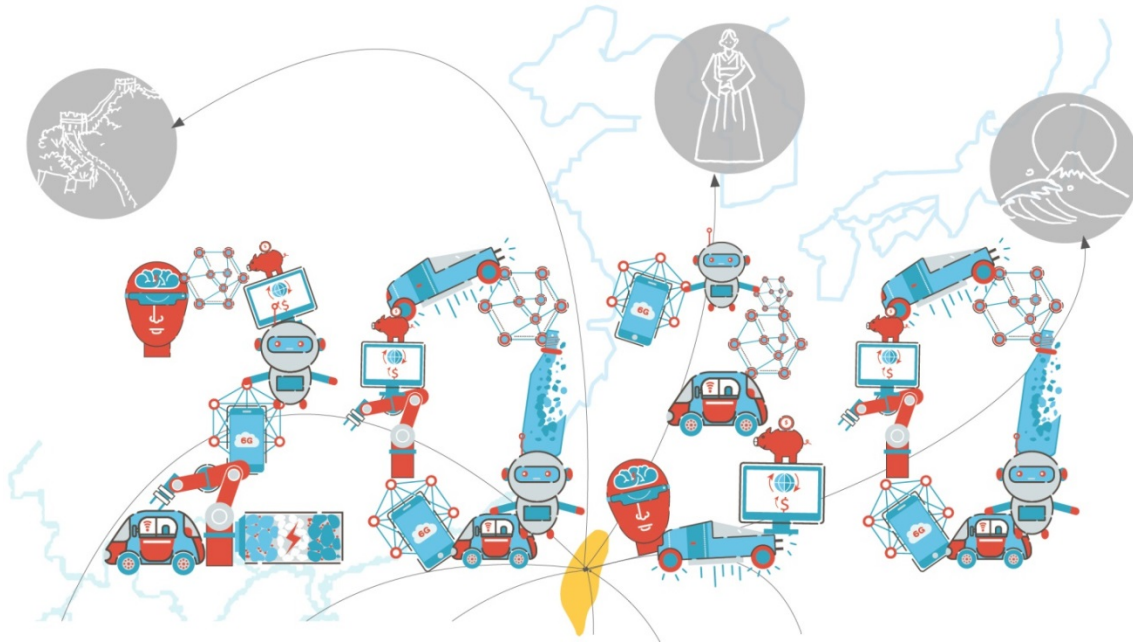




2030 Advanced Technology from an Asian Perspective

Executive Summary

This report aims to assess the 2030 market perspectives and policy plans of major Asian countries and find the 10 most crucial advanced technologies that will affect the Asian region. These technologies are 1) Artificial Intelligence (AI), 2) 6G Mobile Network, 3) Autonomous Vehicles, 4) Industrial Robots, 5) Service Robots, 6) Blockchain, 7) New Energy Vehicles (NEVs), 8) Renewable and Biodegradable Plastics Materials, 9) Solid-state Batteries, and 10) Nanomaterials. To identify the top 10 technologies in 2030 in Asia, IEK Consulting of Industrial Technology Research Institute (ITRI), based in Hsinchu, Taiwan, conducted a survey that selected 10 significant markets from which to carry out survey and data acquisition. The subjects answered questions related to advanced technologies in terms of impact, penetration rate, and investment priority.

The research results have been divided into five key findings.

- 1) Most countries focus on breakthrough technologies; however, Asian countries focus a little more on living technologies.

- 2) For technologies with a higher score in the impact index, economic development is the most important consideration in Asia, and that scored significantly higher than other categories such as society, environmental protection, safety and security, and infrastructure.
- 3) In investment priority, most Asian countries agree that governments should invest significantly in AI, 6G mobile networks, and autonomous vehicle technologies.
- 4) Some technologies have a high impact but a low investment priority. This indicates that these important technologies may be imported from abroad and not developed locally.
- 5) Green technology and biotech are in ranked lower in Asia because a large amount of R&D investment is required, they carry a high risk, and there is a long payback period.

Why 2030?

Many countries have set the year 2030, which is approximately 12 years from now, as time zero for long-term advanced technology research. This period of time is appropriate for governments to invest in R&D and for research institutions to conduct studies and do research. If we invest in the R&D of technology now, we would more likely be able to overcome challenging technologies or changes in large-scale infrastructure in 12 years.

If we look at long-term prospective studies, most only focus on the global perspective or a country's own domestic and industry development demands. However, this "global perspective" is still more inclined toward the perspectives of developed regions such as Europe and the United States; for the developing countries and markets in other regions, this type of global perspective overgeneralizes them. Therefore, this report looks at a general global perspective and then focuses specifically on the Asia region. Hopefully, by studying the predictions and outlooks of major Asian countries, we can foresee the future technology and market demands of that region.

Asian countries play a major role in international advanced technology R&D, including areas such as AI and mobile communication technologies; from a long-term perspective, Asian countries such as China and India have a large market potential. This is why this report aims to figure out the 2030 market perspectives and policy plans of major Asian countries and find the 10 most crucial advanced technologies that would affect that region. This would help us understand the differences between Asia and the rest of the international community in terms of long-term technology prospects and market demands.

Methodology, Subjects, and Procedure

This report begins with studies of general global trends. We combined multiple methods, including literature analysis, STEEP (society, technology, economy, environment, and policy) analysis, and word cloud analysis, to scan global 2030 major advanced technologies and trend foresight. We then used technology portfolio planning to select the top 30 advanced technologies around the world to use as the technology items listed in the Asia think tank survey. After analyzing the collected questionnaires, we selected the top 10 key technologies in Asia and carried out scenario analyses to present the 2030 Asia outlook. The 2030 advanced technology research procedure is shown in Figure 1.

To obtain perspectives from Asian countries, this report selected 10 significant markets from the Asia region to carry out survey and data acquisition. During the data analysis, the 10 Asian markets were categorized into two groups according to level of development and market characteristics. The first group (G1) includes China, Japan, Korea, Singapore, and Taiwan; the second group (G2) constitutes Malaysia, Thailand, Indonesia, the Philippines, and India.

For the survey, the report chose a government-related advanced technology R&D or research facility in each country and gave questionnaires to the experts there. The subjects answered questions related to 30 advanced technologies in terms of impact, investment, penetration rate, etc.

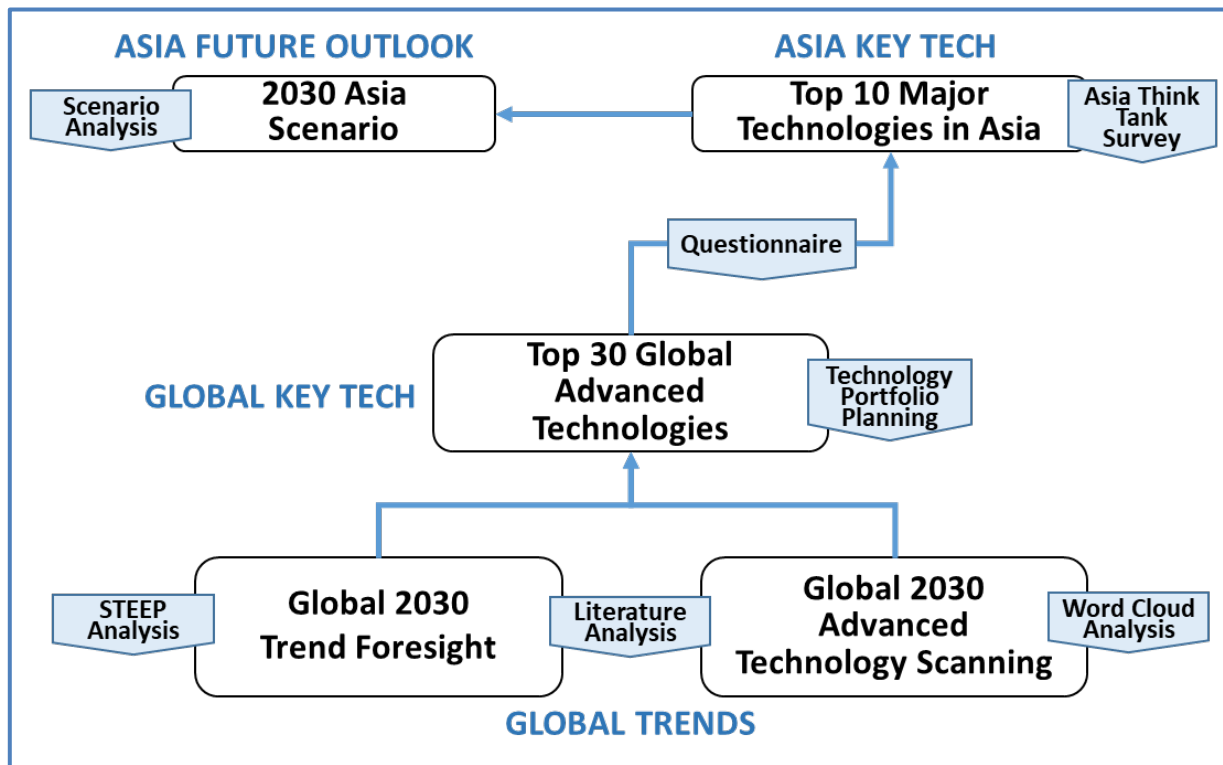


Figure 1. The 2030 advanced technology research procedure.

Target Readers

This report focuses on 2030 advanced technology items and has sequenced them according to their importance in Asian countries. The technologies include **digital technology**, smart machines, green technology and energy, advanced materials, and **biotechnology**. This wide range **encompasses** the most important technologies of today. **The results can be used as a reference** for governments and industries when they are **planning long-term technology R&D strategies**.

For this report, surveys were conducted on various advanced technologies in Asian countries and data obtained regarding the countries' predictions in terms of domestic market demand, technology R&D **demand and requirements**, **investment intensity**, and **future penetration rate**. These are valuable references for businesses and governments when they are planning their technology and market deployments.

2030 Global Technology Scanning

To understand the trend of 2030 global advanced technology developments, this research study reports on long-term technology trends from international organizations and research

facilities. The literature reviewed includes *Global Trends to 2030: Can the EU Meet the Challenges Ahead?* (EU); *Science Report, Towards 2030* (United Nations Education Scientific and Cultural Organization, UNESCO); *Deep Shift: Technology Tipping Points and Societal Impact* (World Economy Forum, WEF); *Future State 2030: The Global Megatrends Shaping Governments* (KPMG); *Trend Compendium 2030* (Roland Berger); and *An OECD Horizon Scan of Megatrends and Technology Trends in the Context of Future Research* (Organization for Economic Co-operation and Development). (See the “References” section for a literature list.) This study focuses on the projected environmental shifts in 2030 and the needs and demands that may emerge due to the transformations depicted in these reports. The findings are used as the basis to predict global technology trends in 2030.

Challenges in 2030

This study will discuss transformations in 2030 from five aspects: 1) society, 2) technology, 3) economy, 4) environment, and 5) policies.

In an aging society, the employed population will decrease. Sixty percent of the middle class will be in Asia, forming a new consumption pattern. For technological developments, interdisciplinary technological collaborations will be the key to innovation. Digital technology combined with energy and environmental protection technology, smart manufacturing, and advanced medical technologies to enhance physical health will be areas of interest. In terms of the economy, in 2030, bilateral trade flows worldwide will grow to over double their current amount. Asia’s percentage of international exports will rapidly increase by 40%. Regarding the environment, the massive energy consumption market will spur countries to invest in energy technology R&D. Alleviating measures, which focus on conserving energy and reducing carbon emissions, and adaptation measures, which focus on adjusting and adapting energy structures, will be the two major corresponding actions in environmental resource management and energy demand. For policies, emerging countries will play an influential role in the international economic market, creating diverse and complex international relations and making it difficult to predict if the world will be led by a super power or follow a multilateralism trend. Therefore, this report will not go into detail in the policies aspect. Nevertheless, it can be expected that, under the structures of common markets and production bases, regions will improve their competitiveness in industry development and technology R&D. The level of international competition will shift from an

individual country level to a regional level, forming a new technological geopolitical landscape and stimulating technology R&D collaborations between regions.

Society: Employed Population, Megacities, and Asian Middle Classes

According to the United Nation's estimation, the global population will exceed 8 billion in 2030, and the main population growth will occur in southern Asia and Sub-Saharan Africa. In addition to population growth, the population structure will also change: over half of the world's elderly population will be in the Asia region. Developing countries, in particular, have to take note that their society is aging at a rate faster than in developed countries. Due to the pressure of aging societies and decreasing working populations, industries will continue to transform into intelligent industries to manage challenges brought forth by a decreased labor supply and population structure transformations.

In 2030, the population in megacities around the world will increase from 3.2 billion to 5 billion. Maintaining a reasonable quality of living in all aspects, reducing urban crime rate, waste disposal, and recycling will become important issues.

In 2030, the global middle-class population will reach approximately 5 billion, with 3 billion of that population in Asia. This social class mainly relies on its salary for a living and is generally well educated. Members of this class have professional knowledge, stronger occupational abilities, and a corresponding household consumption expenditure. In emerging regions, the middle class has become the main force of consumption internationally. Different consumer preferences in different areas give rise to a segmented consumption pattern.

Technology: Interdisciplinary Collaborations to Innovation

In 2030, according to forecasts, the number of global Internet users will reach 5 billion, which will be 60% of the global population. Therefore, digital applications will become more popular and integrated into other areas of life, such as energy and environmental protection, smart manufacturing, and advanced medical technologies. This will enhance precision sensing, broadband connections, and data-computing capabilities and create innovative and diverse business application opportunities.

In response to climate change, technologies related to renewable energy, solar power, electric cars, and advanced energy storage will be integrated with energy-efficiency solutions.

These will play an increasingly important role in energy services. Production technologies used in manufacturing industries will mature and be combined with front-end sensors and integrated virtual and physical systems. The trend of emerging technologies entering manufacturing industries will deal with issues raised by flexible manufacturing and labor shortages and stimulate a revolution in industry structure. Life expectancy will be longer due to advanced medical care, and this aging society will see many breakthroughs in medical technology. People will have a better understanding of the human cell atlas, and there will be continual innovations related to genetic control, liquid biopsies, and gene vaccines. The survival capabilities of human beings can be directly enhanced through biotechnology and advanced medical technologies. However, the application of biotechnology and gene manipulation, technologies that alter organisms, may also bring about controversies in ethics and social values.

Economy: Bilateral Trade Flows within Main Economies Increase

The global exports share of Asian countries will grow rapidly and estimate to reach 39% in 2030. Furthermore, bilateral trade flows between the three major economies of the United States, the European Union, and Asia will more than double by 2030.

During long-term global economic developments, the importance of emerging markets and countries will gradually increase in the world's developing regions in terms of real gross domestic product, export amount, and spending power. China and India will become the global suppliers of international products and services, and Russia will be the main global supplier of raw materials. India's actual exports will increase, on average, by 13% annually. In 2030, India and China will take up 6% and 14%, respectively, of global exports. The middle-class population in emerging countries will increase, stimulating the growth of spending power and changing the global consumption map.

Environment: R&D Combines Alleviating and Adaptation Concepts

According to an estimate by the U.S. Department of Energy, due to the rapid industrialization and population growth, the energy consumption rate will continue to increase in the next decade. The large energy-consumption market will push countries to invest in related technology. The IEA's *World Energy Investment Outlook* pointed out that, in 2035, global energy investment demand will reach US\$40.2 trillion, 25 times more than the current US\$1.6 trillion.

Alleviation measures, which stress energy saving and carbon reducing, and adaptation measures, which are deployed to adjust and adapt energy structures, will be the two major corresponding actions to energy demand. Environmental resource management will ensure that many ecosystems are protected and maintained. To find a balance between industry development and environmental protection, countries will actively establish an effective environmental management system to develop a sustainable economic structure that can satisfy basic living needs and not exceed environmental limits.

Opportunities in 2030

This research ran text mining on approximately 20,000 major international prospective literature studies published between 2012 and 2017 and collected 150 advanced technology items. Then 30 advanced technologies were selected according to the challenges the world is expected to face in 2030, in terms of society, technology, economy, environment, and policies. The results of the top 30 technologies were discussed and selected by over 25 ITRI senior researchers from different fields, including the information and communications, green energy, biomedical, mechanical, material, and chemical industries, and industry experts were consulted with to provide a balanced view of the global technology trend. The 30 technologies are categorized into five major groups: 1) digital technology, 2) smart machines, 3) green technology and energy, 4) advanced materials, and 5) biotechnology.

From the results, the study found that different issues were reviewed. For example, between 2012 and 2015, there were many discussions concerning electric cars, bioenergy, nanotechnology, renewable energy, quantum computers, cell research, genes and DNA, and various severe contagious diseases (e.g., H5N1). In 2016–2017, most of the discussions were related to electricity supply and renewable energy, 3D printing, biotechnology, carbon emissions, mtDNA, and energy issues, which have always been a major topic.

In terms of publication selection, this research included prospective study and advanced technology publications and focused on future prospective issues and technologies. Prospective study publications selected had to include keywords such as “foresight,” “future,” and “forecasting” and cover multidisciplinary perspectives. Selected advanced technology publications were mainly influential interdisciplinary technological periodicals. They were evaluated with reference to impact factor to confirm the periodical’s significance and influence.

Drivers: Lifetime Expectancy, Lifestyle Improvement, and Environment Protection

Among the 30 technologies, some of them exist now but are expected to have evolved by 2030. This study has found three basic factors, drivers that have long affected human choices and development. These drivers are not affected by short-term international policies and technology developments and are similar to concepts from physical/safety to self-actualization in Maslow's hierarchy of needs. The three main drivers are extending life expectancy, living a more comfortable life, and protecting the environment, and the 30 technologies are categorized into these factors as shown in Figure 2.

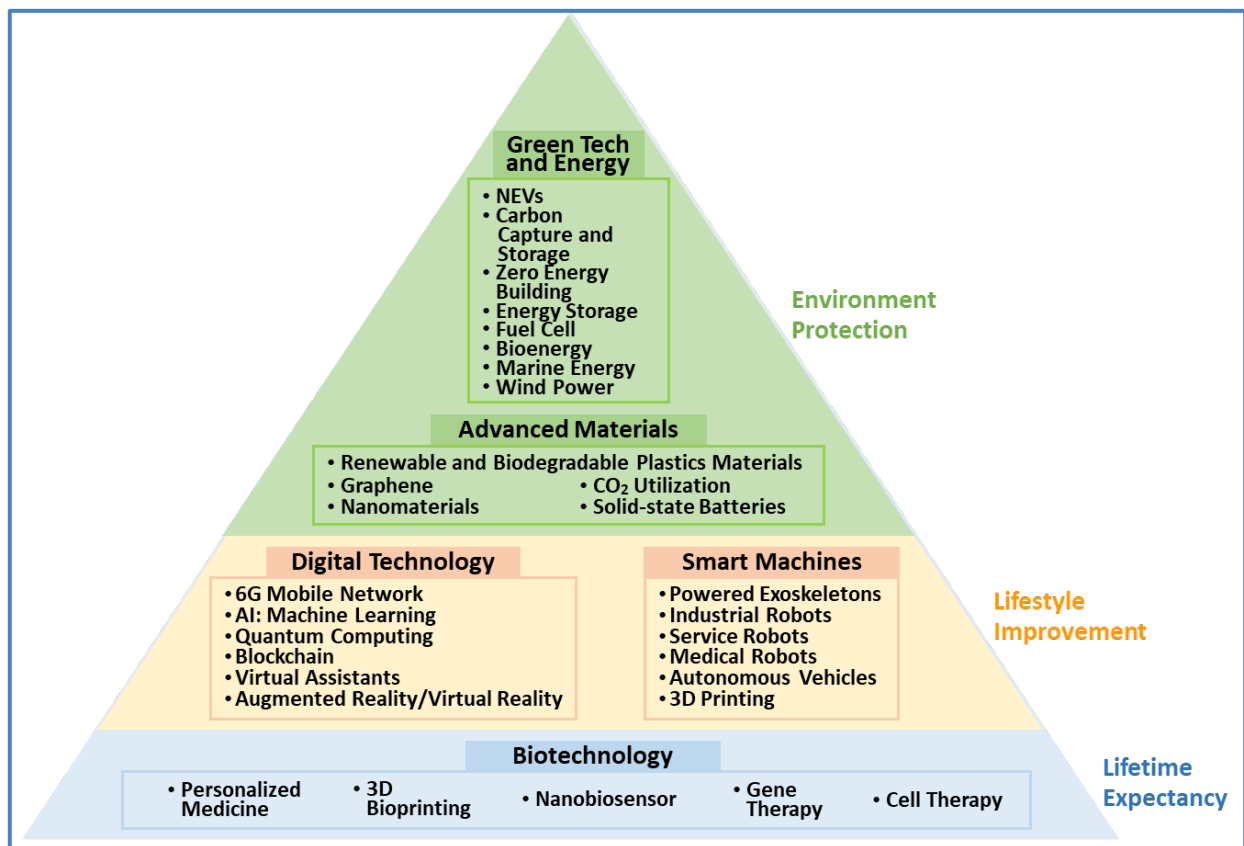


Figure 2. A 2030 worldwide advanced technologies overview.

Even though some of these 30 technology items exist in 2018, they will keep evolving. For example, AI will continue to improve self-learning and be able to function with little data. In addition, AI will protect data better and be able to broaden adoption across a range of applications. The evolution of these technologies will play key roles in lifetime expectancy, lifestyle improvement, and environment protection.

2030 Top-10 Technologies in Asia

To identify the 2030 Top-10 technologies in Asia, this report conducted a survey that focused on three points: impact, penetration rate, and investment priority. The values of these three points were added up and ranked according to their totals. The reason for these three particular points is as follows: 1) impact encompasses not only the technology a country needs but also the resources invested to facilitate its maturity, 2) penetration rate represents the level of demand for the technology in the country, and 3) investment priority indicates whether the country has put money into R&D or made use of this technology. In our survey, we used different rating scales for the three points: impact (1–5 scale, very low to very high), penetration rate (1–7 scale, <5 to ≥50%), and investment priority (1–5 scale, very low to very high).

After sequencing the values, we see that the top 10 technologies in Asia among the 30 major global technologies are AI (14.1), 6G mobile network (13.3), autonomous vehicles (12.2), industrial robots (11.6), service robots (11.6), blockchain (11.5), NEVs (11.5), renewable and biodegradable plastics materials, solid-state batteries (11.1), and nanomaterials (11). There are short descriptions on how technologies will evolve in 2030 from an Asian perspective in the “Appendix: Glossary of Top-10 Technologies in Asia” section.

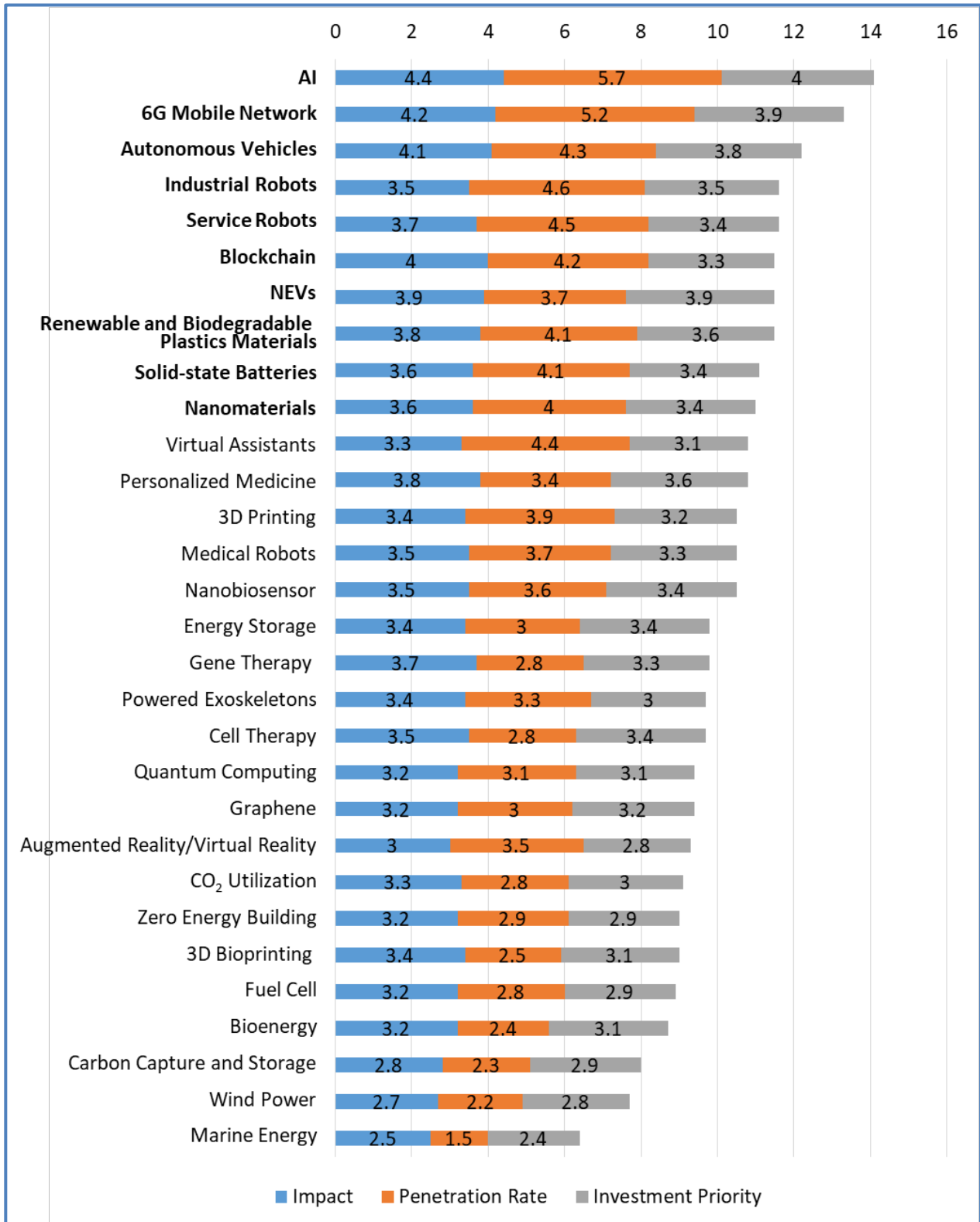


Figure 3. The ranking of the 2030 top-30 technologies in Asia.

Worldwide Versus Asia: Breakthrough Versus Living Technology

To understand the differences between worldwide and Asian technology focuses, this report reviewed research reports on many long-term key technologies regarding 2030 and identified the top 30 worldwide technologies, as shown in Figure 2. From these 30, we took 10 that were mentioned more frequently as the worldwide Top 10 and then used that as a comparison with the Asian Top 10. Figure 4 shows a comparison between the 2030 Top-10 technologies in Asia and worldwide and the differences between Asian and worldwide key technologies. The first quadrant presents the technologies considered important in both Asia and worldwide: AI and service robot. The fourth quadrant presents technologies focused on in other places but not listed in the top 10 in Asia. That is primarily medical technology, and there is a relatively larger proportion of next-generation advanced technologies such as quantum computing, powered exoskeletons, gene therapy, and personalized medicine.

The second quadrant displays the technology focuses in Asia. These key technologies and developments are those related to application and have a greater impact on people's everyday routines, such as communication, blockchain, transportation vehicles, environmentally friendly materials, and battery technologies.

As a whole, the worldwide perspective focuses on breakthrough technologies, while, in Asia, the focus is on technologies more related to daily life. There is a distinctive difference between the two. .

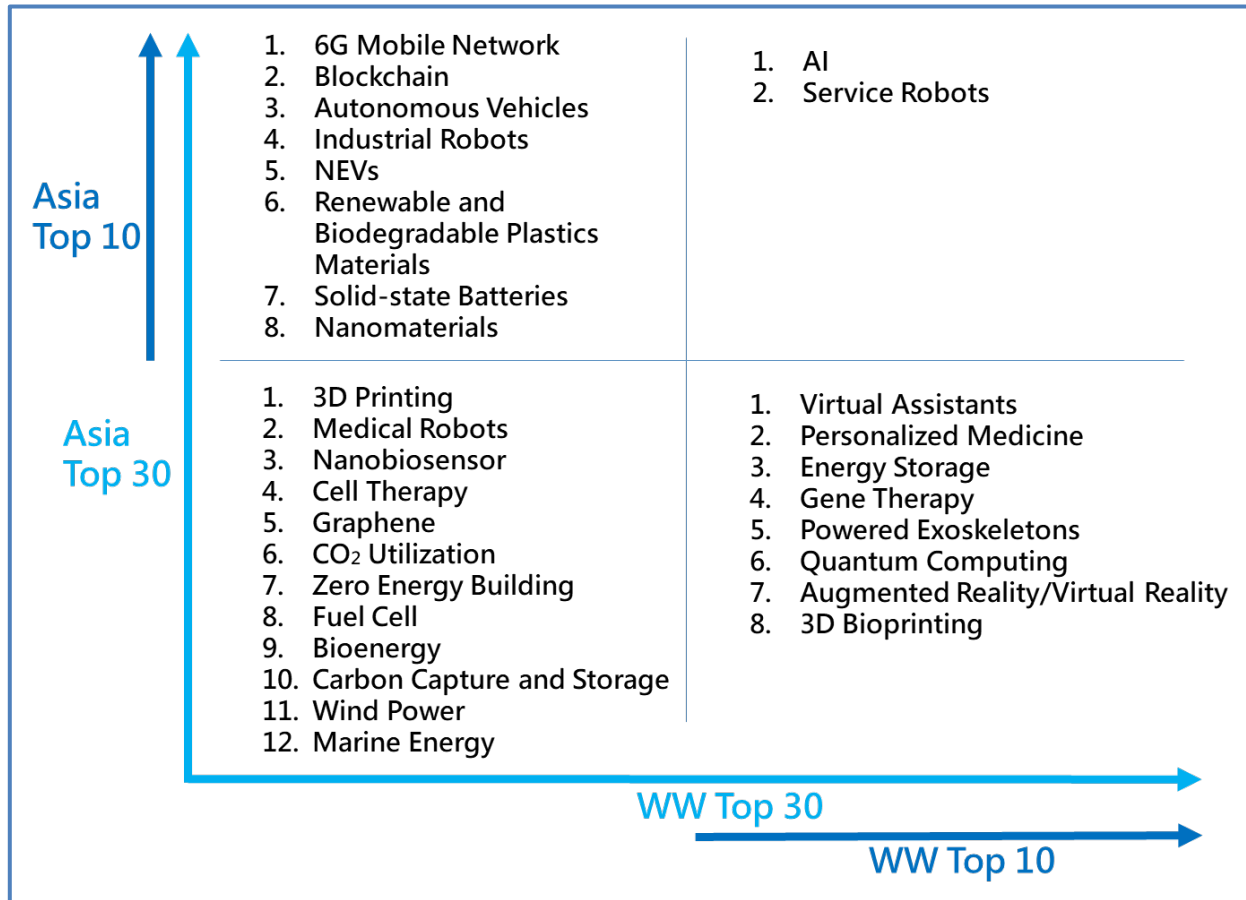


Figure 4. The 2030 key technologies in Asia and worldwide.

Ranked by Impact: Economic Development Is the Key Factor

When ranked according to impact, the results of the two groups and overall in Asia are as presented in Figure 5. For technologies that were ranked with a higher score in the impact index, respondents also had to select the reason (the type of demand that requires this technology) behind their scoring. The reasons include the following five areas: society, economic development, environmental protection, infrastructure, and safety and security. The society category includes problems related to society and its residents, such as population structure and aging. Economic development refers to the development of the national economy and industries, and environmental protection refers to the ecosystem and environment protection issues that occur due to climate change. Infrastructure is regarding the demands related to the basic national infrastructure, and safety and security refers to the safety and security of the nation and/or its people.

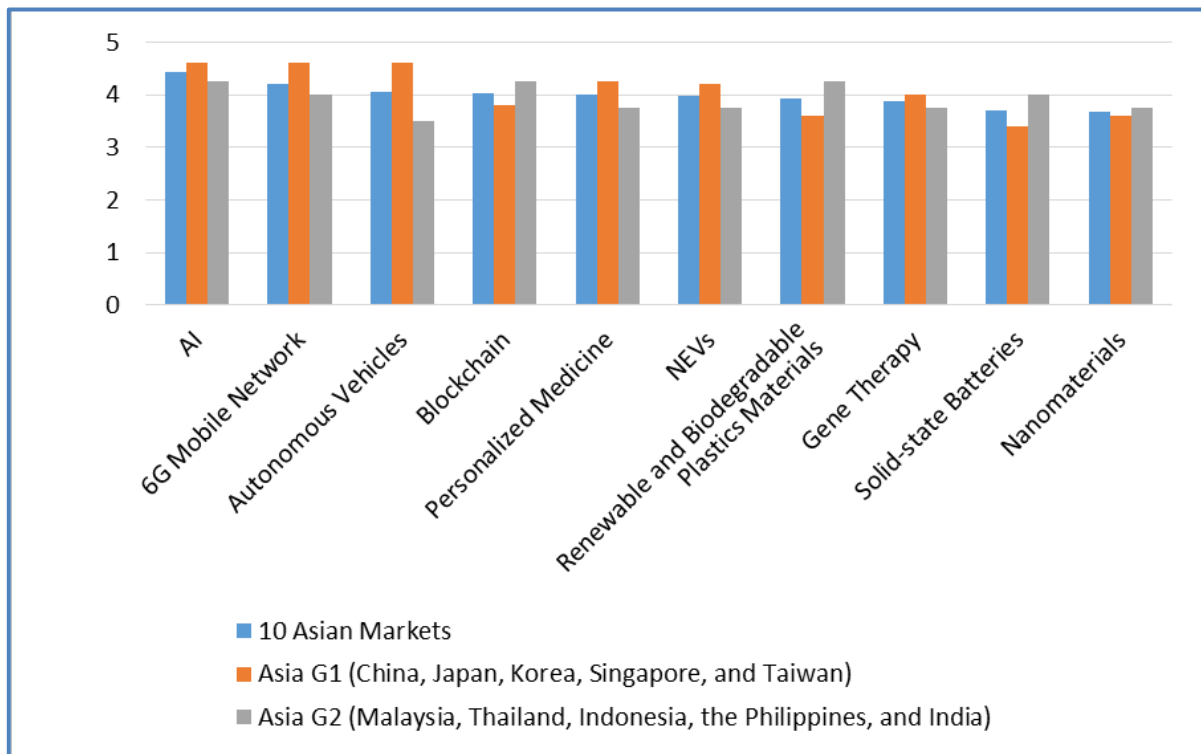


Figure 5. Asian Top 10 technologies ranked by impact.

The results show **economic development (8 points)** is the most important demand and scored significantly higher than other **categories such as society (4.9 points)**, environmental protection (3.1 points), safety and security (2.4 points), and infrastructure (1.9 points). It is worth noting that, while people commonly think that **industrial robots** can solve labor shortage problems brought forth by aging populations, **only 10% of the Asian countries agree with this idea**. Societal demands are the main driver **for developing service robots**, which indicates the market for service robots will mainly be in societal applications.

Ranked by Penetration Rate: Blockchain, Virtual Assistants and Advanced Materials Are Significant

The penetration rate shows how popular the technology might be in each country in 2030. The results show that AI and 6G mobile network are ranked higher than other technologies, but several technologies such as blockchain, virtual assistants and advanced materials are worth exploring (see Figure 6). **Blockchain technology is more popular in G2 than in G1. It may be because developing countries have a higher demand for transaction transparency. Virtual**

assistant technology was not listed as one of the top-10 technologies in Asia but ranked fifth in penetration rate. It may be because virtual assistant is not a technology in which governments will invest many resources, even though Asian countries think that will be used ubiquitously. G2 countries have given a higher score in renewable and biodegradable plastic materials than G1 countries because G2 countries have more abundant biomass resources to fulfill the need for the development of bioplastics.

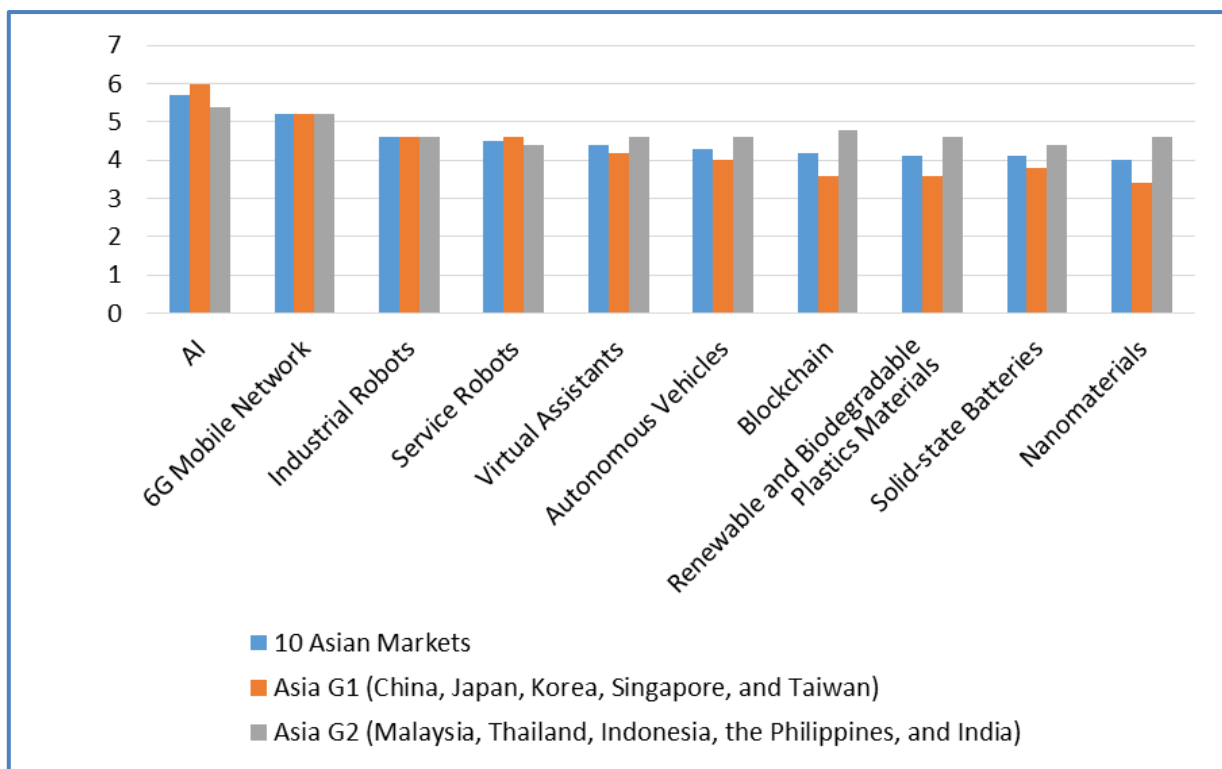


Figure 6. Asian Top-10 technologies ranked by penetration rate.

Ranked by Investment Priority: AI, 6G, and NEVs Are Significant

In investment priority, the results show that Asian countries agree to invest significantly in AI, 6G mobile network and NEVs technologies. Among the top-10 rankings of investment priorities, except for renewable and biodegradable plastics materials, G1 is higher than G2, representing G1 as the leading countries in advanced technologies (see Figure 7). There are significant gaps between G1 and G2 in the investment priority of several technologies. For example, the G1 countries ranked energy-storage technologies higher than G2. This may be because G1 has a higher renewable-energy penetration rate than G2, and renewable energy

requires energy-storage technologies to help solve unstable power supply problems. G1 also invested more in **medical technology and developments than G2**, mainly because the R&D of advanced medicine requires large amounts of investments and many foundations to conduct it. G1 ranked autonomous vehicles higher than G2. This shows that G1 countries are **optimistic** about the future development of autonomous vehicles **and invest heavily in their development to seize the market.**

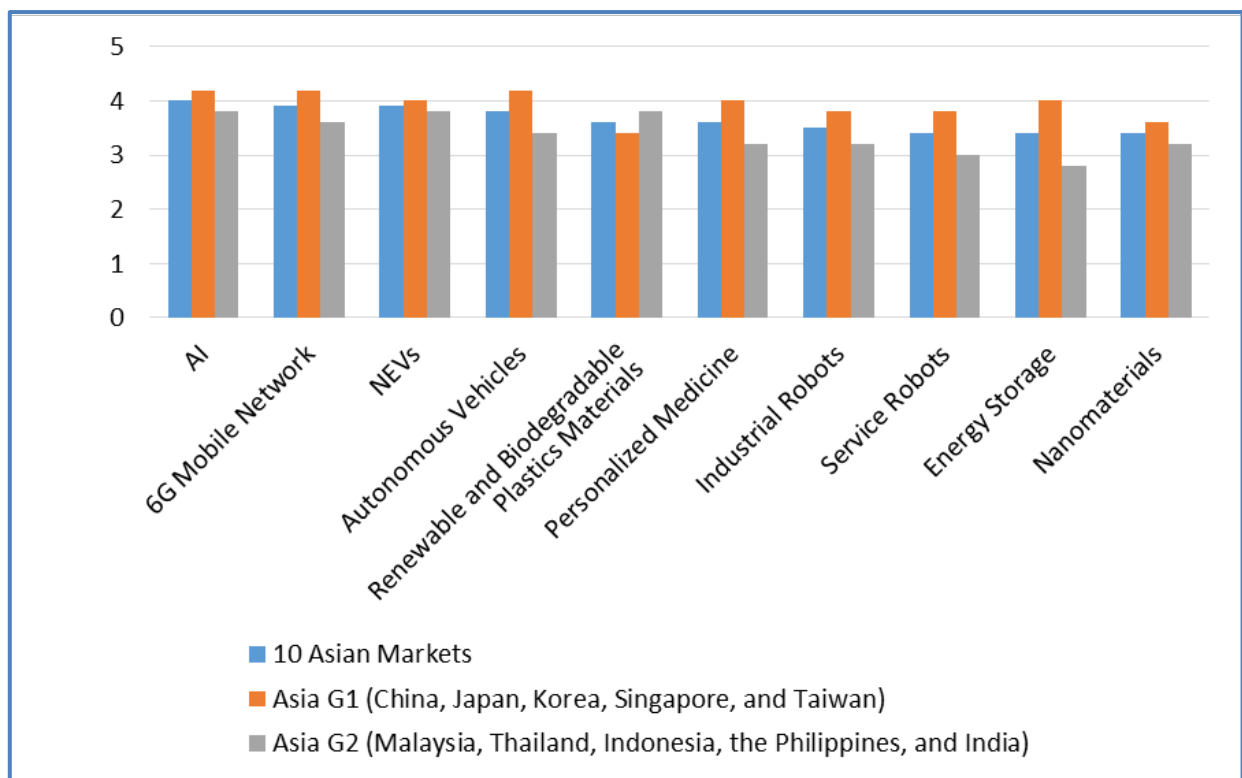


Figure 7. Asian Top-10 technologies ranked by investment priority.

Technologies with High-Impact but Low-Investment Priority: Depend on Imports

After cross-analyzing the **impact and investment priority categories**, we discovered that some technologies have **high impact in a country and yet a low investment priority**. This indicates that these important technologies **may be imported from abroad and not developed locally**. Figure 8 shows technologies such as blockchain, gene therapy, service robots, nanomaterials, and solid-state batteries all belong to this category, followed by cell therapy, industrial robots, nanobiosensors, and medical robot technologies. **In conclusion, medical technology, robots, and nanotechnologies are**

all high impact and important technologies that may be imported from overseas in the future.

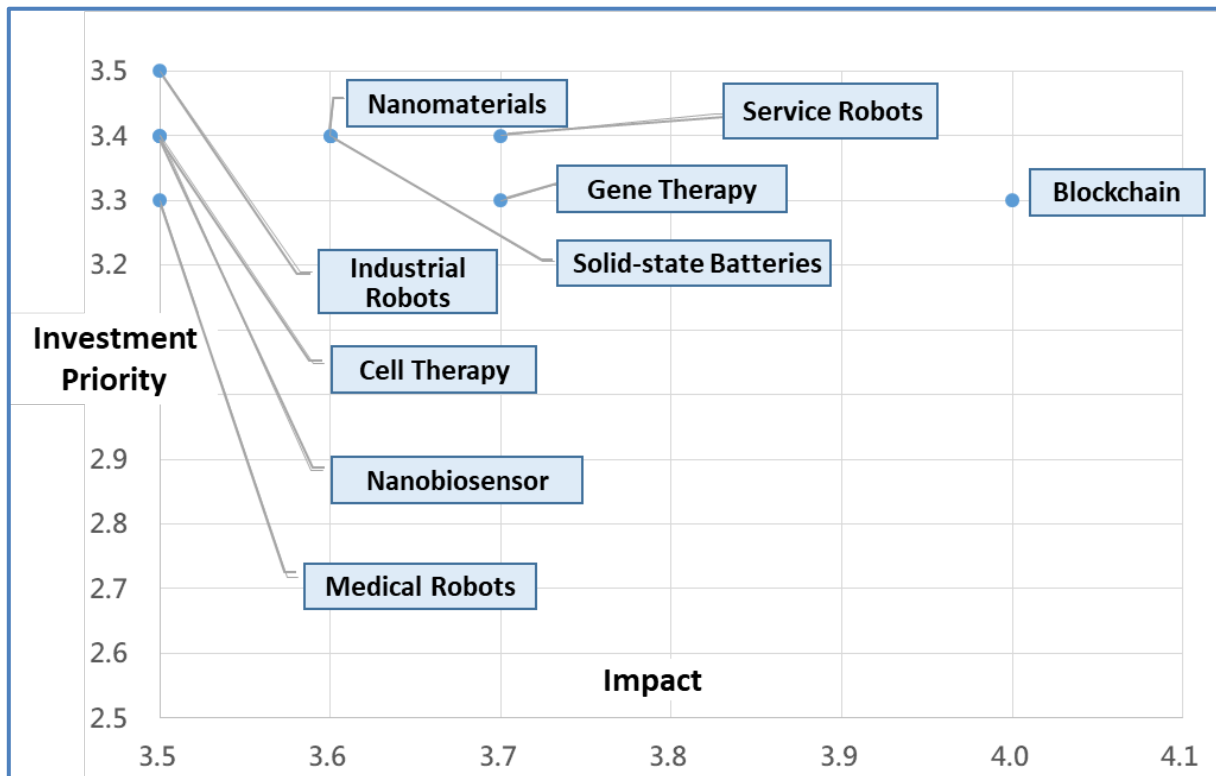


Figure 8. 2030 high-impact versus investment priority technologies in Asia.

Why Is There Only One Example of Green Tech in the Top-10 Technologies in Asia?

In this survey, the global top-30 technologies include eight technologies relevant to green tech and energy; however, only NEVs entered the Top-10 technologies in Asia. IEK Consulting studied past industry data analyses and interviewed related experts and reached the following conclusion.

Green technology requires large amounts of investment in R&D, has a long payback period, and carries high risk; thus, many advanced green technologies are mostly created in developed countries in Europe and the United States. In Asia, only Japan and China invest in related developments. Nevertheless, there are still some trends that can be observed; for example, energy-storage technology is ranked the second highest in impact and investment priority in Asian countries, mainly because of Japanese investments. Japan is the most aggressive country in Asia in terms of renewable energy development and, thus, has a higher demand for energy-storage technology. In the G2 countries, bioenergy has a high impact scoring because many Southeast

Asian countries have large agricultural industries, which are the main advantage to developing bioenergy.

Why Is Biotech Not One of the Top-10 Technologies in Asia?

In this survey, the global top-30 technologies include technologies that are relevant to biotechnology; however, none of them entered the top-10 technologies in Asia. The reasons are as follows.

Advanced medicine technologies require high investment amounts and long R&D periods, have high investment risks, and are slow to be commercialized; therefore, in the past, most of the investments and R&D were concentrated in developed countries in Europe and the United States. The global top-30 technologies include many advanced medicine technologies, yet the top-10 technologies in Asia do not list any biotechnology items. The highest ranking of any biotech item in the Asian list is between 10 and 20, with the highest ranking being personalized medicine. The survey data revealed that, in impact and investment priority, Asian countries gave a relatively high score in personalized medicine and gene therapy. However, the 2030 projected penetration rate all had relatively low scores. This shows that Asian countries do invest in advanced medicine, but the popularity of medicine in 2030 still cannot reach the level of developed countries in Europe and the United States.

A 2030 Asia Scenario: A Clean and Convenient Human–Machine Collaborative Society

Note: *The following scenario is fictional and based on the life of a young man (called Mingshan) living in Taiwan in 2030. The character is 25 years old and started his own company after graduating from university.*

When Mingshan gets out of bed, his personal device, which is connected to the 6G mobile network, has already downloaded all the information he will need for that day's schedule, including news, video, and music clips. These data are all preselected according to Mingshan's needs by his personal AI system. The virtual assistant installed in his personal device vocally confirms that day's schedule and reminders with him.

Mingshan listens to his personalized news briefing and expresses interest in a report on the supply market of bioenergy in Southeast Asia. So he asks his virtual assistant to analyze and predict

future market trends. Later, Mingshan logs into a global transaction system based on blockchain technology to invest in bioenergy.

Mingshan gets dressed and prepares to go to work. The air quality in the city streets is cleaner. The air pollution and heat island effect have been mitigated because over 20% of the vehicles on the road have been replaced by electric cars or clean-energy cars. These electric cars use solid-state batteries that provide safer and more efficient performance. Mingshan asks his virtual assistant to call a self-driving cab to take him to his private factory.

Mingshan is the founder of a private factory that has successfully realized Industry 4.0. It uses AI, industrial robots, and 3D printing systems to carry out precision manufacturing by fully utilizing resources to produce lower volume yet more diverse products. Products produced at the factory include biodegradable plastics. In 2030, there are still plastic bags in Asia, but they do not pollute the environment.

After leaving work, Mingshan goes to an elderly care center to visit his parents. Due to low birth rates and an aging population, Mingshan, as an only child, has to take care of four elder relatives; hence, he had to send them to a care center. The care center employs a large number of service robots to provide basic living assistance, such as helping the tenants walk around, get ready for bed, and eat meals; the service robots also chat with them and help with health care.

As Mingshan is visiting his parents, he talks to their doctor's hologram via a 6G mobile network for more information on his parents' gene-testing results and possible therapies. Mingshan's parents have a rare disease that can only be operated on by medical robots and then treated with gene therapy. With the exception of the medical robots, which are made domestically, the gene therapy technology has to be imported.

2030 Transportation Scenario in Asia: Industrial and Social Issues

Asian countries will actively develop autonomous vehicles. In 2030, approximately 10–20% of the vehicles on the road will be autonomous. The reasons for Asian countries to develop autonomous vehicles include not only industrial and economic development but also to solve social issues as well, for example, the challenge of elderly drivers in an aging society, professional driver shortage, and traffic jam problems in cities. NEVs that run on electricity or bioenergy to reduce air pollution would also reach a 10–20% penetration rate.

2030 Robot Scenario in Asia: Demand on Assistance

Asian countries have a higher demand for assistance technologies such as robots or

autonomous vehicles. Medical and care demand will increase due to aging societies, and low birth rates will lead to labor shortages. These demands will cause Asian countries to invest in related technologies. It is speculated that, in 2030 Asia, industrial and service robots will reach a 20–30% penetration rate.

2030 Environment Scenario in Asia: Plastic Products No Longer the Enemy

Many Asian countries are rapidly developing their economy at the moment. Although the average per capita plastic usage is not as high as it is in Europe and the United States, Asian countries lack competent waste management, and every year massive amounts of plastic waste flow into the oceans. Therefore, environmentally friendly plastic manufacturing technology will become a very important key technology for Asian countries. It is estimated that, in 2030, local businesses in nearly every Asian country can commercially mass produce environmentally friendly plastic materials.

Southeast Asian countries have an abundance of agricultural resources, which is an advantage in developing bioenergy industries. Asian countries actively invest in bioenergy development, and this has partially become a major support for NEV development as well. The countries also actively develop energy-storage technologies. Many renewable-energy power plants have their own energy-storage systems to solve unstable power generation problems.

Conclusions

In 2030, the world will face new challenges and opportunities in areas such as employment, multidisciplinary technology innovations, energy and the environment, and advanced medicine. These challenges are different from what we face today. The year 2030 is 12 years away, and it is appropriate for enterprises and governments to choose advanced technologies in which to invest. It would be beneficial to Asian countries preparing in advance and facing the business opportunities brought by the changes of large-scale infrastructures such as transportation, education, and medical care. Through the diversity of countries and cultures around the world, the goal of improving technology is to enhance the quality of life. We expect that, in 2030, digital technology, smart machines, green technology and energy, advanced materials, and biotechnology will keep playing important parts in improving the lives of people.

By 2030, half of the world's elderly and middle-class people will live in Asia. Therefore, this region will be a major consideration when forming new consumption patterns. The 2030 Asia

scenario shows a clean and convenient human–machine collaborative society that uses green energy and renewable materials. The scenario also shows the same human–machine collaborative society fulfilling the needs of an aging society. From this report, it was found that the 2030 Asian top-10 technologies focus little on green technology and biotechnology but have demands regarding a clean environment and changes needed as its society is aging. These gaps between technology development and local demands might be good business opportunities for global and Asian research institutes and companies.

About the Authors

IEK Consulting is a consulting service provided by the Industry, Science and Technology International Strategy Center of the Industrial Technology Research Institute (ITRI). ITRI has over 6,000 researchers whose research in applied technology covers information and communications; green energy; and the biomedical, material and chemical industries. ITRI has devoted itself to advanced technology development and industry commercialization and made world-class achievements. For example, over 25 advanced technologies developed by ITRI have won the R&D 100 Awards in the past five years. IEK Consulting, with support from ITRI technology researchers, plays a key role as a world-class think tank in helping industry in Taiwan achieve value creation.

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Appendix: Glossary of Top 10 Technologies in Asia

1. **Artificial intelligence (AI):** AI will continue to improve its self-learning capabilities, that is, to learn the learning process itself, and be able to function as well as humans with little data or experience. Asian countries placed AI first in their ranking; however, Asia G1 (China, Japan, Korea, Singapore, and Taiwan) will dominate AI R&D, and Asia G2 (Malaysia, Thailand, Indonesia, the Philippines, and India) do not believe that they have the capability to commercialize AI by 2030.
2. **6G mobile network:** By 2030, our society will be data driven. This will be enabled by near-instant and unlimited wireless connectivity. The 6G network will offer high-speed Internet access through wireless and mobile devices up to at least 11 Gb/s, surpassing the 5G network. G1 and G2 countries have given 6G a high score in both impact and penetration rate; however, G1 countries are still

more willing to invest in 6G. For example, South Korea and China have the highest investment priorities.

3. **Blockchain:** Blockchain is still limited by its ability to scale. Quantum computing will enhance the scalability of blockchain deployment in industry. The main blockchain application markets, including finance, logistics, retailing, and e-commerce sectors, will have grown rapidly by 2030. Blockchain technology is more popular in G2 than in G1, perhaps because developing countries will have a higher demand for transaction transparency in the future.
4. **Autonomous vehicles:** Reaching autonomous driving levels 4-5 by 2030, the vehicle will combine 360-degree vision with a decision-making intelligent algorithm that can make the best driving behavior decisions under various driving conditions. Robo-taxis may be the main method of transportation. Although the development of autonomous vehicles is still dominated by G1 countries, G2 countries agree with the importance of self-driving, but they will not give it a high investment priority.
5. **Industrial robots:** In the future, consumer demand will be customized and personalized. Industrial robots will integrate machine vision, improve their capabilities, and be suitable for the more efficient manufacturing of products made in small quantities and have a short life cycle. G1 countries believe that the penetration rate of industrial robots will exceed 30% by 2030; however, G2 countries have a lower demand for industrial robots because they face fewer problems with a lack of manpower.
6. **Service robots:** Service robots will have the ability to move around, make decisions in complex situations, and communicate with each other by 2030. Facing the problem of a declining birth rate and aging, G1 countries have been dominant in the development of various types of service robots. In contrast, G2 countries still rely on human services in various industries, so they invest less in service robots.
7. **New energy vehicles (NEVs):** NEVs refer to those vehicles with newer-type power systems, completely or mainly driven by new energy sources. NEVs are expected to play a key role in urban areas to provide mobility-as-a-service by 2030. Japan and China are currently the world's top two NEV markets. In fact, 60% of hybrid vehicles are made by Japanese companies. The survey results show that the penetration rate of NEVs will reach 20–30% in Asia by 2030.
8. **Renewable and biodegradable plastics materials:** A consensus was reached, at the recent summit of the G7 countries, that, by 2030, plastic materials will be made from 100% recycled or renewable products. G2 countries have given a higher score to the idea of investing in renewable and biodegradable plastic materials than G1 because G2 countries have more abundant biomass resources to fulfill the need for the development of bioplastics.
9. **Solid-state batteries:** Solid-state lithium-ion batteries have attracted a great deal of attention due to their high safety rating and increased energy density. These batteries may have the opportunity to maximize the driving range of electric vehicles and improve the safety of mobile devices. It is expected that solid-state batteries will have entered the early stage of commercialization by 2030.

Asian countries generally believe that the penetration rate of solid-state batteries will reach 10–20% by 2030. China, Japan, and South Korea will be the main suppliers of solid-state batteries, while the rest of the Asian countries will mainly import them.

10. **Nanomaterials:** The development of nanotechnology has been gradually applied to various industries such as energy, medical, and biotechnology. In the future, mass production and cost reduction are the main development challenges of nanomaterials. G1 countries reached the mass production stage in some nanomaterials, but G2 countries are at an early stage. Therefore, G2 countries have given these a higher score. |