HOW "HORIZON EUROPE" COULD POSSIBLY LEVEREGE YOUR BUSINESS

— HISTORY AND OVERVIEW OF EU RESEARCH AND INNOVATION SUPPORT POLICY —

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SUMMARY

- The EU's major policy framework for supporting research and innovation is called the Framework Programme (FP), which promotes the accumulation of science and technology and the strengthening of European industrial competitiveness. Recently, it tends to emphasize projects with close connections to business.
- Through participating in FP projects, subsidies for technology development, access to the latest trends in relevant technology fields, development of trust with partners, and human networks' expansion can be obtained. Participation in large-scale projects will also provide additional benefits, such as a reduction of commercialization risks, validation of business models, and involvement in standardization, which is an area where Europe excels.
- "Horizon Europe," the FP starting in 2021, will adopt a mission-oriented approach to solving global social challenges, and will further enhance the importance of efforts throughout the value chain.

1. INTRODUCTION

Europe aims to become climate neutral by 2050, and has positioned the European Green Deal, which is closely related to industrial policy, as the most important policy at the center of global warming mitigation measures under the new European Commission team launched in 2019. Even in the COVID-19 crisis, the importance of the European Green Deal has been increasing, as indicated by the fact that the EU planned to link economic recovery with long-term growth strategies by allocating 30 to 40% of the recovery plan budget to sustainable economic activities. While sustainable technological innovations are required for global warming mitigation measures, for which global initiatives are necessary, fierce international competition to achieve commercialization of such innovations has already been ongoing. The EU, aiming to be a global leader in this field, is proactively promoting technology development through its research and innovation (R&I) support policy, bearing in mind the importance to establish a dominant position in the contest of global standards and a focus on the protection and utilization of intellectual property.

This report traces the history of the Framework Programmes (FPs), the EU's R&I support policy, describes the advantages of participation in the FPs through a look at examples of projects implemented under the framework, and discusses the possibility of making use of the next program, called "Horizon Europe", that will begin in 2021.

2. HISTORY OF EU INNOVATION SUPPORT POLICIES — PAST, PRESENT, AND FUTURE

2.1. From the Framework Programme (FP1) to Horizon 2020 (FP8)

Horizon Europe is the EU's main multiannual framework, called Framework Programme (FP), for providing financial support for research and innovation projects in the field of science and technology. After the first Framework Programme (FP1) was introduced in 1984, FP2, FP3 and other FPs each spanning several years have been implemented in sequence. The program name was changed beginning with FP8, which is known as Horizon 2020, and Horizon Europe, which corresponds to FP9, is scheduled to begin in 2021 (Figure 1).

Figure 1: Overview of the Framework Programmes (FPs) and major events in Europe

FP	Years covered	Total budget	Details, focus	Major events in Europe
FP1	1984-1987	EUR 3.8 billion	Presentation and implementation of research, development, and pilot application strategies throughout the region	Establishment of EUREKA (1985) Portugal and Spain became members of European Economic Community in the third enlargement (1986)
FP2	1987-1991	EUR 5.4 billion	Strengthening of the foundations of science and technology and raising international competitiveness to a higher level	Fall of the Berlin Wall (1989) and unification of East and West Germany (1990)
FP3	1990-1994	EUR 6.6 billion	Introduction of a system for SMEs to strengthen the competitiveness of European industries; introduction of a system related to the training and mobility of young researchers	Establishment of the European Union (EU) based on the Maastricht Treaty (1993)
FP4	1994-1998	EUR 13.1 billion	Introduction of horizontal programs in addition to the thematic programs in the areas of industrial technology, life sciences, energy, and transportation	Austria, Finland, and Sweden became EU Member Sates in the fourth enlargement (1995)
FP5	1998-2002	EUR 15 billion	In a departure from programs up to FP4, shift in focus to solutions for socio-economic issues; introduction of the "Key Actions" concept for each technology field	Adoption of Lisbon Strategy (2000)
FP6	2002-2006	EUR 17.5 billion	Improvement and reorganization of subdivided specialty areas; introduction of integrated projects and excellent networks; contribution to the creation of the European Research Area (ERA) through the integration and reorganization of research domains	10 Eastern European countries became EU Member States in the fifth enlargement (2004) (*Note 1)
FP7	2007-2013	EUR 55.9 billion	Simplification of participation procedures, establishment of the European Research Council (ERC) and the Joint Technology Initiative (JTI)	Two additional Eastern European countries became EU Member States in the fifth enlargement, continuing from 2004 (2007) Announcement of Europe 2020 (2010) Croatia became an EU Member State in the sixth enlargement (2013)
Horizon 2020	2014-2020	EUR 80 billion	Three pillars of focus: excellent science, industrial leadership, and societal challenges; continuance of Joint Undertaking (JU/JTI) initiatives and introduction of new themes	Withdrawal of the UK from the EU (2020)
Horizon Europe	2021-2027	EUR 80.9 billion (*Note 2)	Introduction of a mission-oriented approach; introduction of Innovative Europe as a new pillar	

*Note 1: The 10 Eastern European countries are Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia.
*Note 2: EUR 80.9 billion represents the total of EUR 75.9 billion for the Horizon Europe budget and EUR 5 billion for the economic recovery fund (Next Generation EU).
Source: Compiled by the authors based on materials on the websites of the EU, JEUPISTE, NCP Japan, and others

The program's fundamental philosophy of accumulating and disseminating science and technology knowledge and enhancing Europe's industrial competitiveness through technology development has not changed. Rather, awareness of the importance of science and technology and Europe's industrial competitiveness has increased year by year. This is also reflected by the increase in the total and annual budgets for each new FP. At the same time, the FP priority themes have been modified to keep in step with the transitions in Europe, such as deepening EU integration and eastern expansion, and changes brought by technological innovation, represented by the IT revolution.

In the 1990s, the EU began to perceive possible challenges regarding the region's industrial competitiveness. To address this, the Lisbon Strategy, a long-term and comprehensive economic growth and social plan covering the period up to 2010, was announced in 2000, and it was decided to promote strategically high-priority areas at the EU level. Along with this, beginning with FP7 initiated in 2007, the implementation period was extended to seven years, from the original five years. In addition, a technology platform (TP) was established for each technology field, and a strategic research agenda (SRA) was formulated. Furthermore, a program for public-private partnerships called the Joint Technology Initiative (JTI) was created to strengthen cooperation with industry (Figure 2). The JTI clarifies the strategic areas for strengthening European industrial competitiveness, and with the cooperation of the private sector, R&D resources are pooled and invested by both public and private sectors. The program's uniqueness is that each JTI is operated independently, decides its own research agenda and themes, and selects projects through an open call for proposals.

Figure 2: Joint Technology Initiative (JTI) public-private partnerships

Name of JTI		Area	Year established	Budget under Horizon 2020 (EU funding amount)
FP7	Horizon 2020			
Clean Sky	Clean Sky 2	Aircraft	2008	EUR 3.9 billion (1.6 billion)
IMI	IMI 2	Innovative medicines	2007	EUR 3.3 billion (1.6 billion)
FCH	FCH 2	Fuel cells and hydrogen	2007	EUR 950 million (570 million)
ENIAC	ECSEL (combined)	ICT, electronics, cyberspace	2008	EUR 4 billion (1.2 billion)
ARTEMIS			2008	
SESAR（Single European Sky ATM Research）		Air traffic management system (launched as the Single European Sky (SES) initiative)	2004	EUR 1.6 billion (580 million)
	BBI	Bio-based industries	2014	EUR 3.7 billion (980 million)
	Shift2Rail	Trains, railway infrastructure	2014	EUR 920 million (450 million)
	EuroHPC (High performance computing)	Supercomputers, quantum computers	2018	EUR 1.1 billion (540 million) (2019-2020)

Source: Compiled by the authors based on information on the websites of the European Commission, each public-private partnership, etc.

Following Lisbon Strategy, the next medium- to long-term growth strategy called Europe 2020 was announced in 2010. It emphasized the realization of innovation as one of its important policy goals. The FP was positioned as the driving force of this strategy, and FP8, which started in 2014, was renamed Horizon 2020. Not only projects for scientific inquiry and new technology development, but also R&D and demonstration projects with prospects of actual product commercialization and viable businesses were greatly emphasized. The five JTIs[1] established under FP7 were continued in the succeeding partnerships. In addition, three new partnerships, BBI (bio-based industries), Shift2Rail (railway industry), and EuroHPC (supercomputers, quantum computers) were established, expanding the number of JTIs to eight.

2.2. Overview of Horizon Europe (2021-2027)

The core objectives of the FPs to date have been the promotion of science and technology and the strengthening of European industrial competitiveness all the time. The biggest change is that increasingly greater emphasis is being placed on the importance of giving back the fruits of such R&D to the society, and this trend will likely continue in the future. Horizon Europe, which will start in 2021, is structured into three pillars: (1) excellent science, (2) global challenges and European industrial competitiveness, and (3) innovative Europe (Figure 3). With considerable attention being given to the European Green Deal, 35% of Horizon Europe's budget will be allocated to climate change mitigation-related measures.

[1] In Horizon 2020, the partnerships are referred to as Joint Undertakings (JUs) instead of JTIs, but the term JTI is used in this report to avoid confusion. The partnerships are expected to be continued in Horizon Europe as "European Partnerships."

The first pillar places emphasis on expanding basic and applied research in the advanced frontiers of science, as has been done to date, and the second pillar combines the Horizon 2020 themes of strengthening Europe's industrial leadership and contributing to solving social problems. Horizon Europe also adopts a new mission-oriented approach in order to tackle global issues. It is an approach that defines an ambitious mission like the moon landings of the 1960s and combines projects in a multi-faceted manner to achieve it. The five missions are proposed as follows: adaptation to climate change (including societal transformation); climate neutral and smart cities; healthy oceans, seas, coastal and inland waters; soil health and food; and cancer, of which four are entwined with the European Green Deal.

Figure 3: Outline of Horizon Europe

	Pillar 1 Excellent Science	Pillar 2 Global Challenges and European Industrial Competitiveness	Pillar 3 Innovative Europe
Overview	Strengthen and expand the EU's excellent foundation in science	With the aim of solving social problems, promote the development of technologies and solutions that support European policies and the realization of SDGs	Promote market-creating breakthroughs and ecosystems that contribute to innovation
Related organizations	European Research Council (ERC) Marie Sklodowska-Curie Actions (MSCA) Research Infrastructures	Joint Research Centre (JRC) of the European Commission	European Innovation Council (EIC) European Institute of Innovation and Technology (EIT)
Key areas	State-of-the-art science	Health, digital/industry/space, climate/energy/mobility, food/bioeconomy, natural resources/agriculture/environment, culture/creativity/inclusive society, civil security for society	Innovation leading to market creation, growth of SMEs
Budget (draft)	EUR 2.58 billion	EUR 5.27 billion	EUR 1.35 billion
Other shared goals	Widen program participation: possibilities for partner countries and international cooperation Strengthen European research areas (reforming and enhancing the European R&I system)		

Source: Compiled by the authors based on information on the European Commission's website

The third pillar is a new initiative of support measures designed to create markets in Europe by promoting innovation. The aim is to form an innovation ecosystem by supporting entrepreneurships and start-ups while keeping in mind the goal of commercialization in higher education and advanced research. Europe has ideas and knowledge, but the system to financially support innovative breakthroughs to commercialize that knowledge had been less developed than in the US. In light of this situation, the European Commission launched the European Innovation Council (EIC) in 2015, and the EIC began providing financial support to European early-stage startups to support the commercialization of high-risk, high-impact technologies. In its pilot-phase operation, the EIC invested EUR 20 billion in more than 5,000 companies, of which 17 have been listed on the stock exchange and 33 have been acquired by corporations. Based on these achievements, the EIC's financial support program will be fully implemented under Horizon Europe. In Europe where the markets for private-sector capital, such as venture capital, are still developing compared with the US, the EU is building a single capital market by consolidating the systems of Member States. In this process, public assistance, such as that provided by the EIC, plays a significant role.

The relationship with industrial policy is even more intricate, and while the details are not explained here, worth noting is that European Commission-led alliances have been set up one after another in important areas, such as plastics, batteries, fuel cells and hydrogen, and rare metals, in order to create jobs and strengthen the manufacturing industry in Europe, and especially to ensure the region's competitiveness in state-of-the-art technologies.

3. HORIZON 2020 PROJECT PARTICIPATION: REQUIREMENTS AND EXAMPLES

In considering the potential use of Horizon Europe that will begin in 2021, it is important to have a general understanding of Horizon 2020 (2014-2020). The requirements for project participation under Horizon Europe are considered basically the same for Horizon 2020. Below is an introduction to the basic requirements for participation, followed by examples of past projects that have been adopted in the FPs.

3.1. Project participation requirements

For Horizon 2020, the European Commission basically employed a top-down approach in selecting projects by holding an open call every two years to solicit proposals for projects meeting specific themes. To apply for participation in an open project, a consortium must include at least three different organizations from three different countries among the European Economic Area (EEA), which includes the EU member states, and Switzerland. A project attracts seven to eight applications on average, and it seems acceptance is more likely if the applicants have a track record in handling similar projects. In principle, the budget is shared equally between the EU and participants, but the percentage covered by EU grants varies from project to project. Once applicants are approved for participation, they are required to report regularly on the progress of the project and the results upon completion.

3.2. Examples of projects

(1) Typical projects

In order to satisfy the above requirements, many applications are organized as collaborative industry-academia projects in which large companies, SMEs with technologies, consultancies, universities, and research institutes jointly participate from three countries. For example, the Steelanol project, which demonstrates ethanol production from the exhaust gas emitted by steelmaking plants, is being undertaken by the following participants: a Belgian subsidiary and a French research institute, both belonging to ArcelorMittal, the world's largest steel manufacturer; the Austrian unit of Primetals Technologies, a group company of Mitsubishi Heavy Industries; the UK technology consulting firm E4Tec; and the UK unit of the US company LanzaTech (originally a startup from New Zealand), making it a truly international project. LanzaTech's technology is being used at ArcelorMittal's Belgian steel mill, and E4Tech is conducting life-cycle assessment and technological economic analyses. The EU subsidizes 70% of the project budget of EUR 14.56 million.

(2) Large-scale pilot projects close to commercialization

Up to FP7, for the most part, participants were manufacturing companies aiming to accelerate R&D in collaboration with partners to advance their own technology development, but in Horizon 2020, there has been a greater tendency for funding to be allocated to large-scale pilot projects that have a high technology readiness level (TRL)[2] and are close to commercialization. Such projects are also more likely to directly result in a viable business. In the Bio-based Industries (BBI) JTI, for example, open calls for projects are conducted according to TRL, and projects with high TRL are classified into the category of flagship projects. One of the projects adopted under that category, Exilva, was implemented for four years from May 2016 with the aim of establishing Europe's first large-scale plant to create a market for microfibrillated cellulose (MFC). With the participation of five organizations, including Unilever, and with a budget of approximately EUR 45 million (of which EUR 27 million was subsidized by the EU), the annual production capacity of the pilot plant at Norwegian company Borregaard's facility was expanded to 11,000 metric tons. Made from Norwegian spruce, MFC is a 100% natural material and new type of bio-based additive with characteristics such as insolubility and water retention. Since the completion of the project, Borregaard has been selling MFC for use in a wide range of applications under the Exilva brand. According to an announcement by Borregaard, the material is expected to be adopted by more than 2,000 active prospects in over 30 application areas, including pharmaceuticals, cosmetics, and concrete. In this way,

[2] An indicator of the maturity of a particular technology, usually expressed in nine stages from TRL1 (conceptualization) to TRL9 (commercialization). In the EU, TRL is defined in the "Horizon 2020—Work Programme 2016-2017 General Annexes."

through Horizon 2020, the EU has supported projects near to commercialization and helped to bring products of European origin to the market.

In addition, a number of large-scale hydrogen production projects have been selected in the Fuel Cells and Hydrogen (FCH) JTI. The REFHYNE project started in 2018 and involves the construction of a large hydrogen electrolysis plant for producing hydrogen, with a peak capacity of 10 MW, the largest of its kind at the time of project launch. The demo project is being implemented in a refinery complex owned by Royal Dutch Shell. In the Djewels project, which started in January 2020 and will be implemented for a period of five years, entails the construction of a large 20-MW electrolyzer for the production of hydrogen that will be combined with other processes to produce green methanol. The budget of the project is EUR 44 million, of which EUR 11 million is subsidized by the EU. The European Green Deal Call, announced in September 2020, offers an open call for proposals to develop and demonstrate hydrogen production projects of several hundred MW capacity. It emphasizes clear results in the short term, but with a perspective of long-term change. Such large-scale hydrogen-related projects of this scale are also in line with the EU's hydrogen strategy published in July 2020 and are expected to lead to commercialization upon project completion.

(3) Projects to verify business models

As mentioned earlier, FP subsidies have primarily targeted technology development projects, but the scope is expanding to include projects for verifying business models. One example is the CIRC4Life project selected under the Horizon 2020 Circular Economy program. With the participation of 17 organizations from 8 countries, the project aims to establish specific sustainable business models (specifically, for co-creation of products and services, sustainable consumption, and collaborative recycle/reuse) for the value and supply chains in four industrial areas: (i) LED lighting equipment, (ii) computers, tablet devices, (iii) meat supply chain, and (iv) vegetable farming. It is worth noting that the fact that the EU selected not only technology development projects but also such a project for examining the potential of business models strongly suggests the EU's policy of emphasizing commercialization.

(4) Projects with prospects of contributing to standardization

Often in large-scale projects, more than 10 organizations participate as a consortium to collectively study new technologies in a multifaceted way at all stages of manufacturing, application development, safety evaluation, and policy standardization (such as for specifications) and share risks in commercialization. For example, the SECTOR[3] project adopted in FP7 is not only aimed at developing thermochemical conversion technology (torrefaction) of biomass materials, but is a large-scale project that also entails researching torrefaction-related issues in 10 work packages, which include transportation, storage, and utilization of torrefied pellets, sustainability assessment, and standardization. The German Biomass Research Centre (DBFZ) played the coordinator role, and 21 institutions from 9 EU Member States, including technology development manufacturers and research institutes, participated in the four-year project from January 2012. A quality standard for solid biofuels (wood pellets) was issued in 2014 as ISO 17225-1, but since the standard did not cover torrefied pellets and other materials, the drafting of a standard was one of the objectives of the SECTOR project from the outset. Participating research institutes accumulated data by conducting round robin tests[4] on torrefied pellet product standards (a calorific value, water content, ash content, etc.) and sustainability standards (biomass raw materials, a CO_2 reduction ratio), and provided the research results to CEN/ISO, IEA, and other organizations. Project officials involved in the drafting of the standards supported the formulation of the ISO standard, and ISO 17225-8 was published in 2016. It is vital that many companies from the entire value chain become involved in the standardization process, and the SECTOR project is a good example in which multiple research institutes collected data and leveraged their human networks to realize an international standard. In 2012, the European biomass association (Bioenergy Europe) took the lead in establishing the International

[3] SECTOR is an acronym for the Production of Solid Sustainable Energy Carriers from Biomass by Means of Torrefaction.

[4] A collaborative method of measuring by sending the same sample to multiple testing institutions in order to verify the reliability of the measuring methods and equipment, including the skills of the scientists performing the tests.

Biomass Torrefaction Council (IBTC). It is important to recognize movements to establish such associations as something correlated with efforts toward international standardization, and pay extra attention to these movements.

As US-China tensions intensify year by year, it is becoming difficult to unify global standards and specifications, but it should be remembered that Europe is adept at making rules. Europe understands the importance of standards, as illustrated by a quote by Siemens founder Werner von Siemens, who said, "He who owns the standards, owns the market."[5] The EU feels threatened by not only technological innovations coming from the US but also those from China, in particular, in such areas as AI and quantum computers, and the EU is aiming to promote its own standards for adoption as the global standards ahead of these two countries. Although the projects implemented under Horizon 2020 will not be adopted immediately as international standards, it should be noted that the pursuit of these kinds of projects in a variety of areas is an approach that can quickly elevate Europe-originating standardization rules to the international level. The SECTOR project can be said to be a good example of how standards compiled in the course of European R&D has led to international standardization.

(5) Projects Japanese companies participated through EU-Japan coordinated calls

Horizon 2020 is the world's biggest and most advanced research grant program. It is open globally, with an emphasis placed on international cooperation. It is needless to say that Japanese companies can participate in projects through legal entities established in the EU. In addition, they are able to participate directly from Japan through EU-Japan coordinated calls. If a company participates in a project from Japan, it will have to find its own funding source as it will not be eligible for EU subsidies for the portion of the research undertaken by the Japanese side. Nevertheless, 104 organizations from Japan have participated in 88 projects. Among them are NTT (NTT Network Innovation Laboratories), Fujikura, and Hitachi. Japan's National Institute for Environmental Studies participated in the CD-LINKS[6] project, which analyzes the interplay between countries' climate change measures and economic growth, aiming to aid the incorporation of countries' relevant policies based on the research results. The institute points out that the access to latest global trends as one of the benefits of its participation.

4. BUSINESS DEVELOPMENT-RELATED BENEFITS THAT CAN BE EXPECTED FROM PARTICIPATION IN HORIZON EUROPE

So far, we have introduced examples of projects selected for FP7 and Horizon 2020. The following is a summary of the business development-related benefits that can be gained through project participation. There are a number of common benefits for project participants. European companies can obtain not only subsidies for technology development from the EU, but also information on technology development trends, as well as establish relationships of trust with partners by working together on projects, and develop and access human networks through those relationships. Specific benefits to large companies include opportunities to develop and verify technologies in which they have an interest and obtain support for procedures associated with pilot projects. SMEs are given the opportunity to market their technologies, while universities and research institutes have the chance to test industrial applications of their researches and deal with technology evaluation.

Since the trend of R&I in recent years has been focused on projects that are close to commercialization, participation in such projects can pave the way for commercial application and reduce the related risks. Also, because the scope of the program encompasses a more extensive range of innovation themes, it provides the opportunity to try out new business models. Furthermore, participation in a consortium on a project that also aspires to formulate standards will entail involvement in standardization processes such as for technology

[5] Quotation from the *Financial Times* article, "From AI to facial recognition: how China is setting the rules in new tech," October 7, 2020, sourced from Koch, Hermann J., *Practical guide to international standardization for electrical engineers: impact on smart grid and e-mobility markets*, Wiley, 2016.

[6] Linking Climate and Development Policies – Leveraging International Networks and Knowledge Sharing.

standards, which is an area where Europe excels, and thus give the participant timely access to related information. Such information can also be used for making technology risk assessments. As Horizon Europe adopts a mission-oriented approach, efforts across the entire value chain will become more critical, and the benefits like those mentioned above will likely become more obvious.

In addition, a new initiative called “Innovative Europe” in Horizon Europe places participants in an advantageous position to identify, at the earliest stages, the market development potential of cutting-edge technology trends through their involvement in an innovation ecosystem where diverse players gather. For the creation of new business, it will be important to accumulate knowledge, while also identifying investment opportunities by ascertaining the latest trends in the development of technologies and direction of industries.

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