farmers and the integration of smart site sales strategies, strengthen digital integrated management, stabilize the layout of production and marketing strategies, and substantially enhance the digitalization of the agricultural industry to drive the transformation and profitability of the industry chain.

3.1.4.3. Digitally transform industries to achieve Construction 4.0 and develop innovative smart city services

(1) Establish a building data center and develop “digital twin” for the construction industry

The development of Construction 4.0 is focused on a building information infrastructure. A building data center is essentially a database containing all types of building information and algorithms as well as data on every building life cycle, including data on building information modeling (BIM), IoT, equipment operations, and structural monitoring. The static and dynamic information of a building space will be transmitted and collected in large quantities. Through AI algorithm analysis, the center will provide users with optimal control strategies (e.g., predictive maintenance, disaster prevention, health management, energy conservation, and sustainability) for the building. Therefore, the systematic process of static information, the management of dynamic information acquisition, and database security are issues that must be addressed when establishing the building data center. With reference to the National Geographic Information System (NGIS) 3D Basemaps, the government will develop various innovative applications and services for a smart city and introduce local digital applications (e.g., autopilot, urban wind environmental simulation) to develop “digital twin” for the construction industry.

(2) Deepen the application of BIM

BIM applications should have digital files that contain large volumes of information and are easy to share and exchange with another party instead of the conventional plan, elevation, and section view diagrams so that each stage of a building's life cycle can be closely integrated. The entire lifecycle of a building, from needs-oriented and design concept planning at the very beginning of building construction to the coordination of design information (e.g., building, structures, and electromechanical equipment), construction, and finally the maintenance and management of the building itself can be integrated by using BIM, which has a powerful coordination capability to manage all building information. By referring to international guidelines such as ISO 19650 or information classification codes, we will refine guidelines and regulations on the adoption of BIM technologies for assessing the lifecycles of buildings in Taiwan; strengthen the abilities of all participants in the construction industry to collaborate in the establishment and use of information; and establish a complete building information production line, which can concurrently serve as the basis for construction developers to integrate IoT, AI, and digital manufacturing technologies and for the entire construction industry to undergo digital transformation.

(3) Promote smart construction to increase work efficiency and construction quality

The government will integrate the digital manufacturing of building components into smart construction sites to turn the building construction process into an application site for high-tech industries, which will resolve labor shortage problems and reduce occupational hazards. The government should promote the integration of the design for manufacturing and assembly (DfMA) methodology and advanced manufacturing technologies to develop digital designs and technologies for the manufacturing and production of building components, which are then mass produced at a factory and assembled at the construction site to minimize onsite construction works, reduce carbon emissions, and shorten the construction period. The government will introduce a smart human–machine coordinated construction site where ICT-integrated construction machinery can be used for land levelling, and various meteorological and environmental changes can be determined and updated in real time. Finally, environmental monitoring platforms should be constructed for responsive engineering.

(4) Develop intelligent building materials and create a blue ocean economy

Intelligent building materials are innovative materials and constitute a method of control developed using a combination of knowledge and expertise in chemistry, physics, materials, electronics, electro-mechanics, ICT, and automated control. Intelligent building materials feature functions that are found only in biological organisms, such as sensing, subjective perception, judgment, identification, processing, actuation, self-warning, self-repair, and stimulus response. These functions are key to establishing networks for building-related facilities to provide application services for smart living; they are also the core neuron for promoting Construction 4.0. To develop intelligent building materials, strategies include using Taiwan's competitive industries (e.g., electronic sensing and ICT) to achieve cross-disciplinary integration with construction materials and construction industries, conduct innovation and feasibility verification, and transform intelligent building materials into a new high-value industry in Taiwan. Implementation strategies include clearly defining the scope of intelligent building materials, evaluating the

maturity of intelligent building materials, promoting intelligent building material certification, and testing and verifying at sites.

(5) Improve the effectiveness of construction operations by using smart maintenance management technologies

The government will develop building maintenance management service platforms integrating IoT and BIM technologies, and use cloud computing technologies to enable early warning and instant response, rather than a passive approach to building maintenance management (e.g., passive prevention and post hoc follow-up). The government will help building owners and management and maintenance companies to convert unstructured information (generated from building equipment operations) into information that will be useful for building operations, services, and energy control, and assist them to adjust the quality of building spaces and optimize operation efficiency. Lastly, AI technologies can be adopted to shift from preventive to predictive maintenance, and subsequently improve the quality of building maintenance management.

3.1.4.4. Develop 5G transportation and Internet of Vehicles (IoV) information platforms and use AI in highway management

Transportation application is one of the key focus areas of Taiwan's 5G construction development plan. In addition to hardware installations, the organization and convergence of the basic information required for software service development are also imperative. High-definition maps are generally expected to be a necessary part of future autopilot technologies. Currently, authorities in Taiwan have established high-definition mapping technologies, content format, and testing procedure standards; however, the transmission of dynamic map information among cars, roads, the cloud, data exchange, and data analysis are still in the nascent phase. With the concept of smart roads in mind, we will plan the facility specification and management service systems for smart roads, collect information on experimental sites where autonomous vehicles are tested, produce high-definition maps in accordance with the regulations and standards stipulated by the Ministry of the Interior (MOI), and cooperate with the cloud platforms developed by the Department of Land Administration (MOI) to conduct experiments on high-definition mapping technologies (e.g., data collection, transfer, cybersecurity protection, and real-time updating).

The government will research and develop technologies that analyze individual vehicle data and large volumes of real-time traffic information, which can be used to determine accident locations, traffic flow models, road construction or other activity, and road conditions. In future, the government hopes to apply these technologies to different traffic management contexts to improve the quality of decision-making regarding transportation management, solve traffic problems, and increase the value of transportation information. Regarding IoV for motorbikes, the government will test smart safety devices at specific sites and develop IoV technologies for use in motorbikes and road side units to avoid intersection collisions and traffic accidents caused by poor visibility and achieve the goal of reducing motorbike accidents among students and collisions among people who use motorbikes for business purposes.

3.1.4.5. Promote the influence of culture and technology with 5G application sites

5G networks are characterized by ultra-high broadband, ultra-massive connectivity, ultra-reliability, and low latency. Taking the intellectual property rights of content indigenous to Taiwan as a core concern, we should combine cultural art performances and exhibitions with 5G network technologies and augmented/virtual reality, 8k displays, and other smart display devices to create story content native to Taiwan, build an immersive smart museum with virtually and physically integrated content applications, and produce novel performance content (e.g., new dramas that create multiple experiences from multiple perspectives, 3D globe theater performances, real-time guided tours using augmented reality simultaneous localization and mapping, co-acting in different places at the same time, and remote rehearsals). The government hopes to address the digital transformation needs of the culture industry, develop new sites and new operating models for cultural technologies, promote the innovation and upgrading of the culture industry, and guide a paradigm shift for demonstration sites.

3.2. Implement circular economy and environmental sustainability

3.2.1. Strategy 1: Use innovative models to develop a green economy

3.2.1.1. Increase the statistics of green-economy-related industries

The government should engage in cross-ministerial and interdisciplinary collaboration under existing operations, strengthen the collection and estimation of existing statistical data, cooperate in the organization of a green economy industry survey, provide environment-related data (including total assets, output value, and added-value for economic activities) and resource efficiency indicators, and use them in data modeling to examine the effectiveness of environmental policies and measures.

3.2.1.2. Promote green spending to construct innovative business models

The government will encourage green spending, create green consumption models and innovative business models, encourage consumers to select products that are beneficial for or less harmful to the environment, and promote government green procurement, which involves using recycled aggregates in public construction works or prioritizing government-approved environmentally friendly products or recycled products.

3.2.1.3. Promote digital environmental education

(1) Organize environmental education awareness campaigns combined with a green points app

Green points will be awarded for physical or online activities. These points can be exchanged for environmentally friendly products. The purpose of this rewards program is to convey environmental knowledge to the general public through campaign activities and encourage them to practice environmental protection in

everyday life.

(2) Disseminate environmental knowledge through Facebook, YouTube, and other social media platforms

Activities will be designed for the Environmental Knowledge Competition and the Environmental Protection Elite Volunteers Group and combined with Facebook Live and rewards programs. Everyone will be invited to participate to increase the breadth of the activities and public participation, raise awareness of major environmental policies, and improve the environmental knowledge and literacy of Taiwanese nationals. Celebrities or influencers will also be invited to produce educational YouTube videos on the environment.

(3) Promote social networks of environmental education

The government will continue to maintain environmental education on social network platforms, which includes the Facebook group Environmental Education with You and Me and the LINE account Eetouching, and recruit volunteers, private groups, community colleges, non-profit organizations, and other partners involved in various areas of environmental education. Meanwhile, the government will prepare environmental educational materials with reference to Environmental Protection Agency policies, current affairs, seasonal trends, and festive occasions, and organize online environmental education activities on the aforementioned social media platforms.

3.2.2. Strategy 2: Improve resource recycling technologies

3.2.2.1. Promote the recycling and reuse of waste materials that should be recycled

Regarding technologies, the government will cooperate with industries and academia to develop various innovative waste treatment technologies and optimal feasible control technology to improve the recycling and reuse performance of Taiwanese industries.

In terms of implementation, the government will establish management approaches and standards for recycled waste to improve resource efficiency. In addition, marine waste is misplaced resources; turning marine waste into gold to reduce incinerator load is integral to Taiwan's treatment of marine waste. The government will therefore use science and technology to link with marine waste disposal companies and recycling and reuse industries; commission the local government to conduct a pilot test on mechanisms through which discarded fishing nets and polystyrene waste in offshore islands are recycled and reused; and establish the Alliance for Recycling Marine Waste to encourage the general public and corporations to devote themselves to the removal, recycling, and reuse of marine waste to improve the effectiveness of marine waste removal, establish a marine waste circular economy, and accelerate the removal of marine waste. The government should also combine renewable energy with recycling technologies to avoid exposing coastal wasters to land pollution without having to supply additional power, and to recycle and reuse waste. In doing so, the impact of land pollutants on the coastal ecological environment is minimized, which in turn improves the quality of coastal waters, increases the protection, resistance, and restoration capabilities of the coastal water environment, enhances the quality of the marine

environment, maintains the balance between marine organism habitats and the ecosystem, and slowly increases coastal marine resources. Through the protection and sustainable use of marine resources, we can ultimately strive toward SDG 14 by 2030 and ensure the recycling and sustainable development of marine resources.

3.2.2.2. Promote the recycling and reuse of biomass energy resources

(1) Improve biomass waste to energy and resource technologies, mitigate environmental protection, and increase energy diversity and stability

Biotechnology, waste-to-energy incineration, pyrolysis or gasification, and plasma chemical reactions are technologies used to recycle biomass waste to energy and resources. These methods are associated with different energy conversion rates. Therefore, technologies with higher conversion rates should be developed to increase the utilization of biomass waste.

(2) Develop a regional distributed energy supply model to enhance the stability of power supply systems

The model will use synthesis gas (generally carbon monoxide and hydrogen), which is converted from biomass waste, to generate electricity for community residents (e.g., 200 households). The conversion of various types of biomass waste will be modularized into synthesis gas technologies and power generator facilities to facilitate flexible combination and expansion. Energy storage systems can also be developed with the model to connect excess power in parallel to a centralized grid to increase the overall stability of the power supply system.

(3) Initiate a field experiment program of reusing liquor and fiber digestate as fertilizer for farmlands after co-digestion

The government will introduce an experimentation program to promote the co-digestion of food waste and livestock excrement, and cooperate with related institutes to conduct a field experiment for reusing liquor and fiber digestate as fertilizer for farmlands after co-digestion. The collected experimental data will be used as the basis for determining whether liquor and fiber digestate can be reused as fertilizer for farmlands. Subsequently, the government will address technical issues involving the application of environmental microorganisms, environmental planning and management, farmland risk management, and farming nutrition management.

3.2.2.3. Promote the recycling and reuse of recycled aggregates

(1) Ensure material quality and planning and application of recycled aggregates

The government will ensure the quality of materials, plan the appropriate application of recycled aggregates, and establish background information and regulations on the environmental leaching of recycled aggregates, which will be incorporated in construction guidelines.

(2) Implement the demonstrative management and verification of applying recycled aggregates to sea areas

The government will implement the management and verification of sea demonstrations by showing the application of recycled aggregates in marine engineering works and monitoring the quality of the marine environment, water, seabed, and ecosystem of reclaimed land.

3.2.3. Strategy 3: Promote the innovation and R&D of recycled materials

3.2.3.1. Initiate the innovation and R&D of circular technologies and key materials

Regarding technology, the government aims to develop innovative recycled materials, technologies for the recycling and innovative use of resources, and innovative designs for recycled products to strengthen the development of solutions for the diverse use and recycling of energy resources and waste by the agriculture, forestry, and animal husbandry industries and industrial sectors in Taiwan. Through industry–academia–research collaboration, we will conduct R&D on high-value materials made from recycled waste; key materials and technologies required for recycling processes; processes and technologies to turn renewable materials into high-value materials; and green processes for high-value products. Meanwhile, the government will implement commercial mass production in new recycling demonstration parks to bolster Taiwan's ability to supply key materials and strategic supplies, which will serve as the basis to develop the six core strategic industries and solve the problems of overdependence on imported materials and waste treatment problems.

The government will promote cross-ministry/institutional/academic/state-owned enterprises, establish national collaboration platforms, set up optional mechanisms and strategies, and prioritize projects involving industrial key materials that are technology-intensive, have high industrial value, and are associated with disconnected supply chains. We will unite faculty members from prestigious universities in Taiwan and overseas experts to implement basic R&D and talent development, thereby leveraging the resources of cross-system (ministries/institutions/academia/state-owned enterprises)/cross-disciplinary R&D institutes to link the R&D capacity and networks of enterprises in Taiwan and abroad.

3.2.3.2. Implement industry-integrated channels for the application of innovative recycled materials and technologies and export expansion

The government will combine smart green innovative technologies with high-performance optimization processes, such as green processes (high conversion rate) that reduce energy consumption (or increase energy conservation) and reduce wastage; promote channels connecting R&D alliances, redesigned consumer products, and enhance the value and popularization of recycled materials; and create opportunities to commercialize and export high-value recyclable products to bridge the R&D gap.

3.2.3.3. Reinforce the circular momentum of industrial demonstration parks

Through systematic design planning, the government will properly collect, recycle, and reuse the energy, resources, waste, and wastewater discharged from industrial production processes in science parks. The government will establish waste treatment, recycling and use, and environmental application models at terminals to increase the commercial benefit of land in Taiwan, demonstrate a high-quality environmental model of circular symbiotic settlement, and in turn expand this model to the entire country to form an ecosystem of circular industries.

3.3. Expand the use of renewable energy

3.3.1. Strategy 1: Make various plans for green energy technologies

3.3.1.1. Develop high-efficiency photovoltaic technologies to achieve the objectives of energy policies

Taiwan is a densely populated country where spaces for solar power installations are considered valuable. By developing high-efficiency solar cell technologies, we can increase the conversion efficiency of silicon solar cells to 24% from 15%–22% and reduce the demand for land by 10% or more, which can help Taiwan to achieve its solar power installation goal of 20GW, relieve the pressure for electricity during summer peak usage times, and concurrently bolster the competitiveness of Taiwanese industries. The government also plan to develop stacked solar cell technologies, which will be used to overcome the limit on the theoretical conversion efficiency of silicon solar cells and to create new technical plans for the post-silicon era and for industries in Taiwan.

3.3.1.2. Develop smart and unmanned intelligent testing technologies, improve the operational efficiency and autonomy of offshore wind farms, and plan the development of offshore wind farms in deep sea areas

In accordance with the government's three-phase (demonstration, potential, and zone) offshore wind policy, we will conduct an inventory and survey of the marine environment and engage in cooperative competition and negotiations with respect to marine spaces. Without sacrificing the balance between wildlife habitats and ecosystems, the government will develop the capacity to analyze wind energy potentials for water depths of less than 50 m, expand the scale of domestic offshore wind power market, and attract domestic and foreign investments in sustainable wind power markets.

Considering the characteristics of industries in Taiwan and global technology development trends, the government believes that Taiwan has a great chance of accessing the smart and unmanned intelligent testing market. By using unmanned vehicles with non-destructive testing (NDT) equipment and related instruments, we plan to independently develop competitive technologies that can be used to conduct operational maintenance, testing, and repairs intelligently.

The government will establish local supply chain of key components for offshore wind power plants, and transform it into an Asia Pacific hub of offshore wind energy industries. Through assisting domestic manufacturers of wind turbine components/steel

structural products and domestic developers of smart process equipment (e.g., smart welding equipment, NDT, and smart devices that record production processes) in investing in the development of high-performing intelligent grooving equipment, we intend to improve the capacity of local manufacturers to produce steel structural components and establish a local supply chain relating to the repair and maintenance of production equipment.

3.3.1.3. Develop local capacity of testing and verification relating to renewable energy

(1) Establish national energy storage system standards and the capacity to conduct safety testing

The government will establish national energy storage standards, as well as the demand and capacity for testing power cell units that can satisfy the energy storage requirements of domestic power companies. The objective is to address the safety problems derived from the mass deployment of energy storage facilities in the future and to comply with international standards.

(2) Develop MW smart inverter testing capacity for the integration of renewable energy sources with the electric power grid

The government plans to develop the capacity for testing products related to power regulation systems and MW-capacity smart inverters in response to the government's efforts to promote the solar power industry and to achieve the 20GW solar photovoltaic installation goal by 2025.

(3) Develop the capacity to perform offshore wind farm engineering works and to test, certify, and verify key components

Pursuant to Taiwan's offshore wind power policies and the demand for the localization of the offshore wind power industry, we will formulate (revise) national standards, local technical rules, and verification management systems to achieve the goal of sustaining the operation of local offshore wind farms.

3.3.2. Strategy 2: Build an Asia Pacific green energy center

3.3.2.1. Establish a green energy technology demonstration site and link the clusters of the green energy industry

The site will include an integrated platform that demonstrates the different functions of a green energy system, including energy production, energy storage, energy conservation, and power management. The platform provides a one-stop service for the development of green energy technologies in Taiwan and abroad and for promoting comprehensive industrial applications such as testing, verification, and demonstration. The platform is also linked to the resources of neighboring science parks and industrial zones to achieve the benefits of a clustered green energy industry chain. The government will also cooperate with related ministerial departments to create a world-class shopping window that uses plug and play to demonstrate the world-class

verification and integration of industrial technologies. Finally, the government will also take the lead in developing a wide range of technology applications, such as green energy electronics (e.g., power conditioning systems [PCSs]), power electronics for automobiles (medium to small PCSs), vanadium redox batteries, and high-efficiency permanent-magnet brushless motors.

3.3.2.2. Promote an offshore wind-powered marine technology industrial innovation park and become an Asia Pacific hub of the offshore wind power industry

The government will develop an offshore wind power underwater manufacturing base, establish Taiwan's local capacity to manufacture underwater bases, and concurrently build a comprehensive Asia Pacific offshore wind power talent development center by building an offshore wind power talent training base.

3.3.2.3. Combine smart technologies and integrate green energy system solutions

The government will develop intelligent frameworks, integrate multiple virtual power generating units such as energy supply, load control, and energy conversion, to strengthen the tenacity of energy systems; develop composite application systems, innovative application services, near-zero energy consumption demonstration houses; and integrate optimized green energy system solutions to create startup clusters and ecosystems, thereby actualizing the plan to export and integrate green energy systems.

3.3.3. Strategy 3: Increase the resilience of energy-integrated electric power grids

3.3.3.1. Increase operational flexibility through use of smart grids and increase the stability of electrical grids that use large amounts of renewable energy

The government will develop MW energy storage demonstration sites, focusing particularly on high-voltage safety, durability, smart battery management, and operational maintenance. The government will step up efforts to develop long-term energy storage systems that feature high performance and durability, and also verify electrical grid demonstrations, and develop business operation models for energy storage and power generation systems.

To effectively integrate large amounts of renewable energy sources, improvements must be made to regulatory systems, system operations, infrastructure, and technology R&D. To improve system operations, the government must integrate non-conventional power resources as well as user resources and energy storage systems to improve the flexibility of grid operations. In terms of technology R&D, the government should develop independent power distribution system solutions and promote the construction of smart grids.

3.3.3.2. Strengthen green energy distribution management and stabilize power supply quality

The government will develop localized smart power distribution management systems by using cross-disciplinary system integration capabilities and develop stable feeder voltage functions that will improve power supply quality and create a sustainable environment for renewable energy.

3.3.3.3. Build a friendly environment for public–private collaboration and create services for the application of meteorological information in energy transition to strengthen the resilience of energy systems

By building a friendly environment that facilitates public–private and interdisciplinary collaboration, the government will improve energy-related weather forecasting technology, combine relevant energy monitoring information, and use emerging technologies such as AI and big data to create services for the application of meteorological information in energy transition to mitigate the impact of energy transition on energy systems.

3.4. Boost the startup economy

3.4.1. Strategy 1: Nurture potential tech startups

3.4.1.1. Look for academic research results with potential for commercialization

From domestic universities and research institutes, we will look for research results that have the potential for industrial development and commercialization, which will then be reviewed by academicians and industry practitioners to determine whether the research results can be commercialized. By granting teams early fund and providing professional coaching, we can help promising teams to successfully access the market. In doing so, the government hope to encourage higher education institutions to conduct an inventory of their technological potential and assist them to commercialize their laboratory research results, which can in turn increase the contribution of scientific R&D results to national economic development.

3.4.1.2. Improve mentorship mechanisms to assist research teams to nurture tech startups

Bring industrial entrepreneurs from various areas to provide professional consultation and mentoring support to assist early stage research teams without preliminary business plans yet to work out preliminary business plans or verify concepts. Connecting networks of domestic and foreign resources through the mentoring mechanism is expected to increase entrepreneurial resources and funds and to maximize the commercial value of research results to catalyze the development of new products or

services, which in turn generate more funds for startup development or encourage existing companies to merge with the research teams, and subsequently infuse a steady stream of innovation energy into the industrial sector.

3.4.2. Strategy 2: Improve the entrepreneurial investment environment

3.4.2.1. Boost domestic early-stage investment environment and reinforce startup investment momentum

Integrate cross-agency entrepreneurial resources; boost domestic startup investment environment through expanding angel investments, entrepreneurial investments, and preferential financing per startups needs to support startup businesses with funds for steady development. Furthermore, cooperate with world-class venture capital and investment accelerators and introduce international smart money to provide the funds, connection, and market-related resources that startup businesses would need for further expansion. With different sources of funds, the government can become the main facilitator for startup businesses to explore global market opportunities.

3.4.2.2. Input business resources to startup ventures and drive the exponential growth of startup companies

In order to attract private sectors resources to invest in startup businesses, we will propose the feasibility to loosen the regulation regarding angel investment tax benefits. In addition, we will strengthen communication with enterprises to understand their needs and recommend promising startups to them. By improving mechanisms and investment tax benefits that motivate companies to cooperate with startups, we plan to encourage companies to set up investment departments or corporate venture capital (CVC) and increase their investments in startup businesses, which will speed up the growth of startups and at the same time introduce external innovation capacity for investors, strengthen their business competitiveness, and boost industrial transformation. The government will match startups to angel investment resources, attract domestic and foreign venture capital, and create more fundraising channels for startup businesses. Moreover, the government will also direct corporate funds toward startup companies to promote the entrepreneurial development of CVC investments.

3.4.3. Strategy 3: Bridging resources to nurture startups

3.4.3.1. Assist startups to connect to private companies and create the marginal benefits of strategic collaboration

Taiwan industry clusters rank ahead of the world. It represents the industrial development is relatively complete. In future, the government will take advantage of our industrial cluster and systematically link it to the continuous development of startup businesses. By observing the dynamism of domestic startup businesses, the government can provide startups with resources required to meet their development needs. Besides, the government will enhance the collaboration between startups and private sectors on

product/service development, sales marketing, and strategic aspects to generate real-life validated benefits. Moreover, the government will screen startups that cooperate with private enterprises to identify those that show high growth potential. By using cross-agency support to guide large enterprises and SMEs to expand their international market experience, the government will help startup businesses to introduce their products/services more effectively into domestic and overseas markets, thereby creating the marginal benefits of strategic collaboration.

3.4.3.2. Develop international entrepreneurial clusters and promote mechanisms to achieve international success

Taiwan's innovation capacity ranks number four in the world. Cutting-edge technologies and innovation talent can attract more foreign investors to move their base to Taiwan. In the future, Taiwan's world-class entrepreneurial clusters should make use of these advantages, integrate the Taiwan startup ecosystem, and increase their international exposure with the Startup Island TAIWAN brand to establish the startup image of Taiwan and attract international startups and world-class accelerators to relocate to Taiwan. We must also assist Taiwan's world-class entrepreneurial clusters and the entrepreneurial clusters of other countries to develop a reciprocal and normal collaboration mechanism, which will help startup companies to attain international success, increase the international visibility of Taiwan's startup ecosystem, attract foreign investments in Taiwan, and boost the global development of Taiwan's startups.

Goal 4: Enhance Smart Living Capacity and Realize a Secure Society

4.1. Develop healthcare

4.1.1. Strategy 1: Establish a comprehensive epidemic prevention policy

4.1.1.1. Comprehensively enhance the cross-disciplinary infectious disease prevention strategy and promote the sustainable development of national vaccination policy

(1) Strengthen the cross-ministerial collaboration network and decision-making system for zoonoses

The government will integrate the R&D capacity of agencies across the government; continue to strengthen national consolidated epidemic prevention system; monitor and investigate the epidemiology and risk factors of zoonotic diseases in Taiwan; and simultaneously evaluate the effectiveness and appropriateness of current prevention practices to reinforce the scientific evidence of management policies. The government will also participate in international health programs to capture opportunities that will allow Taiwan to cooperate with other countries and join the World Health Organization.

(2) Combine evidence-based practice with digital technologies to develop sustainable vaccination strategies

Long-term vaccination follow-ups can prevent disease epidemiology and provide an evidence base for vaccination policies. IT equipment is used to strengthen the preventive vaccination management system, reduce the workloads of health authorities and hospital staff, and increase data accuracy and integrity. Hospitals can make real-time inquiries into the vaccination history of an individual, which serves as the basis for providing correct vaccination services and disease diagnosis. A strengthened system also makes it easier for the general public to gain instant access to their vaccination record, thereby achieving the benefits of fully using disease prevention information.

(3) Build vaccine R&D production technology platforms to promote technology transfer for mass production

From pre-clinical studies to clinical trials, the government will encourage industries, academic communities, and research institutes to commit to the research and development of vaccines for emerging infectious diseases. The government will also develop new vaccine development strategies to speed up the production of vaccines made in Taiwan. These strategies could include developing novel recombinant vaccines, developing fast vaccine production technology platforms, establishing vaccine strain production technologies (good laboratory practice-based influenza

vaccine strain), and developing technologies to increase production capacity for mass production.

(4) Cultivate central and local health survey interdisciplinary talents to achieve precision epidemic prevention

By using a cross-agency training and exchange model, we will cultivate field epidemiology talents and establish a fully competent and well-coordinated team composed of members from different agencies with diverse work backgrounds. The government will improve the intermediary and advanced normal training system for zoonotic disease epidemiology talents. In addition, the government will reinforce mosquito ecology field surveys to enhance core technologies for local mosquito control and maintain the capacity of professionals and research personnel with expertise in mosquito control.

(5) Implement infection control, biosafety, and biosecurity in healthcare institutions

The government will investigate the burden of disease and attack rate of major infectious diseases among different population groups in healthcare institutions and communities, and refine healthcare-related infection prevention and control technologies. Furthermore, the government should establish laboratory biosafety supervisory systems to strengthen and implement the laboratory biosafety and biosecurity supervision functions of all entities that possess, store, and use infectious biological materials.

(6) Improve the efficiency of case diagnosis, treatment, and management and promote new prevention and treatment strategies

By setting up diverse screening channels and an epidemiology statistical model database, the government will reach out to vulnerable groups and detect clustering events in real time to prevent transmission. Through hospital collaboration and use of mobile devices, the government will improve healthcare services, treatment efficacy, and quality to reinforce follow-up, screening, and medication treatment consultation services for high-risk groups and infected individuals. Meanwhile, new medicines, vaccines, refined diagnostic tools, and testing technologies will be introduced.

4.1.1.2. Combine added-value smart technologies to develop a robust system for monitoring public opinions about infectious diseases and early risk warnings

(1) Construct nationwide infectious disease testing networks and testing technology support platforms

The government will develop testing methods for important and emerging infectious diseases, integrate advanced control and testing processes, and expand and integrate infection control and testing laboratory networks to increase testing capacity, timeliness, and quality. The government will also further expand the database of important and emerging pathogens and genes to optimize national disease control and monitoring. By developing and promoting new rapid testing technologies, the government will advance pathogen identification practices and pathogenicity and

drug resistance testing, and keep monitoring infectious disease, pathogenicity, and drug resistance trends, which will serve as evidence of infection control and prevention to build national infection control laboratories. With the expanded pathogen and gene database, we will construct complete national infection control and monitoring networks to keep abreast of pathogen trends and drug resistance changes. Lastly, the government will develop and promote rapid test kits and platforms, and improve pathogen identification and drug resistance diagnosis to enhance the timely diagnosis of infectious diseases and provide an evidence base for disease treatment.

(2) Develop a sound automated system of monitoring public opinions about infectious diseases and risk assessment procedures

By integrating cross-agency resources to improve disease control information platform, the government will use cloud computing technologies to establish a standard data exchange format, and also develop next-generation zoonotic disease risk assessment that supports data interface formats and cross-agency risk assessment mechanisms, which will not only improve reporting timeliness and accuracy and facilitate instant monitoring of nationwide epidemic status, but also provide intelligent technologies to achieve better epidemic status warning capability and support precise decision-making.

(3) Develop smart infectious disease information sharing and risk reporting mechanisms

The government will introduce new technologies (e.g., chatbots) to enhance the accuracy and convenience of public access to disease prevention information. The government will work with external agencies to broadcast disease-related reminders or vaccination information on information display devices (e.g., existing display boards, electronic scroll signs) installed in crowded places, or send infectious disease warning messages in real time by using cell broadcast service technologies.

(4) Monitor pathogens and drug resistance trends from different dimensions and incorporate results into practice

The government will implement a cross-agency integrated antibiotic resistance action plan, establish diversified antibiotic resistance monitoring mechanisms, monitor antibiotics usage and drug-resistant bacteria from multiple dimensions, concurrently enhance the antibiotic resistance and infection control knowledge of medical and healthcare personnel, and strengthen the antibiotic resistance knowledge of the general public to mitigate the threats of drug-resistant microorganisms.

(5) Research and develop integrated early warning and decision support platforms for mosquito-borne diseases through collaboration with industries, academia, and medical institutions

The government will connect to the central and local mosquito-borne infectious disease collaboration and prevention systems and set up integrated early warning and decision support information platforms for mosquito-borne infectious diseases to establish a sound mosquito-borne infectious disease control network for Taiwan. The government will develop medicines, diagnostic kits, and control technologies by using mosquito control and viral study results. AI and big data analytics will be

used to develop smart mosquito identification and trap devices, strengthen technology-based disease control capacity, reinforce Taiwan's biomedical industry, and export our experiences to Southeast Asia and the rest of the world.

4.1.1.3. Integrate the "one health" response capacity with border and community control in response to threats of emerging epidemic diseases

(1) Evaluate the effectiveness of biological disaster prevention strategies to support community infection control decisions and judgments

The government will investigate the effectiveness of infection control practices, such as supporting measures adopted in response to disease outbreaks, reporting of suspected cases, case management and follow-up, isolation and quarantine, and autonomous health management. The government will conduct an inventory of community disease control capacity, improve infection control decisions, and improve community disease control networks by integrating the infection control resources of the public sector, private communities, and professional groups to effectively curtail disease spread.

(2) Evaluate the effectiveness of port disease and health control for more effective border control

By referring to international regulations and practices of advanced countries, the government will integrate and analyze port and personnel quarantine information, improve quarantine policies and effectiveness, and reduce the number of imported cases of notifiable diseases. To provide infection control agencies with a precise method of tracking imported cases, the National Immigration Agency of the MOI has planned the development of the Passenger Name Record system, which accesses travel information from airline companies or travel agencies. Travel information includes detailed travel history (including transfers and accommodation) and seating information. In addition to helping infection control agencies to quickly access tourists' travel history, the system is also integrated with big data analytics to analyze the overseas travel records of infected tourists, and in turn screen for high-risk patients, thereby optimizing the control procedures to avoid infection control breaches.

(3) Increase the effectiveness of risk communication by using flexible and diverse awareness service models

By combining the use of different platforms such as traditional media and new media, the government will increase the reach of promotional information, improve risk communication and reporting strategies, and adjust promotional models as appropriate to prevent targeting only a single audience, which influences the effect of promotion. In doing so, the general public will be more aware of hygiene practices and the government's infection control measures, and will in turn spread correct information within their community, thereby to form a community disease control network to ensure health and safety.

4.1.2. Strategy 2: Develop precision healthcare and welfare

4.1.2.1. Develop personalized healthcare and big data applications

(1) Construct big data for precision healthcare

I. Big data governance and standardization for precision healthcare

(I) The government will develop a cross-agency distributed healthcare big data sharing framework, set up a designated big data area for precision healthcare with priority given to catastrophic diseases commonly found in Taiwanese citizens (e.g., cancer, cardiovascular diseases, and infectious diseases), and adopt a big data healthcare database to construct healthcare big data architecture and data standardization mechanisms for Taiwan.

(II) The government will set up a friendly national biomedical information analysis- and sharing- platforms; build an environment with value added by a precision healthcare big database; and provide data storage, calculation, and analytical tools by integrating database and IT infrastructures, which will be provided to research communities and industrial sectors for use to promote the value-added application of big data for precision healthcare.

II. Set up clinical translation-oriented big data

(I) By building a local cancer gene database, the government will accelerate the matching of novel targeted therapies, and optimize the multicenter clinical trial collaboration platform by collecting and sharing cancer genome data.

(II) The government will evaluate the feasibility and benefits of replacing current single-gene testing for cancer with next-generation sequencing.

(III) The government will build a big database combining Chinese, Western, and precision medicine.

(2) Develop regulatory guidelines for real-world big data application and develop precision health technology assessment

I. The government will develop a drug R&D analysis platform that uses real-world data of precision medicine to develop disease prediction models and screening and prevention strategies and to evaluate the correlation between each genetic testing platform and drug efficacy.

II. The government will amend Taiwan's related laws and management regulations in accordance with domestic and global healthcare development trends. For instance, we will develop laws and regulations for real world data and real world evidence, establish management regulations and a testing environment for smart innovative medical

materials, and adjust Taiwan's relevant regulations and technical guidelines in accordance with global emerging regenerative medicine development trends.

III. Health technology assessment (HTA): The government will expand the application of HTA mechanisms and develop different assessment payment models. The government will continue to conduct research on healthcare resource allocation and optimal health insurance coverage mechanisms. For expensive treatments and technologies, we will propose methods of assessing their efficacy and follow-up management mechanisms to provide a reference for future policy planning.

4.1.2.2. Translational research and industrial application of big data in healthcare

(1) Cross-disciplinary integration of genetic studies, cell therapies, regenerative medicine, molecular imaging, and drug development facilitates systematic review of genetic disorders and accelerates the generation of applicable results.

(2) Make use of the big data and AI computing capacity of biomedical databases to develop novel biomarkers for risk prediction, diagnosis, and treatment and also to develop disease risk assessment models.

(3) Develop treatment strategies and medications for specific diseases (e.g., rare/complex diseases specific to Taiwan, brain and neurological disorders, cardiovascular diseases, hereditary cancer, depression) to provide precision medicine.

I. Conduct systematic review and meta-analysis on non-clinical and clinical studies of specific diseases, assess the validity, results, and applicability of literature, research strategies and provide evidence-based recommendations.

II. Establish a gene catalogue of diseases that are rare and difficult to diagnose in Taiwan, attract the participation of domestic and foreign pharmaceutical companies, and accelerate the development of drugs and treatment strategies required in Taiwan.

III. Develop precision medicine for antidepressants and use IT systems to develop electronic or interactive service models for disease prevention and patient care.

IV. Implement cross-disciplinary integration of brain and neurology-related innovation studies and key technologies, forge international ties to increase the value of industrial and clinical applications derived from scientific research results, and develop AI-assisted high-specificity nuclear imaging contrast agents, precision nuclear medicine, receptor-specific drugs for brain and neurological disorders, and nuclear imaging for the identification of neurodegenerative diseases.

V. Provide technical services for biotech industries and new drug industries in Taiwan, internationally certified pharmacokinetic and new drug screening pre-clinical data, which will help industries to shorten the period from new drug development to clinical trials and become a strong support for new drug industries in Taiwan.

4.1.3. Strategy 3: Promote smart healthcare

4.1.3.1. Use technology to develop smart medicine and healthcare

(1) Develop and apply smart technologies in public health monitoring and individual health management

I. Continue to improve the adoption and application of digital and IT systems in public health monitoring and surveys.

(I) Use emerging and popular digital and ICT systems to develop health monitoring and survey models with effective target access.

(II) Incorporate a computer-assisted interviewing system in various health surveys to replace traditional paper-based surveys, reduce data entry errors, and increase survey efficiency and quality. Given the popularity of the Internet and the maturity of technology in Taiwan, we will develop questionnaire survey models with various channel interfaces by comprehensively considering the compatibility of survey issues and survey methods.

(III) Use IoT and AI technologies to develop a personalized health management service model, strengthen autonomous health management and health promotion initiatives, and increase the number of elderly users and their ability to use smart technologies.

II. Develop more data sources for public health monitoring

(I) Conduct an inventory of available individual-level monitoring databases and combine it with a regional environmental database, adopt related big data analytics, strengthen the various aspects of monitoring data (including the abilities of these data to be compared with local and international data, to predict demands, to be applied in decision-making, and to facilitate dynamic detection and their geographic orientation), and improve the environment for the value-added application of monitoring results.

(II) Improve the basic environment and knowledge management of health monitoring surveys by developing integrated and visualization tools to manage and index the contents of health survey programs and questionnaire items, and to present and search for survey data and statistical charts.

(2) Improve medical and healthcare with smart technologies

I. Remote healthcare services (telemedicine)

(I) Accelerate to improve remote healthcare related laws and expand its application.

(II) Adopt 5G and smart technologies and improve the healthcare

environment of rural areas with telemedicine and mobile medicine to solve the problem of inaccessible healthcare in rural areas.

(III) Develop remote healthcare services for indigenous people living in rural areas and on offshore islands, and set up a special telemedicine clinic in health departments.

(IV) Increase the user contexts of home-based service apps and develop a lightweight home-based healthcare system for real-time transmission of medical data. The system can be provided to care institutions for use in remote areas to complete home-based medical consultation.

(V) Use 5G and ICT systems to develop rural healthcare resource-sharing systems, and customize digital courses on healthcare tips and health management to improve medical and healthcare services and quality.

(VI) Evaluate the effectiveness of providing insurance coverage for remote healthcare services in rural areas, offshore islands, and mountainous regions where insurance coverage and medical specialists are lacking. We will collect opinions from service providers and service recipients and provide practical and valuable recommendations for policy improvements.

(VII) Develop and use tools to aid remote healthcare services to improve the accessibility and quality of chronic care.

II. Improve the performance of government services

(I) Integrate NHI big data applications, increase the value of AI applications, and strengthen the functional architecture of the AI R&D platform, which uses AI to analyze test results and medical imaging data. By combing the platform with NHI claims big data, we will develop smart review tools, which can be used to aid professional review and in medical services, and also improve the performance of NHI big data analysis and the availability of the data that the National Health Insurance Administration has collected thus far.

(II) Continue to optimize NHI information cloud inquiry systems based on the experiences of medical service providers, increase the value-added functions of healthcare data, and improve cybersecurity management mechanisms.

(III) Continue to improve the NHI reporting system, develop evaluation and research methods for healthcare quality information disclosure indicators of specific diseases, and enhance the benefits of using NHI healthcare quality indicators.

(IV) Establish a smart healthcare model by using virtual NHI cards.

(V) Develop better functions for the My Health Bank platform, including personal wearable device data interface and barrier-free web pages.

(VI) Introduce AI speech recognition and semantic analysis technologies, integrate the service trajectory of the general public on various channels, construct a smart NHI database, and provide

smart omni-channel NHI services that are available 24/7.

(VII) Establish a platform for children's diseases that are difficult to diagnose and plan remote consultation services for this platform to provide clinical evaluation and treatment suggestions, and increase medical accessibility for children with difficult-to-diagnose diseases.

(VIII) Introduce Child Death Review analysis to strengthen basic data collection and setups.

(IX) Make plans to develop an AI-assisted child development screening model, which will include an AI-assisted child development screening module, examinations by physicians, and daily assessments of a child's development status by parents or caretakers.

(3) Establish applications for smart long-term care services

I. Conduct inventory of smart long-term care service needs

(I) Develop integrated care services for smart healthcare, and then establish a smart care system by assessing the needs of community care takers and administrators for first-line services, which include home care, community care, nursing institution services, and hospital discharge services.

(II) Develop precision medicine and evidence-based care for patients with dementia. By using AI technologies, we will develop dementia prediction and evaluation systems and build evidence-based non-pharmaceutical intervention platforms to promote effective care models.

II. Integrate the resources of long-term care services and healthcare services to optimize the overall care model

Complete a smart platform that integrates continuous care information and service resources, and then increase the efficiency of service delivery by linking the platform to various levels of long-term care services and healthcare services.

III. Establish smart healthcare service demonstration sites for an integrated care service system

(I) Establish a smart community-integrated care service demonstration site to create a community-based care service demonstration site and an integrated community care service system, which uses ICT to provide community care services as well as innovative application services.

(II) Develop a human–machine rehabilitation device that senses the status of the human body and provides appropriate feedback, thereby improving the shortage of nursing resources and healthcare quality.

(III) Develop a long-term care service model that is localized to rural areas, as well as applications that support home-based care settings to increase the integration of home-based care services.

(4) Use AI technology to develop traditional Chinese medicine (TCM) diagnostic and treatment systems

I. Develop smart healthcare for TCM

(I) Build TCM big data and TCM mobile health systems

Use smart devices to develop TCM-related applications (e.g., body composition questionnaire, tongue diagnosis, acupoint massage treatment, and TCM-based exercises). With these mobile apps, users can upload body composition questionnaires and images of their tongue. The app will immediately analyze changes in body composition and tongue features, assess the suboptimal health status of users, tell users which acupressure points to massage and what TCM- exercises they should do, and also provide physiological assessments. By developing this integrated TCM healthcare service, we provide people with personalized health management information, and assist them to conduct self-health management, thereby achieving the goals of preventive medicine.

II. Combine AI healthcare technologies to construct a smart data-driven TCM management system based on molecular biology technologies

(I) Build a smart data-driven TCM management system based on molecular biology technologies; develop a system that quickly and precisely identifies the origin of traditional Chinese medicinal herbs; integrate data on existing morphology and chemical analysis characteristics; use big data and cloud technology to build a smart management model, which will serve as reference for the recognition and identification of Chinese medicinal herbs. Meanwhile, we will analyze the diversity of local medicinal plants and strengthen the preservation of plant germplasm and strong plant varieties to boost the development of local TCM healthcare products.

4.1.4. Strategy 4: Reinforce the food safety protection network

4.1.4.1. Use technology to improve food safety mechanisms

(1) Introduce smart technology to construct an early warning model

Achieve this by (I) using AI machine learning methods and a big food database to establish risk prediction models, and (II) adopting cloud technology to integrate Food Cloud and Chemi Cloud to effectively prevent unauthorized use of chemical substances in the food supply chain.

(2) Develop novel and high-throughput food testing technology

Achieve this by (I) developing new high-throughput testing technology to strengthen mechanisms for identifying unknown substances, specifically improve the capability to identify unexpected substances, and achieve the goal of proactive prevention of potential problems; and (II) promoting food testing technology exchange to increase information sharing channels, advance testing R&D capacity, and reduce monitoring blind spots.

(3) Strengthen the food safety net

(I) Analyze and keep track of various scientific evidence of food management and strengthen Taiwan's food safety management regulations in accordance with international and industrial trends; (II) predict the risks of hazardous substances in food products and conduct safety assessment by adopting scientific methods to identify potential hazards and reduce the food safety risks of Taiwanese nationals; (III) improve the inspection capability of verification institutions, focusing particularly on enhancing the verification quality and performance of third-party institutions that implement Level-2 quality control of food product companies; and (IV) establish scientific evaluation mechanisms that can be used to collect safety or toxicology information and international management regulations for evaluating Chinese medicinal herbs, conduct safety assessment of Chinese medicinal herbs that may be used as raw materials in food products, investigate whether the herbs can be used as raw materials in food products, and provide the recommended intake and relevant warnings.

(4) Develop border radiation testing and screening technology to improve the efficiency of radiation safety testing of imported food products

Because the general public is extremely concerned about the health risks of radiation in food products, we recommend adopting the approaches used in advanced countries. Specifically, food safety authorities will establish autonomous testing technology and laboratory, and set up a border control outpost (a mini laboratory) for effective food screening and control. Samples screened to be suspicious are sent to a precision laboratory for quantitative analysis. This process forms a deep network of protection to safeguard public food safety.

4.1.4.2. Create a safe and new form of agriculture with public–private collaboration and virtual and physical integration

(1) Launch the BIG granary project to increase domestic production of coarse grains

(I) Develop a farming outsourcing system and provide guidance on establishing a corporate group production area to increase the scale of production; (II) incorporate smart technologies into production processes to strengthen the post-processing capacity and food safety management capability of farmers' markets and implement a product grading system; (III) introduce a safety tracing and verification system and establish market segmentation; (IV) increase the added-value of products by developing functional and diverse processed products from coarse grains; and (V) enhance marketing promotions for domestically produced crops and implement food agricultural education to increase public support for domestically produced crops.

(2) Introduce a third-party verification system for stricter risk control

(I) Establish an all-inclusive organic farming model comprising soil fertilization, crop cultivation, and pest control, and develop pest control materials for organic agricultural products and commercialize these materials; and (II) expand the promotion of the agriculture and food traceability system and guide farmers to comply with Taiwan Good Agricultural Practices to improve the safety and quality of domestically produced farm products and strengthen the autonomous management and food safety accountability of domestic producers.

(3) Step up efforts to encourage the independent management of agricultural producers and bolster audit capacity

Use rapid screening mass spectrometry technique to test field crops. Crops that fail the test will be harvested until they pass the test to ensure that only products that meet safety and quality requirements are produced.

(4) Establish a cold chain logistics system to reduce loss and ensure the quality of delivered products

(I) Establish a cold-chain and long-distance storage and transportation business model for agricultural exports; (II) upgrade the cold-chain sites of existing wholesale markets; (III) establish a regional cold-chain logistics center for multifunctional agricultural products according to the fruit and vegetable production areas; and (IV) introduce cold chain technology and talent training to sites and connect the entire production-to-consumer process.

4.1.5. Strategy 5: Optimize the Institutional Review Board (IRB) process to expedite biomedical research

4.1.5.1. Improve IRB procedures

Carry out biomedical S&T projects with greater flexibility, reassess the possibility of expanding the scope of human subject cases eligible for expedited review by IRBs or exemption from review by IRBs and improve the regulatory and administrative aspects of review procedures while keeping in mind the core value of ethical reviews and the operation and timeliness of practices. Meanwhile, we will also solicit the suggestions of healthcare institutions and academic institutions and recommend ways to improve IRB processes or regulations.

4.2. Strengthen cybersecurity

4.2.1. Strategy 1: Build a resilient and safe smart country

4.2.1.1. Recruit global top-tier talents and foster autonomous innovative research capacity

In response to cybersecurity talent demands for national development, various

responsible agencies have initiated relevant plans during the fifth phase of the National Cybersecurity Development Program to invest resources to create a cybersecurity training environment. This environment will emphasize a practice-oriented innovative cultivation model based on industry–academia–research ties and integrate the cybersecurity teaching capacity of domestic universities. With the goal of developing a needs-oriented cybersecurity talent training system, such a training environment will be used to nurture outstanding cybersecurity talent for various industries in Taiwan to increase their training capacity.

Currently, Taiwan is implementing the DIGI+ plan and the 5+2 Industrial Innovation Plan, which are the foundation for developing its six core strategic industries to drive the digital upgrading of industries. Because cybersecurity is fundamental to digital transformation, a large pool of cybersecurity talent and advanced research is urgently needed. For Strategy 1, we plan to establish a Cyber Security Center of Excellence that lays the technical and talent foundation for supporting Taiwan's future cybersecurity demands. The objective is to transform Taiwan into a talent and technology innovation hub in Asia.

(1) Increase the quota of cybersecurity educators and teaching resources in higher education

I. Increase the number of teachers in higher education

Invite first-rate teams, teachers, academic scholars, and practitioners with expertise in cybersecurity from Taiwan and overseas, and offer them competitive salaries and benefits to recruit top-tier researchers to teach cybersecurity in higher education. Encourage universities to compete for outstanding cybersecurity talent with domestic and foreign industries and research institutes, so that schools can cultivate cybersecurity professionals and maintain teaching quality.

II. Open access to sites (e.g., academic regional network centers, government networks) for learning and practice

(I) We will work with university network regional centers and cybersecurity laboratories to provide learning programs that feature themes of instructional experimentation, physical/virtual training sites, and teaching and research courses of university cybersecurity departments. We will integrate regional networks or simulated laboratory situations into teaching practices, and conduct research and analysis or offensive and defensive drills to cultivate talented cybersecurity practitioners

(II) The government will plan the backbone network of the Government Service Network (GSN), which will serve as an open data field to expand the site for cybersecurity teaching and practice and improve facilities and the environment for teaching cybersecurity.

(2) Invest in higher education cybersecurity research

I. Develop national mission-oriented and strategic cybersecurity frontier research

In response to emerging threats and development trends in cybersecurity, the Center will recruit international talents to be in charge of the short- to mid-term applied technology research required by government agencies, and long-term basic research on strategic and core areas. The objective is to cultivate and strengthen Taiwan's self-sustaining forward-looking research capacity in cybersecurity.

II. Deeply cultivate academic cybersecurity research

Advance the research and development of software- and hardware-related cybersecurity technologies to meet the cybersecurity technology needs of public and private sectors, enhance the R&D capabilities of industry, government, academia, and research institutes, and activate the cybersecurity research ecosystem.

III. Transnational talents exchange and research collaboration

(I) Participate in the formulation of international cybersecurity standards and regulations; ensure that the developed technology conforms to international standards; and carry out international collaboration based on the results of frontier research on cybersecurity to enhance the international visibility of Taiwan.

(II) Cultivate top-tier talents with global vision and R&D skills; promote science and technology diplomacy; and forge international partnerships for the cultivation of multinational talents.

(3) Cultivate top practical and cross-disciplinary cybersecurity talents

I. Cultivate students, working individuals, and government employees to be cybersecurity talents

(I) Students

Develop demand-oriented design course contents and modules; optimize resources for teaching cybersecurity practices; cultivate cross-disciplinary cybersecurity talents; and strengthen cybersecurity education to nurture talent in cybersecurity practices.

(II) Working individuals

Promote cybersecurity teaching and practical courses for major industries; develop cybersecurity professional training and practical application talents; and help industries to quickly improve the capacity of their cybersecurity talents.

(III) Government employees

Promote the blueprint for training cybersecurity competencies, which will cover three aspects of strategy, management, and skills. We will plan six dimensions of cybersecurity competency training to improve the cybersecurity management and technical capabilities of government agencies, and train full-time government employees.

II. Cultivate top cybersecurity talents with practical experience

Our initial training targets will focus on elites in Taiwan with cybersecurity potential. We provide training programs for top talents in industry, academia, government, and the military. Different evaluation mechanisms (e.g., obtaining relevant licenses or passing exams) will be planned for different types of cybersecurity talents. Top talents who complete training are able to obtain better job opportunities and assist the government with safeguarding the cybersecurity of the critical information infrastructure. They can also serve as Taiwan's backup support in the event of an emergency. Long-term recruitment targets will be expanded to the Asia Pacific region. The ultimate goal is to become Asia Pacific's top cybersecurity talent training base.

4.2.1.2. Promote public–private collaborative governance to enhance the resilience of critical facilities

The fifth phase of the National Cybersecurity Development Program has established eight major critical infrastructure (CI) sectors and a national information sharing and analysis center (NISAC), computer emergency response team (CERT), and security operation center (SOC), all of which will assist the government to manage and transmit cross-regional national cybersecurity intelligence to facilitate domestic handling of cybersecurity emergencies and keep track of cybersecurity joint defense monitoring status at all times.

To make the CI more responsive to and resilient against cyberattacks, this strategy will involve continuous efforts to promote and implement cybersecurity protection criteria in various areas, coupled with offensive and defensive drills and audits to examine the effectiveness of their implementation. Meanwhile, we will construct a cybersecurity training blueprint to improve the CI frontline personnel competency.

(1) Build operating mechanisms for public–private collaborative governance in various areas

I. Continue to promote the implementation of the Cyber Security Management Act, and review it in due course to respond to international cybersecurity protection trends

Adjust relevant laws and regulations to meet practical implementation needs, and continue to improve and expand the assessment of cybersecurity governance maturity in order to build Taiwan's cybersecurity environment more quickly.

II. Promote the implementation of the safeguarding criteria for CI cybersecurity

Establish and revise the cybersecurity protection criteria for the CI sector and

introduce CI providers who are tasked with Level B or higher cybersecurity responsibilities. Through cybersecurity audits, we will determine CI providers' compliance with cybersecurity laws (e.g., maintenance plans, to-do lists, and cybersecurity protection criteria) to strengthen the integrity and effectiveness of cybersecurity protection.

III. Establish the maturity of cybersecurity governance in the area of industrial control

Industrial control systems provide management and control for various industrial processes and are widely used in CI sectors such as petroleum, water resources, natural gas, and electrical grids. To effectively measure the extent to which industrial control systems are protected against cybersecurity threats, we will establish cybersecurity governance evaluation models for industrial control to keep abreast of the cybersecurity implementation status of CI providers and improve their cybersecurity preparedness.

IV. Promote national-level cybersecurity risk assessment

Identify the core ICT systems of CI sectors and their cybersecurity threats to effectively observe Taiwan's overall cybersecurity threats.

(2) Reinforce personnel' cybersecurity awareness and capability development

I. Appoint a Chief Information Security Officer (CISO) and strengthen personnel's professional cybersecurity capabilities

(I) Encourage CI providers to a appoint top-ranking CISO who will oversee the implementation of cybersecurity policies and resource scheduling to boost the organizational culture that embraces the cybersecurity of CIs.

(II) Establish a cybersecurity experts database (e.g., retirees or companies) in various areas of CI who will handle external cybersecurity audits or drills for CI providers.

(III) Develop cybersecurity learning maps for various areas of CI, develop relevant courses over the years, and train a certain number of personnel.

II. Establish a simulated field as a means of verifying response capabilities, and incorporate cybersecurity situations in teaching and training

Establish a national CI simulation site, which provides a site for verifying the cybersecurity solutions required by domestic CI sectors, and support education and training, large-scale cybersecurity drills, and international cybersecurity competitions.

(3) Promote public–private collaboration to deepen information exchange and response drills

I. Improve the CI's cybersecurity joint defense mechanism (information sharing, reporting, cybersecurity monitoring)

(I) Continue to improve the integrity and effectiveness of government cybersecurity monitoring.

(II) Establish a reporting and exchange format that meets the latest international standards; quickly transform cybersecurity events into information that can be applied and shared, and improve the timeliness of reporting, response, handling, and information integration.

(III) CI authorities will continue to improve the cybersecurity joint defense operations and enhance the qualitative and quantitative benefits of these operations.

II. Regularly conduct public–private joint drills on site

CI authorities will regularly implement offensive and defensive drills to increase personnel's familiarity with and sensitivity to cyberattack events in the hope to ensure faster response and reduced losses.

III. Handle interdisciplinary (or transnational) drills for CI

We will regularly conduct cross-CI sector or transnational offensive and defensive drills to verify the effectiveness of cybersecurity protection and strengthen the cybersecurity resilience of CIs.

4.2.1.3. Utilize pioneering smart technology and proactively resist potential threats

Given increasingly sophisticated cyberattack methods, traditional defenses are no longer sufficient. Future implementations should focus on active defense practices, such as converting information into effective intelligence, which is then used to predict attack methods and necessary preparations and even to trace the source of attacks for prevention. This strategy entails formulating defense actions for each stage of the 7-step Cyber Kill Chain: Reconnaissance, weaponization, delivery, exploitation, installation, command and control, and finally, actions on objectives.

In reconnaissance, reduce cybersecurity risks by establishing a mechanism to proactively identify, report, and repair vulnerabilities in the ICT system in advance, and promote the upward centralization of the government's Internet, Intranet, and cybersecurity protection. For weaponization, improve threats intelligence gathering and proactive reconnaissance capacity; increase the depth and breadth of intelligence gathering through international collaboration; and predict attack patterns for preemptive deployment. For delivery, exploitation, installation, command, and control, develop active defense technologies and establish a zero-trust cybersecurity verification network environment for deeper cyber defenses. Finally, actions on objectives will involve achieving deterrence by strengthening cybercrime detection and prevention capabilities, enhancing traceability and tracking capabilities, and strengthening cross-border cybercrime detection.

(1) Continue to promote centralized sharing of government information (cybersecurity)

I. Link the needs for autonomous national defense and develop an ecosystem of domestic cybersecurity industry

(I) Provide internal-to-internal, internal-to-external, and cross-organizational network flow operations to strengthen the internal security of the GSN.

(II) Encourage government agencies to centralize their network export to higher-level agencies in accordance with the upward centralization of informational resources.

(III) Strengthen the proactive defense capacity of the government's Internet and Intranet to block malicious attacks in time.

II. Establish the mechanism to actively identify, report, and repair vulnerabilities in the ICT system

Through an automated reporting mechanism, we will shorten the period between the release and repair of cybersecurity vulnerabilities to reduce the risk of system hacking.

(2) Expand international participation and deepen transnational intelligence sharing

I. Develop innovative active defense research and technological applications

Research and develop automated smart collaboration and response cybersecurity modules; integrate AI technology to enhance the detection and respond competency to cyberattacks; create a cybersecurity R&D ecosystem.

II. Integrate domestic and foreign information sources to deepen international collaboration

Develop the NISAC into the main domestic intelligence and information integration platform; integrate domestic and foreign intelligence and information sources; enhance threat intelligence gathering and active detection capabilities; and promote standard intelligence and information exchange formats to meet international standards.

(3) Stay ahead of rivals to block attacks at the border

I. Apply emerging technologies to refine effective intelligence and develop proactive defense technologies

Through proactive defense thought, collect and analyse intelligence; adopt in-depth defense to actively control, trace sourcing and prevention; tracing related technology R&D and application in the hope to bolster the cybersecurity capabilities of government agencies.

II. Improve the GSN for deeper and wider defense

(I) Evaluate and introduce the Zero-Trust Network and make gradual attempts to verify its feasibility.

(II) Improve the threat analysis capacity of the GSN and observe intelligence on active defenses and an overview of threats and attacks.

(III) Strengthen external networks to more effectively detect and defend against regional malicious cyber intrusions; and enhance the resistance of the domain name system (DNS) against attacks to ensure the confidentiality and integrity of DNS data and the continuous availability of the DNS.

(4) Enhance the capacity of technological investigations to prevent new forms of cybercrime

I. Strengthen the capacity to detect new forms of cybercrime

Analyze the attack patterns and defense mechanisms of hacker attacks on the IoT and relay stations; strengthen the practical training of crime investigation skills; and build a simulation platform for the investigation of cybersecurity incidents to enhance the overall investigation and actual combat capacity.

II. Improve the capability to trace and track the source of cybersecurity events

Continue to expand the cybersecurity forensics capacity; autonomously develop on-site evidence collection tools; strengthen information sharing and technology exchanges; and analyze and compare the sources of countermeasures and hacker organizations to achieve traceability.

III. Strengthen the investigation mechanism of cross-border cybercrime

(I) Participate in various judicial and international cybersecurity seminars; establish foreign companies point of contact for accessing relevant crime information; enhance cross-border cybercrime investigation channels and technologies; and promote international information exchange.

(II) Make use of IT systems to develop independent application systems that can be used to uncover domestic hidden malicious threats.

4.2.1.4. Build a secure and smart IoT to enhance the protection capacity of the private sector

A recent discovery revealed that malicious attackers have switched to using a circuitous mode of attack, in which they first attack information service providers of government agencies, and then indirectly hack into the government systems. Therefore, apart from continuing to strengthen the cybersecurity capabilities of government agencies secure

and smart IoT of outsourced information service providers are also important. Reinforcing the risk management of outsourced supply chains needs to be included for cybersecurity.

The advent of the 5G network era also highlights the growing importance of the security of various ICT equipment. In addition to assisting telecommunication companies in Taiwan to focus on 5G cybersecurity risk issues and propose corresponding solutions, we must also pay attention to various IoT equipment and services related to the development of a new generation network, and formulate strategies related to compliance and site verifications to accelerate the implementation and commercialization of IoT solutions. Moreover, we will refer to international standards to promote internationally competitive cybersecurity solutions, with the hope of exporting them to the international market.

(1) Coaching companies to strengthen their cybersecurity capabilities during digital transformation

I. Integrate private resources to establish a public–private collaboration mechanism that assists companies to develop stronger cybersecurity capabilities

(I) Optimize the cybersecurity system and services of the Taiwan Computer Emergency Response Team / Coordination Center (TWCERT/CC), deepen cybersecurity consulting and coordination services for domestic enterprises, promote cybersecurity awareness, and enhance the cybersecurity capacity and awareness of private sectors.

(II) Improve the cybersecurity literacy and capacity of online retailers, and reduce the risk of personal data leakage.

II. Raise the cybersecurity awareness of the general public

The government should work with the private sector to raise citizens' cybersecurity awareness, infuse such awareness into daily life, and internalize it into the basic need to use service. In doing so, the development of advanced cybersecurity technology, software and hardware, and professional talent can be facilitated.

(2) Strengthen supply chain security management

I. Strengthen the management of outsourced supply chain risks

Assist and coach government agencies to include ICT systems establishment, maintenance, and services to the processing of outsourcing operations, in the hope to strengthen the cybersecurity management of contractors manufacturers.

II. Focus on the security of integrated circuit (IC) products

(I) Develop cybersecurity testing tools for ICs to address the latent cybersecurity risks associated with ICs.

(II) Build an internationally recognized IC cybersecurity testing laboratory; bridge the gaps of domestic IC testing technology and ecosystem; reduce barriers to cybersecurity compliance when exporting domestically produced products.

(3) Build a secure IoT network

I. Build a safe and sound network of next-generation mobile communication technologies

(I) Continue to complete 5G cybersecurity supervision regulations and practices and establish 5G cybersecurity testing laboratories to verify the feasibility of law and regulations and to assist industries to complete the cybersecurity protection of their 5G network.

(II) Establish a national-level ICT security laboratory and develop a reference framework and guidelines for ICT security protection to bolster the security of 5G networks in Taiwan.

(III) Create an environment for the vertical application and development of 5G networks, promote the integration and coordination of 5G applications to facilitate collaboration among multiple parties, and revise laws and regulations to promote the development of 5G vertical applications.

II. Promote IoT compliance and field verifications

(I) Develop frameworks for IoT cybersecurity testing and verification and formulate priority strategies and checklist items for IoT cybersecurity testing.

(II) Set up product improvement site where a supply-demand matching mechanism is adopted to strengthen the integration of the value chain of cybersecurity services.

(III) Assist domestic research institutes and ICT companies to participate in the formulation of international cybersecurity-related standards; foster information exchanges with international standards-related organizations; promote domestic cybersecurity technologies to connect to the world.

(IV) Promote the cybersecurity testing of IoT devices; raise the cybersecurity awareness of manufacturers and users; boost the development of digital innovative applications.

4.3. Create a secure homeland

4.3.1. Strategy 1: Complete adjustments and advancement of disaster warning systems

4.3.1.1. Increase resilience to climate change and enhance scientific research service capacity

(1) Improve the organizational resilience of the disaster prevention system

I. The government should establish a comprehensive disaster prevention system for general use or for use during and after disaster events. We should also plan ways to vertically and horizontally integrate the disaster initiatives of various government departments and city/county governments. These initiatives include resilient policy planning and coordination mechanisms, disaster rescue and preparation, disaster response, and relevant disaster prevention resources. The roles and responsibilities of the central government and county/city governments at different stages must be established.

II. The government should construct a general-use platform that transmits explicit disaster information in real-time. During a disaster event, we should be able to keep abreast of the rescue capabilities of first-line personnel (including rescue resources or tools) and ensure proper resource allocation. After a disaster event, we must establish a comprehensive review mechanism, through which to learn from the disaster experience and improve reconstruction ability and disaster resilience. In addition, the government should encourage private sectors to partake in government disaster reduction efforts.

(2) Strengthen economic resilience against catastrophic disasters

I. Sound financial and economic capabilities are the key to post-disaster recovery and reconstruction. Therefore, post-disaster recovery can be achieved only with the support of financial mechanisms and regular reviews with due consideration to current economic activities, the government's disaster budgets, and companies' coping capability.

II. For this reason, various central competent authorities are advised to develop actuarial techniques for the risks of catastrophic disasters, while each county/city government should pay attention to how disaster reserve funds and budgets are allocated. Meanwhile, we should encourage companies to develop disaster coping abilities and participate in government's disaster prevention efforts to fulfill their corporate responsibility.

(3) Enhance the resilience of society by improving the general public's disaster prevention knowledge

I. The government will raise the disaster awareness of communities, groups, and citizens in general so that they understand potential disaster trends and know how to adopt vulnerability reduction measures, which will in turn increase community participation and make society more resilient.

II. The government can conduct regular surveys of public disaster prevention knowledge, emphasize risk communication in disaster

education, improve the disaster prevention capability of foreigners, and strengthen disaster prevention drills for the community and general public.

III. In addition, the government should continue to promote disaster-resistant communities and plan different disaster prevention methods that are customized to specific communities. The government will monitor the disaster prevention strategies for individuals with specific needs, and bring local enterprises together to develop a disaster-resistant industry and encourage enterprises to adopt business continuity plans or other relevant measures.

(4) Build a completely resilient critical infrastructure (CI)

I. With reference to international trends, we will launch a CI plan that is prepared in advance for the most likely or most severe disaster scenarios, and incorporate it into disaster prevention strategy (e.g., plans and designs for disaster-resistant and life-support facilities).

II. The government will coordinate with the units in charge of the CI plan and ensure stakeholder participation during the process. Furthermore, designated units will be set up to analyze, evaluate, plan, communicate, coordinate, and supervise recovery and reconstruction.

III. CI plans must be based on past experiences to establish a learning cycle and review and feedback mechanisms.

(5) Assess the performance and benefits of a resilient urban green infrastructure in responding to climate change

(I) collect and examine the benefits of adapting urban green infrastructures to climate change and evaluate the performance of these infrastructures; (II) simulate the long-term effects of environmental factors (e.g., type of soil, drainage gradient) on a city; and (III) identify the modular conditions that would yield a green infrastructure with optimal adaptation performance to enhance urban resilience.

(6) Deepen the capacity to conduct scientific research on climate change and strengthen local coping tools and knowledge application

The government will strengthen our capacity to process and compute big data on climate change and reinforce the development and application of local climate change simulations and impact models. In the meantime, the government will also deepen cross-disciplinary research on climate change impact and risk assessment, establish local climate change risk assessment and adaptation tools, and accelerate the progress of climate-related risk assessment. The government will plan sustainable climate change research capacity and promote local climate change research, data estimation, and talent development. In response to policy requirements, relevant agencies across the government will collaborate to launch research on the demonstration of adaptation applications in key areas, promote knowledge accumulation, guide the development of research topics, and generate spillover effects.

(7) Respond to the impact of climate change by developing an atmospheric environment simulation and prediction system to keep abreast of future climate changes and provide interdisciplinary adaptation applications

The atmospheric environment is affected by the atmosphere, ocean, sea ice, and inland sea. In this relationship, complex dynamic, physical, biological, and chemical processes interact to maintain mass, energy, and momentum balances. When these processes are coupled with earthquakes, volcanic eruptions, sandstorms, and greenhouse gas emissions from anthropogenic activities, climate change will intensify, which will further increase the difficulty and uncertainty of weather forecasting. In future, global and climate numerical models will take into consideration the interactive effects of the atmosphere, ocean, sea ice, inland sea, and most importantly greenhouse gases (e.g., CO2 and aerosols) to construct a global atmospheric environmental simulation system that can be used to determine future climate change trends, provide interdisciplinary adaptation applications, and mitigate the impact of climate change.

(8) Establish a network for monitoring nationwide changes in meteorology, hydrology, ecology, and coastal lands and improve the country's marine adaptation strategies and disaster response capability

The government will establish a comprehensive and real-time network for monitoring nationwide changes in sea hydrology, ecology, and lands; conduct basic and long-term investigational research to facilitate large-scale ocean and atmosphere observations and monitor the characteristics and changes of the sea environment around Taiwan; and develop AI technologies, which use scientific data and techniques to aid the development of Taiwan's smart agriculture (fishery), green energy, marine adaptation strategies, and homeland security. In doing so, Taiwan is made more capable of responding to disasters and tackling climate change challenges.

4.3.1.2. Use big data and information integration to improve early disaster warning capacity

(1) Use big data and AI technology to determine uncertainties in weather forecasting and strengthen the effectiveness of early disaster warning operations

The demand for weather and meteorological forecasting and early disaster warning is increasing because of our socioeconomic development. Therefore, we must further improve existing forecasting operations. In addition, we should develop a digital weather forecasting system for Taiwan to provide densely populated urban areas, coastal areas, and recreational areas with a real-time early and special warning service on a township scale. Key tasks that need to be planned are as follows:

I. The government must continue to develop a real-time sub-kilometer-scale numerical weather forecasting system, multi-scale numerical model, and ensemble forecasting and data assimilation calculation model to increase big data quality.

II. The government must develop AI technology, using meteorological information to conduct cross-disciplinary integrated disaster prevention

information big data analytics and apply the results to disaster prevention and rescue information services.

III. The government must apply statistics, data science or AI to develop regional IoT digital forecasting and early warning technologies, improve our ability to forecast rainfall and typhoon in small areas, and expand early warning capacity.

IV. The government must build a local regional forecast knowledge base, train local regional professional forecasters, and improve the capacity of small areas to provide services during disastrous weather events.

V. By applying satellite-retrieved evapotranspiration and vegetation products with evapotranspiration models in drought testing, the government will establish a national-scale drought monitoring system, which can be used to conduct pilot research on early warning mechanisms.

(2) Use big data and AI technology to develop single-station on-site early warning systems, and strengthen earthquake early warning (EEW)

I. The government will collect and analyze large volumes of historical seismic records, build big database, use AI machine learning technology, develop highly stable, on-site EEW system to increase the EEW systems of urban areas.

II. The government will use the latest AI and big data analytics methods to develop an EEW microzonation model and database. Specifically, AI technology will be used to establish a micro-zoned EEW model, which divides Taiwan into thousands of zones using a $0.1° \times 0.1°$ grid, then determines the occurrence of earthquake according to real-time signals from seismic stations, and then estimates the magnitude of earthquake, if any, in every zone.

III. The government will collect large volumes of historical seismic records and analyze any connections or patterns with respect to the seismic signals and final seismograms recorded by various seismic stations during significant earthquake events.

IV. The government will use AI technology for seismic signal recognition. Differentiating seismic signals from man-made noise signals is the most basic problem of EEW systems. Current automated recognition systems are not completely free of interference from man-made noises. If the EEW system mistakes a noise for an earthquake signal, the system is extremely likely to send the wrong warning.

V. Seismic array technology is used to detect the location of earthquake sources and predict the magnitude. This technology can be used in the second defense line of EEW systems. In other words, we will set up several seismic stations 50 km away from the center of an urban area according to the location where catastrophic seismic waves are likely to occur, and then determine whether to issue alert to urban areas based on the results of the seismic array technology.

VI. The government will improve the on-site EEW system because if the system can process signals and send an alert to users on the spot, we can quickly inform users of potential seismic events without wasting time sending them information.

VII. Regarding the development of smart disaster prevention technologies, we will use mobile apps to quickly send seismic warning messages to users, which will include the estimated magnitude and response time before the shaking arrives so that users can take early actions in response and effective achieve the objective of disaster reduction and prevention.

VIII. Work with research institutes to conduct research on an AI-assisted microzonation EEW system so that the system can be used in forecasting operations as early as possible.

(3) Use technology to monitor environmental changes and transmit monitoring data in real time, and strengthen early disaster warning capability with big data analytics to improve the detection of disaster precursors

Climate change and global warming have increased the frequency of extreme rainfall events. For example, Typhoon Morakot in 2009 caused severe disasters in the mountainous areas of Central and Southern Taiwan. This event highlighted the disastrous consequences of a large-scale landslide, meaning that mountainous areas in Taiwan are at great risk of severe disasters. Because Taiwan is a small and densely populated island, climate change will bring different types of slope disasters to the country.

Rainfall is the main cause of slope disasters. To monitor debris flow, we will collect information on precipitation and monitor whether an area has reached the rainfall threshold for debris flow warning. Therefore, the government will operate automatic precipitation stations to achieve self-sufficiency in providing electrical power and communication and provide important disaster response information without being limited by the power and communication conditions of other monitoring equipment. Regarding monitoring technology, the government will operate fuel cell power supply systems to increase the monitoring cycle of simple monitoring stations, and then assess the feasibility of applying a low-power wide area network to automatic precipitation stations and simple/mobile monitoring stations to reduce communication cost and expand the monitoring range and cycle. Subsequently, the government will perform value-added analysis on data obtained from on-site monitoring, focusing on the following four aspects: (I) on-site image analysis, (II) establishment of on-site geophone signal analysis methods, (III) geophone signal indoor testing, and (IV) a study of geophone installation position. These analyses will significantly improve the effectiveness of debris flow monitoring stations.

Torrential rain has also garnered attention mainly because it will trigger large-scale landslide. Information on the time of landslide occurrence can be quickly obtained by using semi-automatic recognition to interpret landslide signals recorded by broadband array for seismology. This information is then used to analyze the rainfall information of historical disaster events and subsequently determine the rainfall threshold that causes landslide.

Regarding shallow landslides, we will attempt to develop a bi-factor model for landslide disaster evaluation by using a slope unit-based landslide fragility model. The bi-factor model can be used to develop a sophisticated landslide risk assessment analysis method, which is subsequently used to construct a landslide risk analysis model and provide useful information for disaster mitigation. This work will focus on (I) revising the landslide fragility curve model; (II) assessing the risk of landslide in protected villages and watershed by using a precision disaster prevention procedure; and (III) analyzing landslide warning mechanisms for administrative areas and testing warning models to improve Taiwan's research and development on landslide quantitative analysis, warning mechanisms, and risk assessments and

optimize the possibility of disaster prevention for the general public.

(4) Use big data to strengthen disaster prevention and early warning effectiveness

I. Strengthen disaster prevention and early warning effectiveness

The government will use real-time data collected from the water environment monitoring cloud system and combine the data with smart flood sensors deployed across Taiwan, to analyze the risk and vulnerabilities of the disaster prevention system. Furthermore, the impact of the water system on flooding and water turbidity will be evaluated to increase the accuracy of the basin rainfall runoff simulation numerical model.

II. Improve disaster response capability

Depending on precipitation and typhoon forecasts and environmental monitoring information, we will provide dispatch support recommendations for corresponding warning areas. By using AI learning technology coupled with flood sensors, we will develop a real-time flood early warning system and smart water pump scheduling system to build a disaster prevention decision support platform. Next, long-term precipitation forecast data will be used to develop long-term rainfall forecast technology for reservoir catchment areas. This technology will adopt drought early warning and water resources supply and demand coordination mechanisms to oversee the regional allocation of water resources. With sophisticated water management practices, we will improve the resilience of Taiwan against drought.

III. Build a resilience data system management platform to facilitate urban and rural development

County and city government will build an urban resilience database system and land management platform according to possible disaster scenarios, by using novel urban design ideas and low-impact development methods to define the ratio of open space in the development base and the raft foundation for buildings. Property management and high-end ICT equipment will be combined to develop community torrential rain management in line with regulations related to runoff distribution and outflow control.

(5) Develop smart environmental monitoring technology

I. Refine monitoring technology to keep abreast of disaster risks in real time

The government will set reasonable scenarios of extreme torrential rain induced by typhoon or heavy rains to assess potential risks. Considering the impact of climate change, we will continuously invest in meteorological R&D initiatives to improve our ability to monitor and forecast catastrophic weathers and develop stronger overall capacity to prevent and monitor disasters related to the water environment.

II. Develop water service disaster prevention industry

In response to the implementation of disaster prevention and mitigation policies and the integration of river basin improvement and adaptation plans currently promoted by the Executive Yuan, we will tap into Taiwan's powerful IT R&D capability and integrate public IoT applications for water, air, and land-based disasters to propel the development of a disaster prevention water environmental monitoring industry and form an ecosystem of this industry.

III. Develop the e-Global Navigation Satellite System for crustal deformation monitoring

Crustal deformation is monitored in real time by using precise coordinate results of Taiwan island (which includes Green Island and Orchid Island), Penghu, Kinmen, and Matsu Islands. These results are obtained in an extremely short time with wireless data transmission after the control and calculation center integrates, calculates, and processes continuous GPS monitoring data, which are recorded daily by each base station every second for 24 hours by using the high-precision global real-time dynamic positioning system that combines GPS, Internet, and wireless data transmission technology.

IV. Use high-tech mobile mapping system and remote sensing technology for national land mapping

Drones, mapping cars, and other devices and sensors are characterized by flexible mobility, high performance, fast speed, and low operating cost. Making use of these advantages, we obtain the spatial information of local variances or disaster areas and draw maps of the space. The government will also use satellite sensing and traditional aerial photography techniques to provide geospatial information and maps required for comprehensive disaster prevention and rescue, which is then used to support and assist with making decisions about disaster prevention and rescue operations.

(6) Promote the integration of sea recreational information and safety monitoring systems

The government will set up high temporal–spatial resolution monitoring, remote sensing, and numerical prediction systems; establish an interface for making risk information inquiries based on the type of sea activity and individual capability; publicly display marine environmental data and safety and risk information that are most relevant to participants of sea recreational activities; and develop a scientific safety and risk assessment mechanism. Subsequently, we will integrate low-earth-orbit satellite information, marine radar sensing, marine anchor systems, marine numerical simulation, and biological and ecological environmental monitoring, and conduct long-term monitoring of the marine environment of ocean recreational hot spots in Taiwan to determine coastal ocean dynamics and environmental changes, which can reveal the real-time dynamics of recreational sea areas and provide recreational participants with safety and risk information. Through long-term operational environmental monitoring, the environmental changes and impact caused by regional climate change or anthropogenic activities can be determined.

4.3.1.3. Improve smart disaster prevention systems and technologies

(1) Develop smart fire prevention technology

Smart fire prevention technology features seven functions: (I) It applies multi-environmental monitoring big data analytics to send the correct early warning in advance and locate the point of ignition, thereby preventing fire disaster. (II) It applies different ICT equipment to quickly and steadily provide the correct forecast and alert functions. (III) It accurately identifies and locates the sources of ignition and immediately activates the smart fire extinguishing and smoke control system. (IV) It applies smart push notification and guiding system to instantly provide evacuators with a safe and unobstructed route of escape. (V) It integrates the firefighting and rescue command system to provide reference information on indoor fire dynamics for the commander in charge. (VI) It provides positioning functions for firefighters and uses robots to assist rescue operations to ensure the safety of firefighters. (VII) It applies AI systems to aid the safety diagnosis of post-fire building structures and determines the extent and scope of damage, which are provided as reference for repairs or reinforcements.

(2) Improve smart disaster prevention system to achieve sound industrial chemical substance management and response capability

Nowadays, a single chemical disaster incident can involve a mixture of flammable, explosive, toxic, and corrosive chemical substances, all of which must be considered to facilitate early preparation for disaster prevention and rescue responses during the incident to minimize the harmful effects on the human body and environment. Therefore, S&T concepts for disaster prevention are used to prepare the operating environment, including chemical substances, processes, transport systems, storage facilities, and spatial allocation of emergency resources and materials. This approach not only strengthens operators' awareness and preparedness for emergencies but also helps rescuers to quickly keep the situation under control.

(3) Leverage emerging technological tools and management techniques to refine early disaster warning and rescue operations

Transportation systems are the pulse of national economic development. Tourist or cargo transportation relies on a safe and convenient traffic environment. Given the increasing probability of large-scale and composite disasters, we should strengthen our risk management mechanisms, adjust pre-disaster preparedness plans, improve disaster prevention early warning systems and monitoring capability, and introduce AI, drones, and IoT applications to transportation systems for disaster prevention early warning, including strengthening technological applications and disaster prevention information communication. Technologies will be upgraded and reinforced to enhance the capacity of transportation systems to avert and mitigate disasters.

(4) Apply technologies to strengthen the inspection and monitoring functions of transportation facilities

The environmental impact of climate change and weather has exposed transportation systems to increased disaster risks. Because of extreme climate changes in recent years, landslides and rockfalls on railways and highways, as well as damage to transportation facilities occur from time to time, influencing driving safety and travel safety. Therefore, the development of transportation facility inspection and monitoring technology integrated with transportation environmental information is necessary to provide open information services for greater value-added industrial applications. Moreover, early warning mechanisms should be established to ensure

the safety of public transports.

I. Develop inspection (monitoring) technology for railways, highways, bridges, and port facilities

We should reinforce the development of monitoring technologies for highways, railways, and bridges, and also conduct research on bridge foundation protection and railway inspection. For ports, we should establish port structural maintenance strategies and information management systems to strengthen mechanisms for assessing earthquake disasters and basic port engineering data.

II. Reinforce the integration of transportation system environmental monitoring information and value-added application services

The government will integrate transportation system environmental monitoring information, build a one-stop service platform, and strengthen big data analytics and open data tasks to achieve information integration, accuracy, and real-time display and promote value-added applications.

(5) Develop smart marine disaster prevention technology and smart equipment

(I) make use of remote controllers and remote equipment to carry out rescue operations, monitor marine pollution, and reduce the risks of coast guards; (II) develop maritime disaster statistics database and adopt big data analytics to prevent future maritime disaster incidents; (III) use drones along with smart imaging recognition systems to conduct sea rescues and increase the scope and efficiency of rescue operations; (IV) set up a maritime ship identification system that uses AI systems to automatically warn and report irregularities (e.g., speed, direction); (V) incorporate IoT applications to strengthen the communication and data transmission between various units of the rescue system; (VI) comprehensively and effectively monitor ocean pollutions by using multiple combinations of radar satellite and optical satellite, which provide historical data that can be reviewed retrospectively from a long distance; and (VIII) plan strategies involving smart rescue planning, modern rescue equipment, rescue mobilization, and strict personnel protection requirements to comprehensively enhance the validity of rescue equipment, reduce rescue blind spots, and create a safety net for maritime activities so that the general public can sail the sea safely and with peace of mind.

4.3.2. Strategy 2: Build a secure green chemistry environment

4.3.2.1. Implement global harmonization in green chemistry and establish safer alternative consensus and systems

(1) Integrate and cultivate green chemistry knowledge

(I) integrate relevant information about green chemistry education and safer chemical alternatives in Taiwan and abroad, link industrial demands and experiences, and continue to expand educational resources and teacher database; (II) promote the integration of green chemistry courses into existing (environmental) education courses and certification systems; (III) keep up with international trends and expand

international collaboration and participation to forge domestic and foreign partnerships in education.

(2) Engage in green chemistry innovation and nurturing

(I) gradually build the environment and resources required for industry–academia collaboration and R&D and make plans to provide a platform for green chemistry R&D and innovation and training collaboration; (II) encourage companies to establish green reward system and green production model.

(3) Establish safe alternative consensus and systems

(I) plan a list of consensus and priority areas for safer chemical alternatives; (II) develop strategies for the promotion of safer chemical alternatives and list applicable regulatory requirements; (III) conduct a pilot test on chemical substitution certification and list of chemical substitution demonstration industries and keep track of the assessment effectiveness and difficulties.

(4) Promote green chemistry R&D and reward measures

(I) plan green chemistry presidential awards and feasibility evaluation; (II) set up government subsidies for enterprises to go green and provide subsidies (donations) and incentives for using safer chemical alternatives; (III) research and analyze regulations on the incorporation of green chemistry R&D into corporate social responsibility certifications or competitions.

(5) Implement the 2030 sustainable goals and global harmonization

(I) deepen Taiwan's efforts to promote green chemistry standards and collect real-life examples of strategies that domestic and foreign green chemistry companies adopt to manage their substance use at the source; (II) continue to discuss issues and share information with different ministries to strengthen MOEA and MOST's scientific research collaboration mechanisms; (III) communicate with the international community to effectively share domestic and international experiences relating to green chemistry.

4.3.2.2. Enhance the capacity of chemical substance management

(1) Introduce international technologies to improve hazardous chemicals information and risk management

Keep abreast of any new dynamic information on substitution testing methods; introduce specialized technologies and training programs to strengthen competency and knowledge; equip industries, academia, and research institutes with the capacity to test chemical alternatives through animal testing; conduct an inventory of professional talent and relevant institutions or units that potentially meet certification standards; improve Taiwan's testing and R&D capacity so that it is internationally recognized; and build a complete database of information on hazardous chemical substances to reduce environmental hazards and increase industrial value.

(2) Use smart technology to reinforce chemical substance management and create safe livable cities

Our ministries will collaborate to build a network of smart objects that track the flow of chemical substances. Wireless communication, radio frequency, and IoT technologies will be used in conjunction with enterprise resource planning systems, and Chemi Cloud will be linked to related databases to track and trace the chemical substances involved in a logistic chain (including procurement, transportation, ingoing, storage, outgoing, usage, and waste disposal processes). Big data, blockchain, AI simulated scenarios, and technical analysis will be used to strengthen flow monitoring and traceability functions, cross-check information flow, cash flow, logistics, material balance, and other information, and screen for irregularities and vendor lists to achieve early warning benefits and reduce the risks of food safety and health. Moreover, we will use scientific technologies to assist industrial operators through cross-ministerial collaboration to build a database of information on the spatial distribution of chemical substances, add more information on chemical emergency rescue operations, and increase data visualization so that rescuers can quickly access necessary information when a disaster occurs.

4.3.2.3. Maintain public health by promoting integrated control over use of environmental agents and pesticides

(1) set up a comprehensive pesticide control and management decision-making system to achieve more effective pesticide control; (2) develop eco-friendly environmental agents such as microbial preparations, growth regulating agents, and pheromone products to reduce environmental load and promote environmental sustainability; (3) encourage industry–academia collaboration to improve the technology required for developing environmental agents.

4.3.3. Strategy 3: Advance toward a green society through nuclear decommissioning

4.3.3.1. Ensure environmental sustainability by strengthening Taiwan's nuclear decommissioning and radioactive waste control systems

Taiwan's licenses to use and operate nuclear power plants have successively expired. Given the special circumstance in which the nuclear fuel is still being kept in the reactor core of a facility in the decommissioning phase, we must make advanced plans with respect to decommissioning control technology research and practical needs. Meanwhile, we will learn from the experiences and regulatory requirements of other countries with regard to the decommissioning of nuclear power plants, build decommissioning control technology capabilities, and strengthen the decommissioning control quality and the reasonableness and effectiveness of control requirements, in order to meet Taiwan's control requirements for nuclear decommissioning operations.

4.3.3.2. Learn from international experiences and introduce IT-assisted management to develop independent nuclear decommissioning technologies

Most of the nuclear facilities built in European and American countries during the

1940s to 1950s when the development and application of nuclear technology were in the nascent phase, have expired and are in the process of decommissioning. Various countries are striving to develop independent localization related technologies and continuing to implement nuclear clean-up projects, for various purposes, such as to ensure radiation safety, protect the environment, or to take into consideration the output value of decommissioning industries. The development of nuclear decommissioning and radioactive waste treatment technologies is the common interest shared among nuclear-generating countries. The Nuclear Energy Agency of the OECD has set up a Co-operative Program on Decommissioning working group. The group regularly holds meetings to share decommissioning experiences to promote the nuclear decommissioning and radioactive waste treatment technologies of nuclear-generating countries. The moment Taiwan's nuclear power plants enter the decommissioning phase, the society will be concerned about how to safely decommission nuclear facilities. The Institute of Nuclear Energy Research can promote the technologies and experiences it has established thus far, including engineering information digitization management system, 3D imaging simulation, and knowledge management systems. Combining these with the capacity of Taiwan's domestic industries, we can increase the proportion of local decommissioning industry and assist in the promotion and implementation of domestic nuclear decommissioning.

4.3.3.3. Improve radioactive waste storage, treatment, and disposal technologies to ensure the safety and reduction of decommissioning waste

The UN 2030 Agenda for Sustainable Development Goals included the safe and environmentally sound management of radioactive waste as an issue of international collaboration. The objective is to promote interaction and integration through a broader international collaboration system to ensure the safe management, transportation, storage, and disposal of radioactive waste, so as to achieve the goal of protecting human health and the environment. According to Taiwan's Nuclear Reactor Facilities Regulation Act, a decommissioning plan should be submitted by the nuclear power plant 3 years prior to the scheduled permanent cessation of operation of nuclear reactor facilities, and the decommissioning operation shall be completed within 25 years after the decommissioning permit issued by the Atomic Energy Council is obtained. Nuclear decommissioning will generate large amounts of waste, which must be carefully tested, classified, decontaminated, treated, sealed, and stored, to achieve the sustainable use of recyclable materials and cleaned-up, restored, and planned lands, providing that public safety is ensured and environmental quality is maintained. International experiences show that the establishment of radioactive waste disposal facilities may require decades of planning, including site selection, construction, operation, and entombment. This problem should be properly addressed in this generation so as to relieve future generations of this burden. Once a nuclear facility is entombed, we must ensure that it can no longer endanger the safety of humans in the future, and we should also suppress any potential impact that it may have on environmental sustainability. Therefore, the disposal of radioactive waste requires the government to direct S&T resources to scientific research and development, which will facilitate strengthening safety control and inspection standards and improve technological capabilities, such as disposal facility site selection and survey, facility design, safety assessment, construction, and operations, to properly address radioactive waste problems.

4.3.4. Strategy 4: Create a resilient city with intelligent environment

4.3.4.1. Develop new sensors and sensing technologies

(1) Develop water quality and air sensing technologies

Air and water sampling and sensing analytical technologies are improving on a daily basis, which greatly improved big data processing and wireless transmission technologies. In 2016, the Environmental Protection Agency began promoting environmental sensing IoT applications to develop sensing technologies that automatically measure air and water quality. It uses interactive IoT information systems to develop innovative air quality and water sensing technologies to bridge the gap in traditional monitoring methods. It also adopts low-density, high-frequency, and lost-cost approaches to cast a new network of air and water quality automatic monitoring and develop novel sensing technologies to bridge the gap in monitoring technologies. In the future, these technologies can also be applied to other scopes of water monitoring (e.g., irrigation water in farmland soil, groundwater, and other water quality monitoring networks) in order to transform scientific research innovations and generate added value for industrial technologies, thereby establishing a prosperous and diverse society that steers industries toward the goal of smart city development.

(2) Develop noise sensors for high-noise construction engineering monitoring

The government will develop miniature noise sensors integrated with noise, surveillance imaging, array, and construction site acoustic recognition systems and apply them in noisy construction sites in Taiwan to provide real-time feedback for environmental agencies and construction management units to use as the basis for inspection and independent construction site management. Meanwhile, we will draw up maps of noisy construction sites in Taiwan and use cloud-based big data analytics for information disclosure to increase civic participation and expand value-added data services.

4.3.4.2. Reinforce smart environmental monitoring and forecasting technology and optimize data-integrated information application services

(1) Reinforce smart environmental monitoring and forecasting technology

In line with key national development policies currently enforced by the government, we will apply the critical needs derived from new industries at home and abroad, new information technologies, and new lifestyle patterns, and provide relevant environmental sensing applications and services to the general public, focusing on emerging IoT technologies and smart city concept. The general public is divided into groups and provided with sensing information monitoring and management, public application services and inquiries, as well as IT services and functions required for decision support and analysis to effectively monitor management and create additional data value. We will integrate IoT and big data analytics and strengthen the implementation of cybersecurity policies related to emerging technologies to specifically realize the act of serving the general public with innovative digital

services in Taiwan's environmental initiatives.

(2) Develop smart environmental monitoring technology

Authorities in Taiwan have developed nuclear emergency response technologies, which include incident assessment system, dosage assessment system, GIS (electronic maps), response operation platform, and radiation resource integration system (locations where radioactive substances are used, number of detection and inspection instruments) to instantly provide analysis and assessment results and keep track of various rescue resources, thereby ensuring nuclear safety and radiation protection. To prepare for the impact of climate change in the future, water resources in Taiwan must be used and managed properly, the sustainable development of the ecology in Taiwan must be maintained, and civilian applications and agricultural demands must be ensured. Against this backdrop, we must integrate 5G communication, AI, IoT, and cloud systems by using non-destructive atomic energy technology on Taiwan's existing R&D foundation to develop and establish effective early warning smart environmental monitoring technology for the preemptive deployment of contingency protection mechanisms to ensure the environmental safety of atomic energy-based civilian applications.

(3) Set up urban atmospheric environmental monitoring system, strengthen high-resolution meteorological forecasting capability, and support smart interdisciplinary applications

The demand for weather forecasts has increased considerably following the rapid development of the society, economy, and technology. In response, we will improve the three-dimensional atmospheric space and cross-sea and land monitoring systems by strengthening their ability to monitor the lower atmosphere and physical chemistry (e.g., wind speed changes, air quality monitoring, the altitude of the planetary boundary layer or inversion layer), and in turn develop a sub-kilometer scale grid forecasting and early warning system.

(4) Expand the coastal marine monitoring capability of Taiwan and develop smart marine weather warnings technology

The capability to monitor the weather conditions in land and marine environments must be improved to provide precise weather forecasts, marine weather forecasts, special forecasts, and weather alerts. Therefore, we plan to continue with the following works:

I. Introduce emerging technologies related to IoT and AI to actualize smart marine meteorological monitoring and application management;
II. Establish marine meteorological observations on ships through public–private collaboration to reinforce coastal marine monitoring capability;
III. Reinforce coastal marine monitoring to expand land–sea interface marine meteorological monitoring;
IV. Use ionosphere information and advanced noise cancelling technique to improve the quality of marine weather radar data;
V. Develop subsequent applications for marine weather radar data that will instantly convert basic radar sensing data for interdisciplinary use in

calculations (e.g., water depth, tide level, atmospheric wind field), sea surface oil pollution testing, and oil pollution tracking;

VI. Expand smart marine weather and cross-disciplinary integrated innovative application services;

VII. Build a smart marine weather information platform by using everyday information that is based on the livelihood of individual users, production activities of industries, and the ecology; and

VIII. Expand smart marine weather and cross-disciplinary integrated innovative application services.

(5) Set up national oceanographic information system, develop high-resolution regional ocean environmental information modeling system

Oceanographic information collected from marine monitoring and communication technologies will be integrated into a domestic ocean database to form a big ocean data IT platform. We will continue to enrich resources for oceanographic stations to verify and enhance the accuracy and integrity of oceanographic numerical models of air–sea coupling and wave–circulation coupling in sea areas around Taiwan. Satellite and radar technologies will be used to develop remote technologies for monitoring the ocean environment conditions, which can be provided for use in various areas of fishery, water activities, marine engineering, ocean power, transportation, scientific research, or national defense.

4.3.4.3. Conduct environmental pollution survey and develop analytical technologies for pollution characterization, pollution identification, and source identification

(1) Conduct sampling survey of unregulated emerging contaminants in drinking water, promote drinking water screening operations, and use the results as basis to review and revise drinking water quality standards to ensure the safety and quality of drinking water

The development of technology has introduced a number of new contaminants into water resources. The advancement of water quality testing technologies has continuously unveiled traces of new contaminants in water bodies. Emerging contaminants include pollutants from S&T industries, endocrine disrupting chemicals, persistent organic pollutants, personal care products, healthcare products, pollutants derived from daily activities, and agricultural pesticides. Therefore, the potential health impact of emerging contaminants in drinking water must be considered. With reference to the control items recommended by the World Health Organization and the drinking water quality standards of advanced countries, we will search for and compile a list of available information from known toxicology data, health inquiries, risk assessment tools, and other databases. Concurrently, we will apply monitoring or testing analytical technologies to investigate emerging contaminants that are regulated by advanced countries but not yet included in Taiwan's drinking water quality standards. Using scientific and systematic methods, the government will screen for and establish lists of contaminants under observation or contaminants recommended to be controlled, and provide a summary of their potential health impact, background information on the environment in which they exist, the treatment effectiveness of water purification plant, and the quality of

purified water. These materials will be used as reference for revising drinking water quality standards in order to improve the safety and quality of drinking water in Taiwan.

(2) Develop analytical technologies for pollution identification and source identification

Public nuisance cases endanger public safety and property. Damage assessments are complex and causes of damage are generally diverse, which means that conventional analyses cannot necessarily show a complete overview of the effects of public nuisances. Therefore, we expect to provide source identification methods and techniques by developing new environmental pollution identification technologies for local condition testing and application. The government will develop analytical technologies for environmental pollution and source identification to increase the completeness of source hot spot analysis. If more pollution and source identification technologies can be included in the analysis, information can be quickly provided when water pollution occurs, and relevant authorities can use the information to narrow their target industry and provide the responsible industry with scientific evidence, thereby implementing preventive management.

(3) Use isotope related technologies to characterize PM2.5 and analyze key pollutants in the atmosphere

Air pollution has been a major public concern in recent years. Aerosol composition and formation mechanisms are extremely complicated. The government hopes to use isotope analysis, atmospheric chemistry, and various other technologies to collect the chemical composition of PM2.5 and analyze key pollutants and sources in the atmosphere, and facilitate the formulation of air quality control strategies to safeguard public health.

(4) Analyze the relationship between air quality and health to fine-tune air quality control strategies and improve public health

The government will conduct health impact assessment research by characterizing air pollutants in Taiwan and analyzing exposure to pollutants and source of pollution. The results can serve as the basis for drafting air pollution control strategies. Meanwhile, we will reinforce protection over vulnerable groups and raise public health awareness.

4.3.5. Strategy 5: Enhance the effectiveness of judicial systems by using technologies to enforce laws

4.3.5.1. Make use of technology and prosecute criminal actions to enhance the effectiveness of judicial systems

(1) Crime prevention

This involves identifying abnormalities in advance from online search data and then issuing an alert.

(2) Crime investigation

This involves building up forensic investigation, medico-legal examination, digital forensics, technological supervision, and criminal investigation R&D resources, establishing relevant databases, and adopting certification systems to encourage technological innovation, enhance the effectiveness of technological applications, and maintain forensics quality, thereby increasing case handling efficiency.

(3) AI assistant prosecutor

This involves setting up AI systems to increase the efficiency and correctness of prosecutions so that judicial justice is reinforced, the rights of the parties involved in the litigation are protected, and public well-being is enhanced.

(4) Recidivism risk assessment

This involves using scientific assessment tools to determine whether the person on probation is at risk of recidivism, instead of using previous practices that assess risks of recidivism based on subjective impressions and observations.

4.3.5.2. Increase forensics investigation capability, develop new forensics technology, and maintain social security

The MOI National Police Agency (NPA) is responsible for the investigation of various criminal cases in Taiwan, and assists all levels of judicial bodies in Taiwan with assessing exhibits in various criminal cases and providing evidence for investigation and review. The scope of evidence analysis includes Internet communication, digital evidence, bullets, chemistry, microorganisms, drugs, documentary evidence, images, polygraphs, chemical traces, fingerprints, blood spatter, biochemical evidence, DNA, and crime reconstruction. Every year, over 20,000 cases are accepted for evidence analysis. The continuous advancement of society and technology has changed the face of crime. Therefore, we continue to develop relevant problem-oriented applications, cultivate talent with expertise in various areas, improve professional forensics capacity, and assist with crime investigations and judicial reviews to combat the increasingly severe challenges in public security works.

4.3.5.3. Promote the R&D and application of police administration technologies

The government will take the lead in introducing innovative AI technologies to police administration applications. Previously, a preliminary plan collected 5.2 billion sets of criminal intelligence and data from more than 63 internal and external units of the NPA. By using these data and AI machine learning technologies, we will analyze the NPA's massive volume of videos and intelligence to find clues for ongoing investigations and provide them to police officers. We will also analyze historical cases by using this massive intelligent database to predict criminal behaviors and prevent or eliminate crimes before they occur. This plan will focus on the following three areas:

(1) Intelligence access using AI

Combine data mining and analytical techniques to combat and prevent crime.

(2) Image analysis using AI

Set up high-flexibility image analysis platform for stronger AI image analysis capability.

(3) AIoT

Improve mobile police service performance, AI computing capability, and cybersecurity; strengthen the M-Police AI functions and back-end AI computing capability; enhance image and sound analysis and data processing capability; and reinforce cybersecurity protection.

4.3.5.4. Use smart technology to monitor the dynamic status of ocean safety and prevent smuggling activities to safeguard public health

This plan will involve the collection, analysis, assessment, exchange, and sharing of intelligence related to any ocean activities that might impact national food safety, the economy, and environment, as well as data and information related to ship tracking capability and all ocean activities. It also entails the development and establishment of software capabilities, such as the capacity to enforce maritime laws in threatened sea areas, which includes the construction of hardware facilities for ship tracking, data storage, commanding, control, and communication and also includes computer programs for data analysis and assessment, risk criteria setting, and establishment of relevant laws.

4.4. Support Smart Living

4.4.1. Strategy 1: Create an age-friendly smart living environment

4.4.1.1. Promote an age-friendly community space

An age-friendly community space is characterized by an environment where elderly people can engage in community activities safely and feel respected and harmonious in physical, mental, and spiritual aspects. The government shall integrate property management and community space maintenance to construct an age-friendly community equipped with community-based care facilities for elderly people to live safely and with peace of mind and improve their quality of life.

4.4.2. Strategy 2: Provide citizens with convenient smart public services

4.4.2.1. Strengthen the government’s digital management capacity to promote smart public services

Based on cross-agency data transmission mechanisms, integrate government service processes; adopt MyData mechanism to grants the public legal access to personal data; strengthen digital public services relevant to people's daily life. Furthermore, combine online ID verification mechanisms to simplify application procedures for general public; use technology to reinforce public services and increase the trust between the government and citizens to provide better services and experiences.

(1) Create Omni-Channel public services

Following the rise of mobile networks and social media, government agencies also provide multi-channel services, including official websites and apps, in addition to counter services. In order to solve the problems in people's daily life, the government will review the quality of public service, including whether the information provided at each contact point is complete, smooth, and service satisfaction. The government will actively promote data reutilization. On the premise of meeting compliance requirements to make use of government data and personal data, the required steps include to employ digital data to verify the eligibility of the public service application; to integrate cross-agency service processes to simplify application procedures; and to provide instant, correct, and the desired government services to support the public during difficult times.

For example, a smart environmental protection certification system uses emerging technologies to help citizens to apply for government services and access public services more efficiently. This system also provides a summary of all the information a person needs to supply when applying for a service. In support of the government's digitization policy, we will optimize the registration and application processes that apply to citizens, training institutions, and training centers into a one-stop online application service, and then develop a comprehensive electronic payment system. The government will strengthen the delivery of environmental protection information, including environmental protection training, news, and reminders of services offered by training institutions, and establish information communication mechanisms.

(2) Make use of emerging technologies to create new public service experiences

To restructure government digital services by using data and technology, we will use cross-agency data integration methods and design thinking to design simpler government service processes and digital service operation interface (User Interface and User Experience, UI/UX). A simpler service procedure prevents applicants from time-consuming problems to submit paper documents when applying for government service. Furthermore, AI and blockchain technologies will be employed to build new modes of government service operations. Specifically, AI is used to create better public service experiences, and blockchain is used to protect data from being tampered with, thereby forging stronger trust relationships between the government and the general public.

I. Continue to adopt smart and IT applications in airports

Countries worldwide are actively developing smart airports to keep up with technological advancements. Using more smart technologies and IT applications in airport operations and services to provide a convenient and friendly environment for travelers can not only reduce airport workload but also increase traveler satisfaction. This includes producing early plans on smart airport development, introducing smart design concepts to terminal

facilities, and choosing a pilot airport to create a smart airport environment for travelers. The objective is to improve the operational efficiency and service quality of airports.

II. Promote the digital transformation of ports and smart port services

In response to the digital development of sea transportations, we will make use of Taiwan's current ICT development, introduce related technologies, improve sea transportation operations, strengthen the performance of various port IT systems, and promote the smart development of ports. This includes the application of blockchain technology; the establishment and reinforcement of port-related development database and smart service platforms for sailors; and action plans involving AI-assisted ship operation system, smart port traffic and land transportation systems, and smart monitoring and management systems. The ultimate goal is to increase port operation efficiency and safety.

(3) Use livelihood data and create a new administration vision

In recent years, advanced countries have developed precision governance models for the government to solve the pain points its people are facing in daily life. Based on the policy topics of government agencies and people's everyday pain points, data analysis is used to determine strategies for improving public governance. Addressing livelihood issues is the primary task of government agencies in data governance. By clarifying policy bottlenecks or focuses of public opinions, to determine issues for which a solution is required, or setting the value to be created, the government will conduct cross-disciplinary data comparison and integration, use analytical models and algorithms to support decisions, and adopt geographical maps to support policy focuses and policy effectiveness.

(4) Promote smart public services

I. Conduct an inventory of benefits and services provided by local governments and develop multi-service plans.

II. Examine the operating costs of social services and the demand for professional support; and assist social service providers with digital transformation and developing early warning models that will help them to identify potential service targets. The goal is to tackle emerging societal problems and to improve service efficiency and quality.

III. Measures includes (I) Develop or expand social welfare platforms and systems to serve the public directly or indirectly; (II) Establish (a) electronic devices to aid online application platforms, and (b) electronic operating procedures and functions for resource inventory (private social welfare resources and resources of nationwide social welfare foundations), open data access, and resource review (online private social welfare resources) to publicly share the financial profile of nationwide social welfare foundations; (III) Establish and complete platforms for the online submission and review of community development quarterly publications to build a friendly social welfare industry–government–academia exchange platform; and (IV) Set up a welfare information system for families in hardship and children and adolescents. Specifically, the system will have improved functions such as service report queries chart analysis to analyze the massive database

of various subsystems and provide a reference for planning policies that provide financial support to disadvantaged families.

IV. Conduct an inventory of geriatric service resources and develop innovative service models for elderly people; establish elder abuse assessment tools, which can help first-line service providers to identify potential victims of abuse early and provide the necessary support service measures; develop a sound elderly service transportation system to build a network of social resources for elderly people; and promote future policy planning to properly allocate welfare resources for elderly people and enhance government efficacy.

V. Collect a complete range of basic volunteering information through nationwide volunteering survey programs, and use the information to plan the integration of public volunteering works and establish innovative volunteering models, which can be employed to guide policy developments, thereby encouraging more citizens to volunteer.

VI. Conduct an inventory of child care service resources and build a platform for the electronic management of institutional and home-based child care services so that first-line child caretakers can communicate with parents in different ways.

4.4.3. Strategy 3: Build the network required to support smart living

4.4.3.1. Strengthen public Internet services and computational infrastructures to build a resilient network society

To develop the six core strategic industries and bridge the urban–rural digital divide to achieve equality of resources for children (tribes) living in rural areas, Taiwan must construct advanced network facilities required for supporting the future innovation, Inclusion, and sustainable development of Taiwan.

(1) Strengthen the efficiency and resilience of public service network transmissions

Develop a public service network exchange center, integrate existing public networks and provide a remote center framework to strengthen the cross-network transmission efficiency and backup support of the GSN, Taiwan Academic Network, Taiwan Advanced Research and Education Network, and Academia Sinica Network.

(2) Increase the resilience and quality of cloud services

Provide cloud computing, storage, and data cloud services required for government service operations and educational research. System, file, and data backup services will be made available to critical services. In addition, network applications for resource sharing and on-demand cloud services will be constructed to improve service quality and create diverse digital transformation value.

4.4.3.2. Promote advanced network facilities to support an innovative, inclusive, and sustainable smart living environment

Plan the promotion of 5G, satellite, and Taiwan fiber channel, and the development of advanced network facilities such as the second Submarine and 5G Joint Network Center to establish smart living solutions, which include IoT networks for civilians, communication for disaster rescue and prevention, rural broadband, and smart campus facilities. The purpose of the Taiwan fiber channel is to construct an onshore fiber channel connecting two ends of the submarine landing point in Taiwan, and the purpose of the Submarine and 5G Joint Network Center is to construct a brand-new submarine cable data exchange and backup center. The goal is as follows:

(1) Enhance Taiwan's strategic role in the global cyberspace community and transform Taiwan into a major country linking submarine cable routes in Asia Pacific, a major Data Hub in Asia Pacific, and a global partner providing reliable and secure data;

(2) Boost the digital economy of Taiwan by driving foreign investments in digital software development and attracting transnational providers of digital banking and over-the-top (OTT) media services to build their base in Taiwan; and

(3) Drive the digital transformation of Taiwan by combining cloud computing with AI technology to promote data integration, analysis, and application and steer local enterprises toward digital transformation, data innovation, and digital service development.

Chapter 5. Strategies and Division of Labor for Important Measures

The Plan, which will be implemented by 21 government agencies, contains 4 goals, 15 sub-goals, 44 strategies, and 134 measures related to the strategies. Table 7 lists the strategies and division of labor for the important measures.

Table 7. Strategies and Division of Labor for Important Measures

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 1: Refine the Talent Cultivation Environment and Create Advantages for Talent Recruitment	1.1. Create an environment that facilitates talent cultivation and recruitment	1.1.1. Strategy 1: Enhance the a flexible strategy for cultivating interdisciplinary talents	1.1.1.1. Encourage university–research institutes collaboration and loosen talent cultivation collaboration regulations	Ministry of Education／Ministry of Science and Technology、Ministry of Economic Affairs
			1.1.1.2. Loosen restrictions on the employment and flow of industry–academia–research talents, increase system flexibility, adjust salary structure, and improve incentive programs for talent retention	
			1.1.1.3. Strengthen the interdisciplinary transition of high-ranking talents and enhance the employment of PhD talents	
			1.1.1.4. Promote mechanisms for talent cultivation and industry–academia collaboration in strategic areas	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 1: Refine the Talent Cultivation Environment and Create Advantages for Talent Recruitment	1.1. Create an environment that facilitates talent cultivation and recruitment		1.1.1.5.Cultivate female scientific researchers	
		1.1.2.Strategy 2: Expand the global reach of higher education institutions	1.1.2.1.Transform higher education and improve scholarship and reward mechanisms for students	Ministry of Education、Ministry of Science and Technology／National Development Council、Ministry of Economic Affairs
			1.1.2.2.Combine strengths and promote the internationalization of higher education	
			1.1.2.3.Acquire international scientific research resources to strengthen international research exchange	
		1.1.3.Strategy 3: Improve supporting measures for talent recruitment	1.1.3.1.Promote amendments to the Act for the Recruitment and Employment of Foreign Professionals	National Development Council／Ministry of Education、Ministry of Labor、Ministry of the Interior、Ministry of Economic Affairs、Ministry of Foreign Affairs
			1.1.3.2.Reinforce measures for supporting foreign nationals to live and work in Taiwan	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 1: Refine the Talent Cultivation Environment and Create Advantages for Talent Recruitment	1.1. Create an environment that facilitates talent cultivation and recruitment	1.1.4.Strategy 4: Deepen literacy in the humanities and technology	1.1.4.1.Create an interdisciplinary teaching environment and cultivate innovation talents for future society	Ministry of Science and Technology／Ministry of Education、Ministry of Economic Affairs、Ministry of Culture、Ministry of the Interior
			1.1.4.2.Enhance public science literacy and foster popular science professionals	
			1.1.4.3.Integrate elements of the arts and humanities to inspire talented interdisciplinary researchers	
			1.1.4.4.Reinforce cultural preservation and promote the application of innovative services	
			1.1.4.5.Build a consensus on social innovation and create a sustainable society	
	1.2. Improve industrial talent cultivation	1.2.1.Strategy 1: Cultivate competent talent that meets the needs of industries	1.2.1.1.Link universities and colleges to develop customized talent cultivation programs through industry–academia collaboration	Ministry of Education、Ministry of Economic Affairs、Ministry of Labor

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 1: Refine the Talent Cultivation Environment and Create Advantages for Talent Recruitment	1.2. Improve industrial talent cultivation	1.2.1.Strategy 1: Cultivate competent talent that meets the needs of industries	1.2.1.2.Enhance the links between professional courses and the practices of S&T industries	Ministry of Education、Ministry of Economic Affairs、Ministry of Labor
			1.2.1.3.Establish a regional base for vocational talents and skill cultivation	
			1.2.1.4.Initiate professional training courses on digital technology	
			1.2.1.5.Plan a professional competency identification system for industries based on the competency criteria of industrial talents	
			1.2.1.6.Enhance female re-employment and improve the workplace environment for women	
		1.2.2.Strategy 2: Cultivate talent in national strategic areas	1.2.2.1.Build a reserve of interdisciplinary digital talents in response to the digital economy and new forms of industrial development	Ministry of Education、Ministry of Science and Technology／Ministry of Economic Affairs

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 1: Refine the Talent Cultivation Environment and Create Advantages for Talent Recruitment	1.2. Improve industrial talent cultivation	1.2.2.Strategy 2: Cultivate talent in key national subject areas	1.2.2.2.Nurture frontier semiconductor interdisciplinary talents	Ministry of Education、Ministry of Science and Technology／Ministry of Economic Affairs
			1.2.2.3.Cultivate biomedical and industrial product innovation and entrepreneurial talents with international perspectives and the ability to integrate multiple disciplines	
		1.2.3.Strategy 3: Provide interdisciplinary training to cultivate talents in industrial innovation	1.2.3.1.Foster industrial innovation and R&D capacity	Ministry of Education、Ministry of Science and Technology／Ministry of Economic Affairs
			1.2.3.2.Launch internship programs for students to work in industries	
			1.2.3.3.Encourage university faculty and research personnel to engage in industry–academia collaboration	
			1.2.3.4.Guide universities and colleges to develop general education courses for interdisciplinary	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 1: Refine the Talent Cultivation Environment and Create Advantages for Talent Recruitment			innovative talents with international links	
	1.3. Promote diverse lifelong learning	1.3.1.Strategy 1: Promote the development of smart education	1.3.1.1.Motivate and encourage students to become independent learners	Ministry of Education
			1.3.1.2.Nurture professional teachers on science and technology education	
			1.3.1.3.Provide learning support to students such as learning devices and resources	
			1.3.1.4.Bridge diversified education and the paths for transitioning to higher education	
			1.3.1.5.Enhance the digital knowledge and skills of adults	
		1.3.2.Strategy 2: Promote diverse learning for all age groups	1.3.2.1.Establish cross-platform authentication mechanisms	Ministry of Education／National Development Council、Ministry of the Interior、all relevant ministries
			1.3.2.2.Provide personal learning records	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
	1.3. Promote diverse lifelong learning	1.3.2.Strategy 2: Promote diverse learning for all age groups	1.3.2.3.Recommend personalized learning contents	Ministry of Education／National Development Council、Ministry of the Interior、all relevant ministries
			1.3.2.4.Increase applications for job searching and continuing education	
Goal 2: Improve the Research and Development Ecosystem and Allocate Resources for the Development of Pioneering Technology	2.1. Make use of resources in strategic areas	2.1.1.Strategy 1: Build a decision support system for S&T	2.1.1.1.Improve the methods of formulating S&T plans and review mechanisms	Ministry of Science and Technology／Board of Science and Technology, Executive Yuan
			2.1.1.2.Strengthen the management of key policies and S&T plans and implement tracking and evaluation of mid- to long-term benefits and information	
			2.1.1.3.Improve the data management of S&T plans and establish an agile and professional decision support system	
		2.1.2.Strategy 2: Outline strategic areas of scientific research	2.1.2.1.Develop a system for funding basic scientific research	Ministry of Science and Technology、Ministry of Economic Affairs／Board of Science and Technology,
			2.1.2.2.Implement strategic plans on material topics	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 2: Improve the Research and Development Ecosystem and Allocate Resources for the Development of Pioneering Technology	2.1. Make use of resources in strategic areas	2.1.2.Strategy 2: Outline strategic areas of scientific research	2.1.2.3.Formulate scientific research development strategies based on future mid- to long-term needs	Executive Yuan、Ministry of National Defense
			2.1.2.4.Mobilize different ministries to jointly strengthen national defense scientific research capability and cultivate national defense talent	
	2.2. Foster stronger basic research capacity	2.2.1.Strategy 1: Preemptively identify key feature areas	2.2.1.1.Initiate long-term scientific research development and create advantages and strengths in response to future societal needs	Ministry of Science and Technology、Ministry of Education、Ministry of Economic Affairs／Academia Sinica
			2.2.1.2.Optimize the core infrastructure facilities and services of scientific research	
			2.2.1.3.Establish Excellence research centers to bolster Taiwan’s competitiveness in the global academic community	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 2: Improve the Research and Development Ecosystem and Allocate Resources for the Development of Pioneering Technology	2.2. Foster stronger basic research capacity	2.2.1.Strategy 1: Preemptively identify key feature areas	2.2.1.4.Deploy advanced pioneering industrial technologies	Ministry of Science and Technology、Ministry of Education、Ministry of Economic Affairs／Academia Sinica
		2.2.2.Strategy 2: Integrate the challenges and material topics of different disciplines	2.2.2.1.Strengthen the incentives for interdisciplinary collaboration and encourage interdisciplinary research	Ministry of Science and Technology、Atomic Energy Council, Executive Yuan
			2.2.2.2.Promote interdisciplinary research that focuses on societal needs and reinforce the integration of the humanities, science and technology	
	2.3.Forge deeper industry–academia–research ties	2.3.1.Strategy 1: Promote advanced R&D and innovation across different sectors	2.3.1.1.Facilitate the transfer of talented students and technologies and develop 5+2 innovative industries and key regional industries	Ministry of Education、Ministry of Science and Technology、Financial Supervisory Commission／Ministry of Economic Affairs
			2.3.1.2.Strengthen industry–academia–research collaboration and encourage different S&T	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 2: Improve the Research and Development Ecosystem and Allocate Resources for the Development of Pioneering Technology	2.3.Forge deeper industry–academia–research ties	2.3.1.Strategy 1: Promote advanced R&D and innovation across different sectors	sectors to engage in innovation	Ministry of Education、Ministry of Science and Technology、Financial Supervisory Commission／Ministry of Economic Affairs
			2.3.1.3.Build a regulatory environment that facilitates innovative entrepreneurship	
			2.3.1.4.Loosen laws and regulations regarding scientific research, entrepreneurship, and technology transfer and loosen restrictions on teachers' roles in foreign startup companies and shareholding structure	
		2.3.2.Strategy 2: Linking industries, academia, and research institutions for stronger innovation capability	2.3.2.1.Promote global research and industry alliances and integrate the innovation capacity of regional industries and academia	Ministry of Science and Technology、Ministry of Economic Affairs、Ministry of Health and Welfare／Ministry of Education
			2.3.2.2.Build industry–academia–research platforms and increase the value of the research results achieved by research institutes	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 2: Improve the Research and Development Ecosystem and Allocate Resources for the Development of Pioneering Technology	2.3.Forge deeper industry–academia–research ties	2.3.2.Strategy 2: Linking industries, academia, and research institutions for stronger innovation capability	2.3.2.3.Encourage research institutes to build bridges between enterprises and schools, forge stronger industry–academia–research ties, and promote innovative entrepreneurship	Ministry of Science and Technology、Ministry of Economic Affairs、Ministry of Health and Welfare／Ministry of Education
	2.4.Strengthen S&T risk assessment and data management	2.4.1.Strategy 1: Strengthen S&T risk assessment	2.4.1.1.Develop infrastructure risk assessment and application technologies	Atomic Energy Council, Executive Yuan、Environmental Protection Administration, Executive Yuan／Ministry of Science and Technology
			2.4.1.2.Develop risk assessment for new technologies	
			2.4.1.3.Develop an independent assessment model and analyze potential scenarios, changes in greenhouse gas emissions, and the status of achievement targets	
		2.4.2.Strategy 2: Improve data management mechanisms	2.4.2.1.Construct a privacy-protected data infrastructure environment	National Development Council、Ministry of Science and Technology
			2.4.2.2.Construct a data infrastructure	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
			environment that ensures both compliance and convenience	
Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation	3.1. Speed up the smartization and digital transformation of industries	3.1.1.Strategy 1: Strengthen smart applications for greater tenacity	3.1.1.1.Build smart supply chains to increase the tenacity of supply chains	Ministry of Economic Affairs
			3.1.1.2.Deepen the integration of software and hardware technologies to accelerate the digitalization and digital transformation of industries	
			3.1.1.3.Speed up integration with international smart application standards and develop key measurement and testing technologies	
		3.1.2.Strategy 2: Improve cybersecurity systems through international integration	3.1.2.1.Introduce industrial cyber risk classification and address the cybersecurity needs of industries	Ministry of Economic Affairs
			3.1.2.2.Encourage cybersecurity alliances to create solutions and test innovative systems	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation	3.1. Speed up the smartization and digital transformation of industries	3.1.2.Strategy 2: Improve cybersecurity systems through international integration	3.1.2.3.Introduce joint defense feedback mechanisms for a more tenacious cybersecurity system	Ministry of Economic Affairs
			3.1.2.4.Make Taiwan the global hub of cybersecurity innovation and integrate international systems	
		3.1.3.Strategy 3: Improve sites to optimize the environment for industrial innovation	3.1.3.1.Improve the digital transformation and service functionality of science parks to drive software and hardware integration and industrial innovation	Ministry of Science and Technology、Ministry of Economic Affairs
			3.1.3.2.Motivate R&D teams of academic institutions to invest in smart manufacturing, software and hardware integration, and technology upgrading	
			3.1.3.3.Build a smart technology verification site and promote the practical application and diffusion of research results	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation	3.1. Speed up the smartization and digital transformation of industries	3.1.4.Strategy 4: Achieve virtual and physical integration for a wider scope of interdisciplinary application	3.1.4.1.Integrate resources to build a sound environment for financial innovation	Financial Supervisory Commission、Council of Agriculture, Executive Yuan、Ministry of the Interior、Ministry of Transportation and Communications、Ministry of Culture
			3.1.4.2.Increase the digitalization of agriculture and promote the transformation of production and marketing strategies	
			3.1.4.3.Digitally transform industries to achieve Construction 4.0 and develop innovative smart city services	
			3.1.4.4.Develop 5G transportation and Internet of Vehicles (IoV) information platforms and use AI in highway management	
			3.1.4.5.Promote the influence of culture and technology with 5G application sites	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation	3.2. Implement circular economy and environmental sustainability	3.2.1.Strategy 1: Use innovative models to develop a green economy	3.2.1.1.Increase the statistics of green-economy-related industries	Environmental Protection Administration, Executive Yuan
			3.2.1.2.Promote green spending to construct innovative business models	
			3.2.1.3.Promote digital environmental education	
		3.2.2.Strategy 2: Improve resource recycling technologies	3.2.2.1.Promote the recycling and reuse of waste materials that should be recycled	Environmental Protection Administration, Executive Yuan／Ministry of Science and Technology、Ministry of Economic Affairs、Council of Agriculture, Executive Yuan、Ministry of the Interior、Ocean Affairs Council
			3.2.2.2.Promote the recycling and reuse of biomass energy resources	
			3.2.2.3.Promote the recycling and reuse of recycled aggregates	
		3.2.3.Strategy 3: Promote the innovation and R&D of recycled materials	3.2.3.1.Initiate the innovation and R&D of circular technologies and key materials	Ministry of Economic Affairs、Atomic Energy Council, Executive Yuan
			3.2.3.2.Implement industry-integrated channels for the application of innovative recycled	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation	3.2. Implement circular economy and environmental sustainability	3.2.3.Strategy 3: Promote the innovation and R&D of recycled materials	materials and technologies and export expansion	Ministry of Economic Affairs、Atomic Energy Council, Executive Yuan
			3.2.3.3.Reinforce the circular momentum of industrial demonstration parks	
	3.3. Expand the use of renewable energy	3.3.1.Strategy 1: Make various plans for green energy technologies	3.3.1.1.Develop high-efficiency photovoltaic technologies to achieve the objectives of energy policies	Ministry of Economic Affairs
			3.3.1.2.Develop smart and unmanned intelligent testing technologies, improve the operational efficiency and autonomy of offshore wind farms, and plan the development of offshore wind farms in deep sea areas	
			3.3.1.3.Develop local capacity of testing and verification relating to renewable energy	
		3.3.2.Strategy 2: Build an Asia Pacific green energy center	3.3.2.1.Establish a green energy technology demonstration site and link the clusters	Ministry of Economic Affairs

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation	3.3. Expand the use of renewable energy		of the green energy industry	Ministry of Economic Affairs
		3.3.2.Strategy 2: Build an Asia Pacific green energy center	3.3.2.2.Promote an offshore wind-powered marine technology industrial innovation park and become an Asia Pacific hub of the offshore wind power industry	
			3.3.2.3.Combine smart technologies and integrate green energy system solutions	
		3.3.3.Strategy 3: Increase the resilience of energy-integrated electric power grids	3.3.3.1.Increase operational flexibility through use of smart electrical grids and increase the stability of electrical grids that use large amounts of renewable energy	Ministry of Economic Affairs／Atomic Energy Council, Executive Yuan、Ministry of Transportation and Communications
			3.3.3.2.Strengthen green energy distribution management and stabilize power supply quality	
			3.3.3.3.Build a friendly environment for public–	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation	3.3. Expand the use of renewable energy	3.3.3.Strategy 3: Increase the resilience of energy-integrated electric power grids	private collaboration and create services for the application of meteorological information in energy transition to strengthen the resilience of energy systems	Ministry of Economic Affairs／Atomic Energy Council, Executive Yuan、Ministry of Transportation and Communications
	3.4. Boost the startup economy	3.4.1.Strategy 1: Nurture potential tech startups	3.4.1.1.Look for academic research results with potential for commercialization	Ministry of Science and Technology
			3.4.1.2.Improve mentorship mechanisms to assist research teams to nurture tech startups	
		3.4.2.Strategy 2: Improve the entrepreneurial investment environment	3.4.2.1.Boost domestic early-stage investment environment and reinforce startup investment momentum	National Development Council／National Development Fund, Executive Yuan、Ministry of Science and Technology、Ministry of Economic Affairs
			3.4.2.2.Input business resources to startup ventures and drive the exponential growth of startup companies	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 3: Co-create Economic Momentum and Build a Solid Ground for Innovation	3.4. Boost the startup economy	3.4.3.Strategy 3: Bridiging resources to nurture startup	3.4.3.1.Assist startups to connect to private companies and create the marginal benefits of strategic collaboration	Ministry of Economic Affairs／Ministry of Science and Technology、National Development Council
			3.4.3.2.Develop international entrepreneurial clusters and promote mechanisms to achieve international success	
Goal 4: Enhance Smart Living Capacity and Realize a Secure Society	4.1. Develop healthcare	4.1.1.Strategy 1: Establish a comprehensive epidemic prevention policy	4.1.1.1.Comprehensively enhance the cross-disciplinary infectious disease prevention strategy and promote the sustainable development of national vaccination policy	Ministry of Health and Welfare／Ministry of Science and Technology、Ministry of the Interior、Council of Agriculture, Executive Yuan
			4.1.1.2.Combine added-value smart technologies to develop a robust system for monitoring public opinions about infectious diseases and early risk warnings	
			4.1.1.3.Integrate the “one health” response capacity with	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 4: Enhance Smart Living Capacity and Realize a Secure Society	4.1. Develop healthcare	4.1.1.Strategy 1: Establish a comprehensive epidemic prevention policy	border and community control in response to threats of emerging epidemic diseases	Ministry of Health and Welfare／Ministry of Science and Technology、Ministry of the Interior、Council of Agriculture, Executive Yuan
		4.1.2.Strategy 2: Develop precision healthcare and welfare	4.1.2.1.Develop personalized healthcare and big data applications	Ministry of Health and Welfare／Ministry of Science and Technology、Atomic Energy Council, Executive Yuan、Ministry of Economic Affairs
			4.1.2.2.Translational research and industrial application of big data in healthcare	
		4.1.3.Strategy 3: Promote smart healthcare	4.1.3.1.Use technology to develop smart medicine and healthcare	Ministry of Health and Welfare／Atomic Energy Council, Executive Yuan、Ministry of Economic Affairs
		4.1.4.Strategy 4: Reinforce the food safety protection network 4.1.4.Strategy 4: Reinforce the food safety protection network	4.1.4.1.Use technology to improve food safety mechanisms	Ministry of Health and Welfare／Council of Agriculture, Executive Yuan、Atomic Energy Council, Executive Yuan
			4.1.4.2.Create a safe and new form of agriculture with public–private collaboration and virtual and physical integration	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 4: Enhance Smart Living Capacity and Realize a Secure Society	4.1. Develop healthcare	4.1.5.Strategy 5: Optimize the Institutional Review Board (IRB) process to expedite biomedical research	4.1.5.1.Improve IRB procedures	Ministry of Health and Welfare、Ministry of Science and Technology
	4.2. Strengthen cybersecurity	4.2.1.Strategy 1: Build a resilient and safe smart country	4.2.1.1.Recruit global top-tier talents and foster autonomous innovative research capacity	Department of Cyber Security, Executive Yuan／Ministry of Economic Affairs、National Communications Commission、Ministry of Education、Ministry of Science and Technology
			4.2.1.2.Promote public–private collaborative governance to enhance the resilience of critical facilities	
			4.2.1.3.Utilize pioneering smart technology and proactively resist potential threats	
			4.2.1.4.Build a secure and smart IoT to enhance the protection capacity of the private sector	
		4.3.1.Strategy 1: Complete adjustments and advancement of disaster warning systems	4.3.1.1.Increase resilience to climate change and enhance scientific research service capacity	Ministry of the Interior／Ministry of Science and Technology、Environmental Protection Administration, Executive Yuan、

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 4: Enhance Smart Living Capacity and Realize a Secure Society	4.3. Create a secure homeland	4.3.1.Strategy 1: Complete adjustments and advancement of disaster warning systems	4.3.1.2.Use big data and information integration to improve early disaster warning capacity	Ministry of Economic Affairs、Ministry of Transportation and Communications、Ocean Affairs Council、Council of Agriculture, Executive Yuan
			4.3.1.3.Improve smart disaster prevention systems and technologies	
		4.3.2.Strategy 2: Build a secure green chemistry environment	4.3.2.1.Implement global harmonization in green chemistry and establish safer alternative consensus and systems	Environmental Protection Administration, Executive Yuan
			4.3.2.2.Enhance the capacity of chemical substance management	
			4.3.2.3.Maintain public health by promoting integrated control over use of environmental agents and pesticides	
		4.3.3.Strategy 3: Advance toward a green society through nuclear decommissioning	4.3.3.1.Ensure environmental sustainability by strengthening Taiwan's nuclear decommissioning and radioactive waste control systems	Atomic Energy Council, Executive Yuan

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 4: Enhance Smart Living Capacity and Realize a Secure Society	4.3. Create a secure homeland	4.3.3.Strategy 3: Advance toward a green society through nuclear decommissioning	4.3.3.2.Learn from international experiences and introduce IT-assisted management to develop independent nuclear decommissioning technologies	Atomic Energy Council, Executive Yuan
			4.3.3.3.Improve radioactive waste storage, treatment, and disposal technologies to ensure the safety and reduction of decommissioning waste	
		4.3.4.Strategy 4: Create a resilient city with intelligent environment	4.3.4.1.Develop new sensors and sensing technologies	Environmental Protection Administration, Executive Yuan／Ministry of Transportation and Communications、Ocean Affairs Council、Atomic Energy Council, Executive Yuan
			4.3.4.2.Reinforce smart environmental monitoring and forecasting technology and optimize data-integrated information application services	
			4.3.4.3.Conduct environmental pollution survey and develop analytical technologies for pollution characterization, pollution	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 4: Enhance Smart Living Capacity and Realize a Secure Society	4.3. Create a secure homeland		identification, and source identification	
		4.3.5.Strategy 5: Enhance the effectiveness of judicial systems by using technologies to enforce laws	4.3.5.1.Make use of technology and prosecute criminal actions to enhance the effectiveness of judicial systems	Ministry of Justice／Ministry of the Interior、Ocean Affairs Council
			4.3.5.2.Increase forensics investigation capability, develop new forensics technology, and maintain social security	
			4.3.5.3.Promote the R&D and application of police administration technologies	
			4.3.5.4.Use smart technology to monitor the dynamic status of ocean safety and prevent smuggling activities to safeguard public health	

Goal	Sub-goals	Strategy	Measures	Ministerial departments
Goal 4: Enhance Smart Living Capacity and Realize a Secure Society	4.4. Support Smart Living	4.4.1.Strategy 1: Create an age-friendly smart living environment	4.4.1.1.Promote an age-friendly community space	Ministry of the Interior
		4.4.2.Strategy 2: Provide citizens with convenient smart public services	4.4.2.1.Strengthen the government's digital management capacity to promote smart public services	National Development Council／Ministry of Transportation and Communications、Environmental Protection Administration, Executive Yuan、Ministry of Health and Welfare
	4.4. Support Smart Living	4.4.3.Strategy 3: Build the network required to support smart living	4.4.3.1.Strengthen public Internet services and computational infrastructures to build a resilient network society	Ministry of Science and Technology／National Development Council、Ministry of Education、Ministry of Transportation and Communications、National Communications Commission
			4.4.3.2.Promote advanced network facilities to support an innovative, inclusive, and sustainable smart living environment	

Chapter 6. S&T Development Goals of Government Departments and Agencies

The S&T development goals of government departments and agencies from 2021 to 2024 are summarized briefly as follows.

Academia Sinica (AS)

Academia Sinica aims to achieve global excellence in research, fulfill key social responsibilities, and cultivate top talents.

Academia Historica (AH)

The Museum anticipates using 5G technologies to promote smart exhibitions and online promotions, which will strengthen the soft power of digital content infrastructures, provide higher-quality promotional contents, bridge the gap between sites in urban and rural areas, and realize digital transformation gradually.

Ministry of the Interior (MOI)

The MOI aims to promote green building construction, green building materials, intelligent buildings, and the reutilization of construction waste resources; achieve urban disaster prevention and resilience and building fire prevention and evacuation performance; build an age-friendly environment; develop advanced innovative construction industries and BIM technologies; construct sustainable, circular, energy saving, healthy, safe, and comfortable living environments; promote basic scientific research on advanced mapping to develop modern geodetic reference frameworks; integrate aerial and terrestrial mobile mapping technologies, and quickly obtain national spatial information for more effective analysis; improve crime scene investigation and forensic techniques and provide specialized criminal judice services; block external risks by adopting big data analytics to improve national security; enhance the digital application capability of new immigrants so that new immigrants can lead a digital convenient life; develop a smart emergency medical rescue information network to build an intelligent emergency medical rescue platform; and increase the accuracy of disaster predictions and disaster warnings.

Ministry of National Defense (MND)

In response to threats from opponents, combat needs, and the trends of frontier technologies, the MND aims to plan overall R&D goals for its weaponry system and integrate the capacity of industries, academia, and research institutes to actively develop advanced technologies, make breakthroughs in key technologies, and lay the foundation for the independent R&D of military equipment. In line with the national defense autonomy policy and Executive Yuan’s plans to promote the six core strategic industries, the MND will continue to cultivate an optimal environment for the development of national defense industries, accelerate the R&D and production of weapons, and lead technology upgrading to achieve win-win goals of meeting national defense needs and creating economic benefits.

Ministry of Finance (MOF)

The MOF aims to introduce new ICT systems to increase the value of fiscal data; develop innovative practices to manage customs administration, thereby speeding up the process of customs clearance; and use public cloud infrastructure to promote fiscal cloud services.

Ministry of Education (MOE)

The MOE aims to build basic capability in humanities and S&T and cultivate visionary and interdisciplinary talents; enhance stronger industry–academia–research ties to activate the paths of research results value creation; cultivate environmental sustainability education to improve learners' ability to conserve energy, reduce carbon emission, and prevent disasters; promote digital learning by building a quality educational environment that embraces fairness, openness, and independent learning; develop an environment that is well-equipped for talent development and talent recruitment; promote the internationalization of higher education; foster innovative technology experts industries require; and develop digital learning and applications to promote independent and adaptive learning.

Ministry of Justice (MOJ)

The MOJ plans to improve a judicial investigations and enforcements database, complete the integration of information platforms and systems, and promote cross-disciplinary collaboration services for resource sharing to enhance the overall justice performance; enhance cybersecurity defense capability, promote resource sharing, and strengthen technology-based legal services capacities; reinforce the security and protection technology of prisons and detention centers, promote the technological innovation of prison administrations, lay a firm foundation for correctional systems, and aid prisons and detention centers to introduce technology on security and prison administrations; develop AI assistant prosecutors to aid prosecutors in handling case reviews and public appeals, thereby increasing the efficiency and accuracy of prosecutions to attain the ultimate goal of achieving justice in the judicial system; and develop and set up an AI-assisted system for assessing the recidivism risk of probationers, and establish scientific and objective risk assessing and managing system.

Ministry of Economic Affairs (MOEA)

The MOEA aims to guide industrial innovation, transformation, and development patterns, strengthen the value of industrial innovation and R&D, and build a sound foundation for industrial and environmental sustainability.

Ministry of Transportation and Communications (MOTC)

The MOTC aims to create a green and clean transportation environment, achieve the transportation sector's GHG emission control goals and reduce air pollution, and plan policy blueprints related to the transportation sector's response to climate change; observe the momentum of international sea and air transportation, strengthen the transformation of smart applications, improve the functions of international sea and air transportation hubs, build international logistics capabilities, and promote the upgrading of sea and air transportation industries; develop track fastening testing and slope and bridge disaster prevention technologies to improve the safety and effectiveness of railway and road transportations; develop port smart environmental monitoring and green navigation safety technologies to enhance port performance and

navigation safety, and guide and assist the smart upgrading of ports in Taiwan; integrate commercial port environmental monitoring systems, expand value-added IT applications, and strengthen disaster prevention early warning services to promote the sustainable operation of ports; conduct research and application field experiments on ICTs for smart transportation, and build the basic capability to conduct R&D on science and technology; set up a network of new-generation dual-polarized Doppler radars, develop radar data application technology, improve the ability to forecast short-term heavy rainfalls in real time, develop real-time to climate-scale seamless forecasting technology to support key industrial innovation policies, link weather (climate) cross-disciplinary (new agriculture, green energy industry, digital economy) information services, develop real-time catastrophic weather forecasting technology, and promote sophisticated weather (climate) information smart application services; continue to strengthen earthquake, tsunami, and volcano monitoring facilities and related forecasting technologies, improve Taiwan's capability to issue early warnings in the event of natural disasters such as earthquake and tsunami, and expand the application of seismic information to disaster prevention, national land, and academic applications; apply modern marine meteorological observation and forecasting technology, construct a smart marine meteorological information service platform for maritime disaster prevention and marine industries, and promote accurate, timely, diverse, and active smart marine weather information application services; and respond to the rapid development of 5G/B5G and 6G communication technologies around the world by continuing to carry out research on the preparation of radio spectrum resources and the development of communication networks to assist the development of Taiwan's ICT industry.

Ministry of Health and Welfare (MOHW)

The MOHW aims to promote health and well-being of all citizens, ensure a safe living environment, prevent and control catastrophic diseases of all citizens, provide high-quality medical services, build quality caregiving service systems, improve social welfare systems, strengthen infrastructure, and develop biomedicine and health care industries.

Ministry of Culture (MOC)

The MOC aims to shape a society that is oriented toward cultural and technological innovation, and drive technological innovation and R&D with cultural imagination; popularize smart public cultural services, and promote cultural access and equality; connect with local culture and strengthen content production and art creation for the digital era; accelerate the digital communication of culture and promote the Taiwanese brand; and improve digital management to increase citizen digital participation.

Ministry of Labor (MOL)

The MOL aims to achieve the goal of enhancing labor rights, safety, and healthy workplace by building fairness and justice labor relationships and creating healthy and safe working environments. A smart model for the nationwide management of occupational safety and health will be constructed for diverse use by government sectors, labor agencies, workforce, business entities, and training units to strengthen their occupational safety and health management, improve the effectiveness of administration management, increase the disaster prevention knowledge of labors, and promote occupational safety and health as well as more effective administration management.

Ministry of Science and Technology (MOST)

The MOST's three strategic objectives are: (1) addressing societal issues by using technologies; (2) soaring research research; and (3) increasing the value of research innovation. Objective 1 involves promoting cross-disciplinary collaboration, deepening cultural inclusion, and planning frontier technologies. Objective 2 includes supporting basic research, cultivating researcher talents, and strengthening the impacts for the world. Objective 3 entails building sustainable smart science parks, promoting innovation economy, and expanding research results value.

National Development Council (NDC)

Through the Asia Silicon Valley Development Plan, NDC hopes to make Taiwan a key player of digital innovation in Asia; to accelerate industrial evolution with smart IoT and create a new future for the industry with innovative entrepreneurship. By focusing on citizen's needs, the NDC aims to deepen the promotion of cross-agency services, open data release, and evidence-based decision-making, and guide all ministries to continue improving government digital services, thereby giving birth to a precise and reliable smart government.

Directorate-General of Personnel Administration (DGPA), Executive Yuan

This Administration will improve the efficiency of government personnel services and enhancing national competitiveness.

Environmental Protection Administration (EPA), Executive Yuan

The EPA aims to promote waste recycling, establish a management system, revive the circular economy and environmental sustainability, promote source management, improve chemical substance management and information integration, develop new-generation environmental monitoring and sensing technologies, and create a secure homeland smart technology.

National Palace Museum (NPM)

The Museum will introduce frontier technologies, promote the digital transformation of the museum, and construct innovative smart museum experiencing models. New communication technologies such as 5G will be used to seamlessly introduce intelligent services for visitors and build a seamlessly integrated service environment. Focusing on the three aspects of "collections," "exhibitions," and "services," the Museum will ultimately be transformed into a 21st century smart museum.

Atomic Energy Council (AEC), Executive Yuan

The AEC aims to reinforce the atomic energy safety control to ensure public safety; promote the technological innovation of atomic energy and foster cross-disciplinary talents; and develop energy and back-end technologies for industrial applications.

Council of Agriculture (COA), Executive Yuan

The COA aims to continuously expand agricultural insurance coverage and improve benefits for farmers; reinforce agricultural infrastructures and alleviate agricultural labor shortages; promote the reasonable and circular use of farmlands, farm water, and

other resources; strengthen the quality and safety of agricultural products; accelerate the upgrading of industrial structure, build a cold chain system for agricultural products, and implement primary processing of agricultural products; enhance the added value of agricultural products, and expand domestic and global sales to increase farmers' income; and create a youth-friendly farming environment and strive for the sustainable development of agriculture, farmers, and farming villages.

Council of Indigenous Peoples (CIP)

The CIP will promote the installation of wireless broadband in indigenous areas to increase the overall and indigenous coverage of wireless broadband in Taiwan; safeguard the rights to watch digital wireless TV for indigenous peoples and families living in rural areas and improve the signal quality and stability of TV shows; adopt farming and breeding techniques which help promote environment friendly and diversified management of forest and livestock industry in indigenous communities to facilitate the co-existence of the environment and industries in indigenous areas; provide a model for small and micro indigenous enterprises to strengthen their product features and innovative services to drive the overall transformation of local enterprises; create the content of indigenous cultures and the ethnic identity of indigenous peoples and infuse them into the wisdom and S&T education of indigenous peoples, and fully implement the essence of digital equality and impartial information sharing among indigenous peoples; and integrate central and local resources, analyze data, identify 'pain spots', and develop solutions to serve as the basis for policy formulation, mid-to-long-term planning, and budget allocation for indigenous peoples.

Board of Science and Technology (BOST), Executive Yuan

The BOST coordinates cross agency planning and administration in strategic areas; implements division of labor and coordination across the government to enhance overall effectiveness of S&T policies; and coordinates and promotes nationwide grand S&T plans and programs to strengthen national S&T competitiveness.

Hakka Affairs Council (HAC)

The HAC aims to gather young local intellectuals, scholars, and representatives from characteristic industries to assist with the development of local industries and key talents, improve the self-digital learning capability of local industrial teams, alleviate the shortage of digital talents in local industries, and establish high-quality tourism environment and intelligent innovative services.

Department of Information Management (DIM), Executive Yuan

The Department aims to establish a new-generation cybersecurity protection framework to prevent cybersecurity risks; promote the automated information processing of robotic processes, improve information service efficiency, and increase the depth of administrative data openness to facilitate private value-added applications; integrate machine learning to provide administrative research and analysis information required for the promotion of government affairs; and improve API development and operational management mechanisms to improve the efficiency of informational resources.

Department of Cyber Security (DCS), Executive Yuan

The Department strives to become an Asia-Pacific cybersecurity research and training

hub, construct a basic network for proactive defense, create a network security environment through public–private collaboration, develop world-class cybersecurity solutions for emerging applications, deepen the cybersecurity awareness of government agencies, enterprises, and citizens in Taiwan, and establish a world-trusted cybersecurity system and industry chain to transform Taiwan into a resilient and secure smart country.

National Communications Commission (NCC)

The NCC aims to speed up 5G broadband constructions, quickly shorten the urban–rural digital divide, and promote the development of smart applications and innovative services. Network cybersecurity protection will be strengthened to ensure the security, reliability, and resilience of Taiwan's network. The NCC will also plan the 5G spectrum policy, promote the harmonious sharing of the 5G spectrum, improve the future spectrum supply operations, and adjust technological convergence laws and regulations to create a regulatory environment that facilitates digital transformation and the development of the digital economy.

Ocean Affairs Council (OAC)

The OAC aims to integrate marine scientific research information, deepen the national marine scientific research capacity, improve basic marine surveys, and keep abreast of the national land environment and resources. Smart technologies will be adopted to facilitate marine research development and promote smart marine governance. The OAC will also strengthen marine science and technology, lead the transformation and upgrading of the marine industry, strengthen coastal monitoring of sea areas, enhance sea rescue capacity, and ensure national security and the rights and interests of citizens.

Public Construction Commission (PCC), Executive Yuan

The PCC aims to integrate and build a comprehensive public engineering cloud system, develop online application cloud functions according to user needs, and construct a flexible, responsive, open-data, and energy-efficient system environment to provide stable, high-quality, and convenient system services for the general public.

Financial Supervisory Commission (FSC)

The FSC strives to strengthen its financial cybersecurity capacity to provide safe, convenient, and uninterrupted financial services.

Aviation Safety Council (ASC)

The ASC aims to improve its technological capacity to conduct aviation accident investigations, increase the quality and efficiency of aviation accident investigations, strengthen the management of safety improvement suggestions, perform safety research, and promote the exchange of safety information.

Chapter 7. S&T Resource Allocation of the Central Government

The development of Taiwan's S&T policies is based on multi mechanisms of government agencies including important meetings (e.g., the National Science and Technology Conference, Executive Yuan BOST meetings, Executive Yuan Strategy Review Board meetings, and Bio Taiwan Committee meetings), the Executive Yuan's key initiatives (e.g., six core strategic industries plan, frontier infrastructure plans, and the 5+2 Industrial Innovation Plans), and the strategic areas of the ministries' initiatives (e.g., technological development and industrialization). Based on the consensus and conclusion report of the 11th National Science and Technology Conference, the National Science and Technology Development Plan proposes the main goals and sub-goals of S&T development for the period from 2020 to 2024. As one of the sources of Taiwan's S&T policies, the Plan will be implemented by all participating agencies across the government, which shall adjust and allocate existing resources in accordance with policy objectives and promotion strategies.

Regarding the government's S&T resource allocation, all related agencies will present their plans with required budgets which will be based on the main policy initiatives of the Executive Yuan, agencies' S&T development plans, and conclusions of major meetings. The plans proposed by related agencies will be reviewed by BOST and MOST and then presented to the Executive Yuan for final approval. The related agencies will then write up a budget proposal, which is then submitted to the Legislative Yuan for review. In 2021, the S&T government statutory budget is NT$114.1 billion. To be competitive with major countries, the government's mid-to-long-term target (2026) is to invest 0.7% of the country's GDP in S&T R&D, with the S&T budget demands for 2022, 2023, and 2024 estimated to be NT$130.7 billion, NT$138.3 billion, and NT$145.3 billion, respectively (Table 8). Relevant strategies will be modified in a snowballing manner based on the actual amount allocated.

Table 8. Estimated S&T budget for 2022–2026

Unit: NT$100 million; %

Year	2022	2023	2024	2025	2026
Overall S&T budget	1,307	1,383	1,453	1,504	1,557
GDP estimate	205,441	209,550	213,741	218,016	222,376
Ratio	0.64	0.66	0.68	0.69	0.7

Data source: BOST, organized by MOST.

Note: The Directorate-General of Budget, Accounting and Statistics estimated the 2020 GDP growth to be 2.54%. The NDC estimated the 2021 GDP growth to be approximately 4% (estimated interval 3.8%–4.2%). The budgets after 2022 are tentatively estimated using an annual GDP growth of 2%.

Chapter 8. Implementation and Effectiveness Monitoring

The Plan is composed of two parts: “overall national S&T development” and the “S&T development in different government agencies.” The implementation evaluation is described below:

Regarding the overall national S&T development, the Plan contains 4 goals, 15 sub-goals, 44 strategies, and 134 measures related to the strategies, due to be jointly implemented by S&T related agencies, Academia Sinica, BOST, and the Department of Cyber Security of Executive Yuan. All participating agencies and required to propose an annual progress report, and the MOST is in charge of summarizing all together. Experts and scholars are invited to conduct a midterm evaluation of the plan after two years of implementation and a final evaluation of the plan on the fourth year of implementation. Depending on the target achievement status, cross-agency coordination meetings will be held if necessary, and the midterm and final evaluation results will be submitted to the Executive Yuan for reference. According to Article 9 of the Fundamental Science and Technology Act, the government shall present a written statement once every two years describing the visions, strategies, and current status of scientific and technological development. Therefore, the Plan will be duly modified halfway through its implementation to address domestic and global changes.

Part 2 of the Plan involves the S&T development goals and strategies of government agencies and S&T areas, as well as resource planning for 2021–2024. Specifically, government agencies will present their funding needs in the form of a plan. The Executive Yuan will follow the Operating Procedure for the Early Review of S&T Development Plans to approve the plan, which will be carried out accordingly once the Legislative Yuan approves the budget plan. The implementation results of the plan and relevant effectiveness reports are evaluated by the authorities in charge of the plan.

National Science and Technology Development Plan （2021–2024）

Published by：Ministry of Science and Technology, Republic of China （Taiwan）
Issued by ：Tsung-Tsong Wu
Address ：No.106, Sec.2, Heping E. Road, Taipei 106214, Taiwan, R.O.C
Telephone：+886-2-2737-7992
Website ：https://www.most.gov.tw/

Published：September, 2021
GPN：1011001480
ISBN 978-986-5436-33-9