

DEVELOPMENT TRENDS OF SOME SECTORS OF PRIORITY TECHNOLOGIES IN PERIOD TO 2030 YEAR

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Abstract:

Technologies pass development under strong impacts of the 4th Revolution of industrial development and a productivity revolution. The positions of science and technology (S&T) in the new context are reflected well in its guiding roles for socio-economic development thanks to impacts of fast changes and development to results and qualities of S&T activities. With the roles described in many studies as “platform”, “breakthrough”, “core” and “advancing”, technologies keep on guiding roles for development of modern manufacturing modes in service for targets of sustainable development, digitalization of manufacturing practice, enhancement of productivity, quality, effectiveness of development and competitiveness of national economy to 2030 and further. Vietnam is under preparation process of Strategies for science-technology-innovation (STI) for 2021-2030 period. The paper targets to give contributions to the preparation process of the Strategies.

Keywords: Science-technology; Priority technologies.

Code: 19061701

1. Development context of some sectors of priority technologies

Globalization and the 4th Revolution lead to numerous changes in manufacturing practice. Consideration of scopes of impacts and interactions between technology and manufacturing factors show the huge guiding roles of technologies in production systems worldwide. The transition from quantitative changes of technologies to higher and advanced levels leads to qualitative changes of technologies. The “platform”, “breakthrough”, “core”, “advancing” and “new” roles of technologies are important deciding factors to impact present and future manufacturing practice. The roles of

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technologies are reflected more clearly in context of non-sustainable development. The trends to bind development of technologies and manufacturing practice have become common requirements and commitment of nations. In this context, technologies, in global views, have increasingly important roles but not every one of them. Strategy and policy makers have to select those technologies which have high level of development, cause no waste of resources, make better environment improvement and push up smart manufacturing practice to enhance life quality worldwide.

➤ *Trends to sustainable development*

A summit meeting of sustainable development was held by the UN for approval of 2030 Agenda which is a global and comprehensive program with goals targeting benefits for all people worldwide and leaving no one behind, in present time and future time. 2030 Agenda is a continuation of UN Millenium Development Goals (UN MDG) for 2001-2015 period. 2030 Agenda calls for action from all the countries and social layers: poor people, rich people and medium social layers for promotion of wealth and protection of the planet. On 25th September 2015, 2030 Agenda was officially approved in the UN Submit Meeting in New York. On 1st January 2016, the 17 Sustainable Development Goals of 2030 Agenda were approved and got effective.



Source: <http://vbcsd.vn/detail.asp?id=656>

Figure 1. 17 Sustainable Development Goals by 2030 Agenda

Figure 1 shows the 17 Sustainable Development Goals are important and urgent goals which Vietnam and 198 countries worldwide commit to realize. International organizations define the roles of STI to serve the Sustainable Development Goals. As defined by UNIDO (2017), the globalization needs to orient to STI development to achieve the Sustainable Development Goals.

➤ ***The 4th Revolution and 2030 Agenda will be integrated and transformative***

2017 UNIDO Report on Future of Manufacturing is based on two top aspects of the present time: the 4th Revolution and 2030 Agenda. The Report rises topics from the 4th Revolution such as “Which breakthrough technologies will change manufacturing practice?”, “What are emerging challenges from changes and translation of digital techniques?” and “How the Sustainable Development Goals will be affected by the 4th Revolution?”. The future manufacturing is based on two aspects integrated and transformative.

➤ ***Strong development of global revolutions***

As forecast by international organizations and experts, not only the 4th Revolution makes impacts and influences to the world. In future there will be other important changes such as revolutions of economy-technology, productivity and mobility. Among reports made by numerous organizations, the most attentions are turned to “2015 ESPAS Report: Global Trends to 2030” which lists out the following revolutions.

Industrial revolution and technological changes: A revolution of technologies and applications will change the society in all the aspects. Digitalization, entering and propagating, will cause breakthrough changes in results. Economic, social and political aspects, by 2030, will depend more on efficiency of integrated networks. Digitalization started 20 years ago and, in close future, firms will have to face challenges from management of big data. Without mastering them, the competitiveness of firms will be seriously weakened. Digitalization becomes the main starting point of an industrial revolution based on convergence of technologies

Three new revolutions: As forecast, from now to 2030, there will be three new revolutions: (i) Global economic and technological revolution; (ii) Global social and democratic revolution; and (iii) Global geo-politic revolution. The economic and technological revolution is convergence of digital technologies, bio technologies and industrial technologies as well as increase of available technical tools and affordable prices for that the application of technologies occurs ubiquitously and for all purposes. This revolution, basically, will change the new economy and the new society in their operations (ESPAS, 2015).

Revolution of mobility: “2015 ESPAS Report: Global Trends to 2030” notes that “mobility” will be combination of physical motions and virtual reality. The combination of physical motions, virtual reality, automated systems,

robots, electric engines and hybrid engines already make progress and, while combined with GPS and sensor systems, make cars move automatically and we seating in the car have no things to do as check webs or interact with our smart houses. Mini airplanes will be used for transport of things as result of a revolution of transport between urban centers. The economic scale will change considerably, convergence of 3D virtual reality and 5G systems will be platforms for implementation of remote control systems which leads to a revolution of “Tele-Work”, including autonomous means. These developments occur in context of ageing population and multiplication of “non-traditional families”. Their combination with broadbands may be a road leading to a more just society.

2. Development trends in sectors of priority technologies to 2030 and further

➤ *Technologies to create digital manufacturing techniques*

Digitalization of manufacturing is developed on basis of numerous different technologies permitting improvement of sensors and interaction with physical world, enhancing organizational capacities, capacities of sharing and analyzing big data, collecting data, and linking and controlling systems of producing actors. The convergence of digital technologies such as IoT, cyber-physical systems, big data, cloud computing and artificial intelligence (AI) will permit development of advanced manufacturing for sectors of the 4th Revolution including systems of flexible sensors and automatic manufacturing systems, construction of advanced and simulated models, and systems of smart supplies. Information technologies (IT) will have top roles (see Table 1) creating new trends in global manufacturing sectors (*UNIDO and UCIA, 2013*).

Table 1. Emerging trends in global manufacturing sectors

Data Application	Advanced manufacturing capabilities	Vertical integration Horizontal integration Product lifecycle integration	E.G. Flexible, customisable and self-intelligent production systems, advanced modelling and simulation, autonomous robotics, smart supply chain scheduling ect.
Data Conditioning, Storage & Processing	Big data	Big data analytics	Data mining, reral networks, concutational mathematics, AI and machine learning
	Cloud computing	Data harvest, storage and management	Access to network of remote servers ho ed on the internet

Data Transmission	Network infrastructure	Standards, protocols, networks	- Networks - e.g. PAN, LAN, VIAN, WAN, Internet, etc. - Wireless Proctcls - e.g. Bluetooth, Wifi, RFID, ITF, Cellular, etc. Internet Protocols - e.g. HTTP, TCP, UDP, FTP
Data Generation & Capture	Cyber-physical systems	Connectivity	Access to computer networks of distinct spatial scope (e.g. PAN, LAN, WAN, etc)
		Embedded systems	Comprised of software, electronic hardware, sensors, actuators, and control

Source: UNIDO and UCIA, 2013.

According to UNIDO and UCIA (2013) it is necessary to make discussions on the most important actors of convergence to create “digitalization of manufacturing” which include 6 sectors of technologies:

- 1) Internet of Things (IoT);
- 2) Cyber-physical linking systems;
- 3) Big data;
- 4) Cloud computing;
- 5) Artificial Intelligence;
- 6) Machine learning.

The following sectors of technologies are emphasized in global manufacturing systems (UNIDO and UCIA, 2013).

Table 2. Development trends of manufacturing technologies

Technology sectors	Priority technologies
Photonics	Scanning, sensor and photoshot, communication and network, screen and display, advanced lights, quantum energy system and laser system
Bio technologies	Bio-pharmaceutics; tissue engineering/regenerative medicine, synthetic biology, self-assembly inspired bio technologies
Nano technologies	Nano cacbon tubes; nano composite materials; nano-electronics; nano technology cover layer; nano particles; nano cards
Additive manufacturing	Automatic fabrication; solid free-form fabrication, direct digital manufacturing; stereolithography ² ; 3D printing and rapid prototyping

² Charles Hull is founder of 3D printing technology by 1986, and the first person to invent Stereo lithography - a breakthrough method to create a tangible object from digital data.

Technology sectors	Priority technologies
Micro technologies	Micro production tools (for dissemination) and micro systems in tool machines and products
ICT in manufacturing systems	Smart mechatronic systems for automation and robotics, and progress of computers for manufacturing
Advanced materials	Synthetic materials and advanced hyper-materials
Environmental and energy technologies	Restoration and re-use of resources, renewable materials, storage of electricity, fuel cells, renewable energy (solar, wind, geothermal, bio energy, hydro energy), nuclear fission and fusion, and advanced vehicles.

Source: UNIDO and UCIA, 2013

➤ **Development of breakthrough technologies to 2030**

Report by ESPAS (2015) defined a strong development of coming technological breakthroughs to 2030:

- *Internet of Things*: big data and data-mining, cloud computing and super calculators, brain-machine interfaces and sensors;
- *Dissemination of big data* will affect and transform the whole of society. Collecting, purchasing and controlling these data will be regarded as an essential resource for the economies and societies of the future. Resources, control of operating technologies and ethical questions relating to the fundamental rights and freedoms of individuals;
- *Cloud computing will revolutionise IT platforms* while reducing operating costs, with very significant growth potential;
- *Intelligent mobility*: in 2030, 75 % of the world's population will have mobile connectivity and 60 % should have broadband access. Energy, transport and information systems will be closely linked by sensors of all kinds;
- *Modelling and enhanced (virtual) reality* will be everyday design tools across a broad spectrum, including infrastructure, cars and aircraft, climate forecasting and peace-keeping operations;
- *Ubiquitous sensors* will govern communications devices (including future smartphones), clothes, houses, vehicles and drones. It will be possible to merge information with satellite data and to use it for predictive modelling of events, like pollution or traffic;

- *Additive transformation/3D printers* will play a significant part in industrial production systems, with impacts on the costs and localisation of production and the potential for the recycling of raw materials to be systematic;
- *A combination of robots, nano-technology and artificial intelligence* should replace humans engaged in repetitive production or even in household services. By around 2025, autonomous and even self-teaching algorithms will enable vehicles, mini-drones and anthropomorphic robots to operate autonomously;
- *A combination of nano, bio and information technologies will revolutionise healthcare.* However, delivering high-tech, personalised forms of treatment while ensuring universal access to healthcare;
- *Synthetic biology* should enable many new applications through the industrial production of biomaterials, by replacing chemicals based on non-renewables with renewables (biofuels, including hydrogen).

➤ ***Breakthrough technologies impact the future of manufacturing***

UNIDO (2017) made foresights on breakthrough technologies up to 2030 integrated from the 4th Revolution and the Sustainable Development Goals where technologies impacting the future of manufacturing include:

- *New materials:* Building blocks or starting point of new products and processes; transform atoms and molecules in ways that can mimic nature including metals, polymers, ceramics, novel composites and bio materials;
- *Mechanics:* Range of automation technologies and new automated methods of handling materials, parts and products, including: advanced manufacturing technologies, robots, automated handling and transporting equipment and additive manufacturing;
- *Digital technologies:* Computer systems and devices that can react and take decisions faster and more accurately than people or that facilitate that reaction, including: modelling and simulation algorithms, artificial intelligence, control technologies, sonitoring and diagnostics technologies, sensors and actuators, cloud computing and photonics;
- *Environmental technologies:* Energy technologies (energy-intensive industry, motors, grid management), climate change technologies (CCS, renewables, industrial gases), friendly environment approaches (4Rs) and other technologies (bio technologies, nano technologies);

- *Convergence*: The trend of convergence of technologies in sectors will develop. Distinct entities are merging in a new area providing options for new inventions for a distinct entity. Types of convergence cover: scientific/knowledge (biomimetics), technological (mechatronics), application or products (iphone).

➤ **Key technologies**

By 2016, OECD made a list of 40 key technologies according to that the future technologies will be focused on 10 of them in large industrial sectors: digital technologies, bio technologies, environmental and energy technologies, and advanced materials. These technologies and their meaning are presented as follows:

The number of connected devices in and around people's homes in OECD member countries will probably increase from 1 billion today to 14 billion by 2022 (*OECD, 2015h*). By 2030, it is estimated that 8 billion people and maybe 25 billion active "smart" devices will be interconnected and interwoven by one single huge information network (*OECD 2015i*). Other estimates indicate a number of 50 to 100 billion connected devices in and outside people's homes by 2020 (*Evans, 2011; MGI, 2013; Perera et al., 2015*). The result is the emergence of a gigantic, powerful "superorganism", in which the Internet represents the "global digital nervous system" (*OECD, 2015i*).

- *Internet of Things* have trends to keep on development in future where OECD member countries will probably increase from 1 billion today to 14 billion by 2022. By 2030, it is estimated that 8 billion people and maybe 25 billion active "smart" devices will be interconnected and interwoven by one single huge information network. Estimates show impacts to economy from USD2.7 thousand billion to USD6.2 thousand billion annually by 2025, almost sectors with the largest impacts in sectors of health care, information network industry and production, and development of smart power grids;
- *Big data analytics* keeps on development with targets for service of health care in future;
- *Artificial intelligence* keeps on development producing machines smart as humans and gradually replace humans in all life activities;
- *Neuro technologies* promise to help better understand the natural processes of the brain, to study and treat neurological disorders and injuries, and to enhance neural capabilities, resulting in increased human intelligence and efficiency. Neuro technologies bring together and

combine expertise from neuroscience, microsystems engineering, computer science, clinical neurology and neurosurgery;

- *Micro and nano satellites* will develop space and satellite markets;
- *Nano materials* will advance in all aspects of life, from health care to application for polluted water treatment and environment protection;
- *Additive manufacturing or 3D printing* are regarded as emerging models of manufacturing and promise extension of capabilities of participation in production process;
- *Advanced energy storage technologies* keep on development to enhance possibilities to substitute traditional energy storage products, to save energy, to apply them in electronic and hand equipments and to participate in smart power grids;
- *Synthetic biology* bring breakthroughs in business sectors and create new firms which produce more benefits;
- *Blockchain technologies* will create smart transactions and contracts, transparent currency market, to fight against financial crimes through records to monitor destinations and purpose of use of money. Blockchain technologies will digitalize and certify transaction contract files for safe implementation of contracts.

In summary:

Reports by organizations show that industrial production in future will pass changes where the backgrounds of changes are both quantitative and qualitative development of technologies. From now to 2030, technologies will exhibit the platform, crucial and breakthrough roles, namely:

- *Technologies lead to digitalization of manufacturing:* Convergence of digital technologies such as Internet of Things, cyber-physical technologies, big data, cloud computing, artificial intelligence and machine learning;
- *Breakthrough technologies to 2030:* Internet of Things, big data integration, cloud computing, smart mobility, modelizations, ubiquitous sensors, robot based breakthrough technologies, nano technologies and artificial intelligence, combination of nano technologies, bio and information technologies, and synthetic biology;

- *Breakthrough technologies impacting future of manufacturing*: New materials, mechanics, digital technologies, environmental technologies and convergence of technologies;
- *Key technologies*: Internet of Things, big data analytics, artificial intelligence, neuro technologies, micro and nano satellites, nano materials, additive manufacturing or 3D printing, advanced energy storage technologies, synthetic biology and blockchain technologies.

The trends of integrated technologies are “key” and “breakthrough” such as IT technologies, advanced materials and new material increasingly develop. Developed countries will have moves faster than developing and underdeveloped countries do. The countries like Vietnam wishing to develop industries in modern directions need to base considerations more on endogenic conditions and factors for development of technologies and external ones for absorption of new values from the world. Experiences of some countries in the world show that the right definition of priority technologies will give contributions to process to make strategical planning and policies for STI development.

3. Definition of priority technologies to 2030 by some countries

In strong trends of development of key technologies, breakthrough technologies, technologies for digitalization and technologies for sustainable development, the countries such as Russia, China and Japan do not only base considerations on needs of socio-economic development but, more importantly, on potentials, desires and aspirations of development of the country for selection and choice of priority sectors and technologies. Different countries have different approaches to selection and choice. The selection and choice are exhibited through planning of strategies, policies, plans and programs of national S&T development (Table 3).

Table 3. S&T development planning by some countries

Countries	Planning	Time	Sectors of priority technologies
Russia	S&T Development Program of 2013-2020 period, Russian Federal Government	2013-2020	1) New materials and nano technologies 2) Information-communication technologies 3) Bio technologies
	S&T vision to 2030	2030	1) Information-communication technologies 2) Life science (bio technologies, medical science and public health care) 3) New materials and nano technologies
China	STI Development Strategies of China	2020-2050	Priorities for renovation of common technologies, advanced boundary technologies,

Countries	Planning	Time	Sectors of priority technologies
	in new eras		modern technical technologies and breakthrough technologies
	13 th Five Year Plan for STI (2016-2020)	2020-2030	1) Core technologies 2) Breakthrough technologies 3) Technological outplanning (not noted in plans) Priorities for breakthroughs based on big data in AI technologies
	13 th Five Year Plan for socio-economic development	2016-2020	Faster advancing for creation of breakthrough of core technologies in sectors: next generations of information-communication technologies, new energies, new materials, aerospace technologies, bio-medical technologies and smart manufacturing. Definition of big data as “basic strategic resources”
	Made in China to 2025	2025	Focused on big data, cloud computing, IoT and related smart technologies
Japan	Japan Vision 2050	2020-2050	1) Robot technologies 2) Bio technologies 3) Nano technologies 4) Information-communication technologies
	Strategies for STI Global Development	2013-2030	<i>Virtual technologies</i> 1) AI related technologies 2) Technological equipment 3) Network technologies 4) Cyber-physical technologies 1) Robotics 2) Sensor technologies 3) Actuator equipment technologies 4) Bio technologies 5) Human interface technologies 6) Material/nano technologies 7) Optical/quantum technologies
Korea	National Visions 2025: Long term plan for S&T development	2021-2030	Core technologies: 1) Information technologies 2) Bio technologies 3) Environmental technologies 4) Energy technologies 5) Mechatronic and system technologies 6) Materials and processing technologies 7) New materials

Countries	Planning	Time	Sectors of priority technologies
	5 th S&T foresight	2016-2040	Future technologies in groups of main problems: <ol style="list-style-type: none"> 1) Social infrastructure: software technologies for decision making 2) Eco systems and friendly environment: water quality monitoring technologies by real time and remote system of remote probe monitoring 3) Transport and robotics: underwater rescue robots. 4) Medical science and life: technologies of heterogenic artificial cultivation of internal organs using individual genetic map. 5) Manufacturing and convergence: high efficiency printing technologies for flexible pieces 6) Information-communication technologies: haptic sensing technologies for realization of virtual reality
Malaysia	Visions to 2050	2050	<ol style="list-style-type: none"> 1) High automation and Robotics 2) Blockchain technologies 3) ICT driving technologies 4) Basic ICT systems

Source: Summary by the research team from documents of visions, strategies, plans and programs of Russia, Korea, China, Japan and Malaysia.

Table 3 shows that Japan and Korea as developed countries make fast strategic plannings and policies to integrate technological development into the 4th Revolution and sustainable development trends. Russia defines platform and breakthrough technologies. China fast defines and selects priorities for development of breakthrough technologies on basis of core technologies. The visions defined by these countries are to 2020, 2030 and 2040. The main ways these countries define the selection of breakthrough technologies are based on consideration of the sectors of technologies which are under realization or expected by other countries after certain time terms of 5 or 10 years. Malaysia defines the selection in some sectors of technologies developed by the 4th Revolution with vision terms to 2050, longer than the one of Korea, Japan, Russia and China. This shows Malaysia, as developing country, notes that impossible in short time periods to get qualitatively developed technologies like Russia, China, Japan, and Korea have now. Clearly, technological development require certain

conditions and time. Therefore, Malaysia orients to 2050 to get the required technologies.

4. Some technological results and achievements of Vietnam

➤ *Remarkable S&T achievements of Vietnam (SIU REVIEW - No. 76)*

- 90m self-lifting rig: Being owned by Petro Vietnam, this product shows that Vietnam is listed among top the 3 countries in Asia and the top 10 in the world to have quality rigs.
- Re-start of operations by Da Lat nuclear reactor. Da Lat nuclear reactor has three time periods of operation during the last 50 years, namely by 1963, 1984 and 2011 as the last one. This event shows that Vietnam is able to provide a stable nuclear energy source which marks development moves in domestic power production in general.
- CT scanning machines for industrial use. IAEA had made an order of 6 units.
- ASEAN most advanced production lines of electronic communication equipment which are built and introduced to operation by Viettel Electronic Equipment Center. This line is capable of producing about 5 million USB devices, 3 million mobile telephones and 900,000 PCs per year.
- Endoscopy surgery method to cut out pancreas tumors. This success marks a new markstone in techniques of endoscopy stomach surgery in Vietnam.

➤ *Remarkable S&T events of Vietnam, 2018 (SIU REVIEW-No 76)*

- The digitalized Viet Knowledge system introduced to operation for sharing knowledge, stimulating creativity and connecting communities for the future of Vietnam.
- New materials: the research project in physical field “Polimer structure and mechanism of catalytic activity for production of H₂ by amorphous molybdenum sulfide” by Dr. Tran Dinh Phong³ *et al.* had prove successfully the structure and mechanism of amorphous molybdenum sulfide. This is a considerable step in the competition for solutions to clean energy and cut down CO₂ emission.

³ Dr Tran Dinh Phong, Hanoi University of Science-Technology (known also as Vietnam-France University). Address: Building A21, Vietnam Academy of Science-Technology, 18 Hoang Quoc Viet Str., Cau Giay, Hanoi, Vietnam.

- On-line fee-cost counting system of Viettel Corporation named as vOCS 3.0 which was introduced to use in 11 countries with 170 million mobile subscribers. Every area can serve 100 million subscribers. The most particular point of its capacities to design a subscription package for each subscriber which open chances for vOCS 3.0 to be applied in other countries worldwide.
- Machine to make ice from sea water for sea food conservation in off-shore fishing (*Le Van Luan, 2018*).
- Vingroup introduces S&T Application Fund of VND2 thousand billion value (USD86 million) as supports for research projects in fields of computer, AI, robot, authomation, nano technologies, renewable energy and new generation materials.

The most recent S&T achievements and events show, in certain difficult fields, Vietnam has achieves the regional level and makes positive international affectation such as information-communication technologies, new materials, automation. Vingroup focuses on important technological fields producing certain results and achievements as background for future development.

5. Guiding lines and policies for technological development in Vietnam

5.1. Guiding lines and policies for technological development to 2020

➤ *Definition of prioroty technologies to 2020*

The Prime Minister issued Decision No. 418/QĐ-TTg on 11th April 2012 for approval of Strategies for S&T Development, 2011-2020 period (called afterward as Strategies where 5 technological fields are defined: information-communication technologies, bio technologies, new materials, automation-machine engineering and environmental technologies.

In context of international integration and competition, and trends of fast and strong development of the 4th Revolution, by 2017, the Prime Minister issued Decision No. 13/2017/QĐ-TTg for amendment in the list high techs of products encouraged to be developed as attachment to Decision No. 66/2014/QĐ-TTg by 2014. Some amendments also were made in the list of priority technologies, mainly related to information-communication technologies such as: (a) Renaming “Technologies ensuring network security, safety and information confidentiality in high level” to “Technologies ensuring network security, safety and information confidentiality”; (b) Renaming “Next network generation technologies ((NGN, LTE-A, IMT-advanced))” to “Next generation technologies (NGN,

4G, 5G”); and (c) Renaming “Virtualization technologies and cloud computing” to “Virtualization technological and cloud computers”

➤ ***Some large guiding lines and policies for continuous renovation of growth models, labor productivity and economic competitiveness (Resolution No. 05/NQ-TW by the Party Central Committee, Session XII, 2016)***

Some S&T related targets include: Total Factor Productivity (TFP) gives contributions to average growth rate of 30-35% for 2016-2020 period, shortening gaps in national competitiveness among ASEAN 4 countries.

Large guiding lines and policies include:

- Priorities for S&T development and transfer, particularly advanced ones which are to be important factors to enhance productivity, quality and competitiveness of economy;
- Continued development of industrial zones and high tech zones, promotion of start-ups, innovation and creativity; building and implementation of technology import policies.

The above noted priority guiding lines, strategies and policies show focused attentions for modern fields of technologies which are mainly to meet demands of renovation of growth models, higher growth quality, labor productivity and competitiveness of economy.

5.2. Large guiding lines and directions of the Party and the State for definition of technological development in future

➤ ***Directions of priorities to bind technological development and industrial development***

Resolution No. 23-NQ/TW on 22nd March 2018 by the Party Politbureau on directions of national policies for industrial development to 2030, visions to 2045 shows that the definition of S&T in general and technologies in particular gets bound to policies of economic development. Some main aspects are presented below:

- ***Overall objectives:*** By 2030, Vietnam is to complete the objectives of industrialization and modernization, basically to become an industrial country in modern directions and to be in the group of the ASEAN leading 3 countries in industrial fields, and in some sectors Vietnam will have international competitiveness and deep participation in global value chains. Vietnam is to become a modern industrial developed country by 2045;

- *Actual objectives to 2030*: Minimal ratio of high tech based industrial products in processing and manufacturing sectors is to be 45%;
- *Some directions of national policies of industrial development*: policies for development of priority industrial sectors:
 - + *For period to 2030*, focused priorities for industrial sectors such as: information-communication technologies and electronic industry are to achieve the world's advanced level to meet demands of the 4-th Revolution for creation of background of digital technologies for other industries; clean energy industry, renewable energy, smart energy; processing and manufacturing industries for agriculture to meet international standards. Priorities for development of national defense and security industries and their combination with civil industries for dual use purpose. Continued development of textile-garment and leather-shoewear industries in combination with smart manufacturing process and automation. Priorities for development of certain mechanical-engineering sectors such as cars, agricultural machines, construction machines, industrial equipment, electrical equipment, medical equipment and etc;
 - + *For 2030-2045 period*, focused priorities for development of new generations of information-communication technologies, universal application of digital technologies, automation, high grade equipment, new materials and bio technologies.
- *Orientation of S&T policies for industrial development*

S&T policies should orient to make strong advancing moves in development of infrastructure (4G, 5G) and application of information-communication technologies to ensure safety and meet demands for integrated IoT, building up of national strategies for digitalization, stimulation for investment and development of large big data centers, strong development of science of analytics, management and processing of big data to produce new knowledge, creation of favorable and equal conditions for people and firms in access to development of digital contents, building and implementation of strategies and proactive participation in the 4th Revolution of Vietnam .

Priorities of resources should orient to implement effectively National program of technology renovation to 2020, Program of development of some high tech industrial sectors, National program of enhancement of productivity and quality of products of Vietnam firms to 2020 and accelerated implementation of Program of S&T application in process of restructuring industry-trade sector, period to 2025 and visions to 2030.

Supports should orient to building and development of S&T firms in industrial sectors, particularly for priority sectors, building of mechanisms and policies to stimulate development of technological incubators, S&T firm incubators in leading and priority industrial sectors.

➤ ***Large guiding lines and policies for some technological sectors, 2020-2030 period***

Large guiding lines and policies are defined as follows.

ICT sector: National strategies for information of development to 2025, visions to 2030 (*Decision No. 149/QD-TTg on 8th November 2018*) defining priority technologies for electronic information and grassroot level information.

Biotechnology sector: National strategies for bio technological diversity to 2020, visions to 2030 (*Decision No. 1250/QD-TTg on 31st July 2013*) defining: preservation of natural eco systems, preservation of wild species and valuable, rare and endangered species, sustainable use and implementation of mechanism of sharing of benefits from eco systems and bio diversity, Preservation of bio diversity in context of climate change, National strategies for development of Vietnam pharmaceutical sectors to 2020, visions to 2030 (*Decision No. 68/QD-TTg on 10th January 2014*) defining priorities for generic drugs, special treatment drugs, vaccins, preparation for preventive medicine, production of pharmaceutical materials.

New material sector: Vietnam strategies for development of renewable energy to 2030, visions to 2050 (*Decision No. 2068/QD-TTg on 25th November 2015*) defining:

- For period to 2030: development and use of sources of renewable energy, investment for grid development and connection of renewable power plants, development and use of renewable energy sources for heat production, development and use of bio energy sources, supports for pilot projects of production of bio fuels, generations 2 and 3 which do not consume food materials;
- For visions to 2050: strong development of renewable energy technology markets, industrial sectors for local manufacturing of renewable energy machines, equipment and services, enhancement of potentials for research and development, transfer and application of new renewable energy types.

Environmental technologies: National strategies for environment protection, to 2020, visions to 2030 (*Decision No. 1216/QD-TTg on 5th September 2012*)

by the Government) defining related technology tasks such as: technologies for treatment of residual pollutions and environment protection technologies. Besides, there are action plans for development of environmental technologies and energy saving for realization of modernization strategies of Vietnam in framework of Vietnam-Japan cooperation to 2020, visions to 2030 (*Decision No. 1292/QĐ-TTg on 1st August 2014*) defining: strong development of environmental technology sector and energy saving to 2020 to become driving technologies, to give contributions to national economy and to be capable of meeting demands of environment and pollution treatment and sustainable use of energy.

5.3. Proposal of some priority technologies in Strategies for STI development to 2030

Vietnam has only almost one year time to complete the ten year development program (2011-2020) and to prepare and plan the Party guiding lines and the State macro policies for 2021-2030 period, visions to 2035. On basis of analysis of development trends of some priority technologies worldwide and recent development capacities of Vietnam, the paper makes proposal for some technology sectors and technologies for priority in Strategies for STI development to 2030, namely:

1) Information technology sector

Priority technologies include: Internet of Things, cyber-physical connections, big data, cloud computing, artificial intelligence, machine learning, 5G, blockchain and etc.

2) Bio technology sector

Priority technologies include: synthetic biology, biopharmaceutics, neuro technologies and etc.

3) Engineering-automation technologies

Priority technologies include: convergence of technologies, CAD/CAM/CAE, flexible manufacturing systems, design and manufacturing of robots, smart mechatronics for automation and robotics, automated production, solid free-form fabrication, digital techniques, 3D printing, rapid prototyping, micro processing and etc.

4) New material sector

Priority technologies include: synthetic materials and advanced hyper-materials, nano materials, bio materials, 3D printing technologies and materials, technologies for production of self-disintegrating bio polymers,

technologies for production of combinant polymer materials and high quality polymer composite materials which are resilient to climate changes.

5) *Convergent technologies sector*

Priority technologies include: combination between robotics, nano technology and artificial intelligence, combination between nano technologies, bio technologies and information technologies, synthetic biology, combination between new materials and bio materials for environment protection.

6) *Environmental technologies*

Priority technologies include: technologies related to energy, climate changes, friendly environment (4Rs), integrated technologies (bio technologies and nano technologies).

The definition, selection and choice of sectors of priority technologies are necessary and urgent works because:

First, sources to serve sectors of prority technologies are not found enough for development, particularly R&D human resources in sectors of high techs, advanced technologies, finances and infrastructure for R&D activities.

Second, the level of economic and S&T development of Vietnam is found lower than the one of many countries. Then Vietnam needs to be highly careful in definition and choice of priority technologies.

Third, the proposal of development orientations for some sectors of national priority technologies should be based on large guiding lines and policies, S&T results and achievements of 2011-2020 period (both quantitatively and quanlitatively), take references from international experiences) and take large consultations with S&T organizations in academic sector (research institutes/universities), enterprise sector, management sector, international organizations and experts which are now present in Vietnam./.

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