European Commission

Roadmap for EU-Japan S&T Cooperation

1. JAPAN AS A PARTNER OF THE EU

EU-Japan relations have developed steadily over the past two decades. Sharing many of the same challenges (energy security, access to critical raw materials, ageing populations), and defending a similar approach to key international challenges such as international security and climate change, Japan is in many ways one of Europe's closest partners on the international arena.

While trade and investment remain the anchor in EU-Japan relations, a wide range of dialogues and cooperation programmes are taking place in other areas. In particular, Japan has developed stronger political cooperation with the EU and is closely aligned with Europe on key issues including regional security (Ukraine, Iran, North Korea, South China Sea, etc.) and the Sustainable Development Goals (in particular, cooperation with Africa).

At the centre of the EU-Japan cooperation agenda are the Economic Partnership Agreement (EPA; the world's largest free trade agreement) and a wider Strategic Partnership Agreement (SPA) covering political dialogue, cooperation in addressing regional and global challenges, and sectoral cooperation, including Science and Technology (S&T). These two agreements, signed at the EU-Japan Summit on 17 July 2018, will strengthen the strategic partnership between the EU and Japan and boost cooperation prospects in Science, Technology and Innovation (STI) and related issues of norms and standardisation, with strengthened IPR protection. The conclusion of EU-Japan talks on 16 July 2018 on a reciprocal recognition of the adequate level of data protection is also important in this context. This mutual adequacy arrangement will create the world's largest area of safe transfers of data based on a high level of protection for personal data.

Cooperation between the EU and Japan in Research and Innovation (R&I) is governed by the Agreement on S&T Cooperation, which came into force in 2011. The EU-Japan Joint S&T Committee established under this Agreement has met four times (June 2011 and June 2013 in Tokyo, May 2015 in Brussels, and November 2017 in Tokyo) to exchange information and views on S&T policy issues; identify and decide cooperative activities; review accomplishments; provide advice on the implementation of the agreement; review the reciprocal access to Research and Innovation (R&I) programmes and projects and arrangements for visiting researchers; and to examine measures to improve that access and to ensure the principle on reciprocity. The next meeting is planned to be held in Brussels in 2019.

In addition to the Joint S&T Committee, the 21st Summit in November 2013 mandated the setting up of a task force of senior officials to look at concrete ways to bring EU-Japan cooperation in R&I to its 'full potential'. This Task Force held its first meeting in Tokyo in April 2014, a second took place in Tokyo in February 2015, and a third in Brussels in October 2016.

The 23rd EU-Japan Summit (29 May 2015) endorsed a new EU-Japan Strategic Partnership in Research and Innovation, which involves:: thematic cooperation in key strategic areas; putting in place framework conditions that facilitate cooperation (mechanisms for the joint funding of projects, and measures to enhance researchers' mobility); regular consultation and possible cooperation in R&I policy areas (such as Open Science); deepening strategic cooperation by frequent consultation at multiple levels (Summit, Joint S&T Committee meetings, Senior Officials meetings, Task Force meetings, thematic dialogues); and support activities and public engagement (National Contact Points in Japan and outreach activities).

Besides the S&T Agreement, the legal framework for cooperation between the European Atomic Energy Community (Euratom) and Japan is underpinned by several agreements in the field of fusion energy: The Agreement for co-operation between Japan and Euratom in the field of controlled thermonuclear fusion (in force since 1988), the multilateral Agreement on the Establishment of the ITER International Fusion Energy Organisation for the Joint Implementation of the ITER Project (ITER IO Agreement, in force since 2007) and in particular the Agreement between Euratom and the Government of Japan for the Joint Implementation of the Broader Approach Activities in the Field of Fusion Energy Research (in force since 2007), which is complementary to ITER.

Japan is a global leader in S&T, accounting for 10 % of global expenditures on R&D (OECD 2014), with 24 Japanese Nobel Prize winners in total for the natural sciences. For FY2016, Gross domestic expenditure on R&D (GERD) was 3.42% of GDP, and a long-term goal as expressed in the 5th Science and Technology Basic Plan (2016-2020) of 4% of GDP towards R&D remains. Overall research expenditures decreased from around €143 billion in 2015 to around €139.2 billion in 2016. The expenditures by industry decreased by 2.7%, to around €100 billion; for universities they decreased by 1.1% to around €27 billion; and for non-profit and public bodies they decreased by 6.2% to around €11.4 billion. Japan accounts for around 5.2% of the world's top 1% cited publications according to indicators from the National Institute of Science and Technology Policy (NISTEP). In 2015, 7.9% of domestic scientific documents with authors affiliated to institutions in Japan were in the world top-10% most cited, just ahead of China (7.6%), but behind the United States (13.9%) and the EU (11.9%).

Japan is witnessing a declining share and rank over time in top 1% cited publications. Japan has one of the lowest levels of international collaboration in science and innovation among OECD countries, with 1% of patents involving co-innovation, and 24.4% of scientific publications involving international co-authorship. Experimental indicators on the international mobility of scientific authors, based on bibliometric data for 2002 to 2016 show that Japan has lost more authors than it has attracted; over the 15 years to 2016, almost 8000 more scientific authors left Japan than entered.

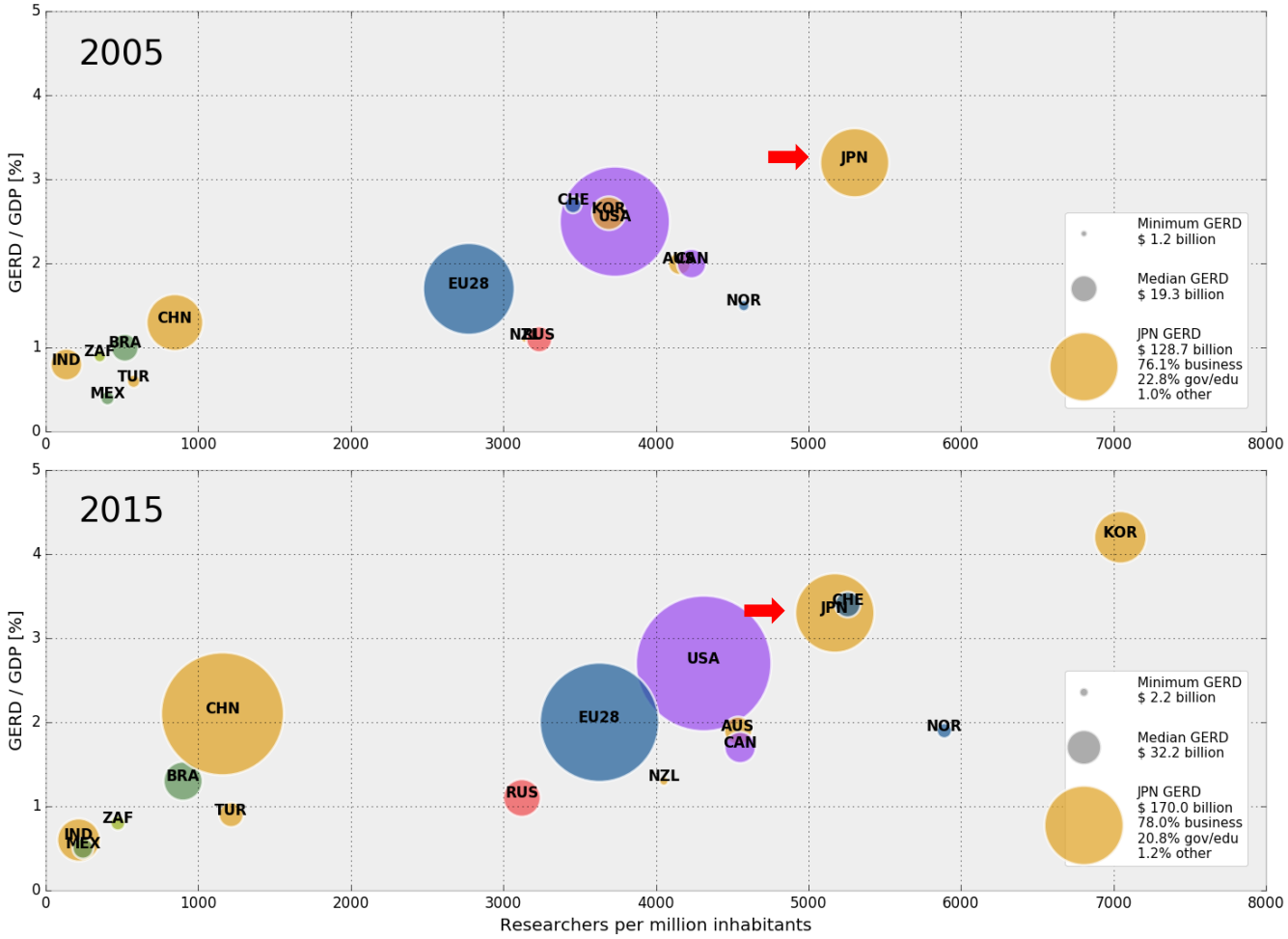
Japanese firms are very active in patent filing (total stock of 1.9 million patents in force, and there is a large number of Japanese companies included in the 2,500 top global R&D spending firms. Japan has a strong innovation base, as measured by patent applications and R&D spending, which rose from 2.7% of GDP in 1995 to 3.6% in 2014; Japan is third after Israel and South Korea among OECD countries. In the 5th Science and Technology Basic Plan (2016-2020), the government set a target of raising it to 4% of GDP by 2020 and developing industries at the knowledge frontier. Japan has particular strengths in automobiles and parts, pharmaceuticals and biotechnology, electronic and electrical equipment sectors. Japan traditionally performs

well in innovation rankings, immediately below South Korea, Canada and Australia, and above the EU average. According to the 2018 *European Innovation Scoreboard* Japan's performance is above that of the EU, and the country is a Strong Innovator. Performance has increased since 2010. Japan's relative strengths are in Business R&D expenditures, Innovation collaboration, and Patent applications. Japan's top R&D spending firms spend about 50% more on R&D as compared to EU top R&D spending firms.. Business-sector R&D is one of the highest in the OECD at 2.8% of GDP in 2014, making Japan one of the top contributors to the development of disruptive technologies and a world technology leader. The structure of the economy is comparable to that of the EU. According to the 2017 Global Innovation Index (GII) released by the World Intellectual Property Organization (WIPO), the most innovative country in the world is Switzerland followed by Sweden in second place, Netherlands in third and the USA in fourth. Japan ranked 14th, jumping up two ranks from 16th place in the previous year. In Asia, Singapore ranked the highest in the region at 7th, followed by South Korea in 11th place.

The innovation system is dominated by large firms, with little co-operation with universities and government research institutes (GRIs). 99.0% of business-financed R&D takes place within firms, leaving little room for universities and GRIs, at 1.0% together. Consequently, mobility of researchers between the business sector, universities and GRIs is limited. In order to boost R&D collaboration between universities and firms to help raise both productivity and inclusive growth in 2016, the government has launched a Programme for an Open Innovation Platform with Enterprises, Research Institutes and Academia (OPERA). This will promote such cooperation at a pre-competitive stage of development, with financing from the business sector and the government.

When it comes to human resources, Japan consistently ranks among the best performers in the OECD Programme for International Student Assessment (PISA), which tests the skills and knowledge of 15 year-old students. The share of adults with a tertiary education is the second highest in the OECD. Japan ranked first in the OECD Survey of Adult Skills (PIAAC) in both literacy and numeracy skills of adult workers. 59.6% of the Japanese population aged 25-34 has completed tertiary education (OECD average is 42.1%). In 2014, there were 5,386 researchers per 1 million inhabitants: 74% in the Business Enterprise sector, 24.5% in the Higher Education and Government sector, and 1.5% in neither of these two sectors. Japan belongs to one of the top countries in a global perspective in terms of GERD volume and number of researchers per million inhabitants. Both the number of Japanese researchers per million inhabitants and the volume of Japanese GERD have increased from 2001 to 2014 (see Figure 1).

Figure 1: Expenditures in Research & Development and researchers per million inhabitants



Note: GERD in current PPP; Top chart: Data for CHE from 2004. Bottom chart: Data on researchers per million inhabitants for BRA from 2014, for CAN from 2014, for MEX from 2013 and for AUS from 2010.
Source: DG RTD - International Cooperation
Data: UIS, OECD, EUROSTAT; extraction date: 11/10/2018

2. State of Play of EU-Japan Cooperation in Research and Innovation

2.1 On-going FP7 and Horizon 2020 cooperation

In **Horizon 2020** (2014-2020), up to October 2018, Japanese applicants are involved 377 times in 313 eligible proposals to collaborative[1] actions. This has led to 30 successful projects, involving 33 participations, with an impressive success rate of 21.5% (as compared to 15.8% overall). Japanese beneficiaries have received EUR 2.5

[1] Here referring to non-bottom-up, internationally open, collaborative actions, i.e. all actions except for ERC, MSCA, actions under the SME Instrument and Access to Risk Finance.

million from the European Commission (EC) and EUR 3.0 million from non-EC sources. Cooperation with Japan is further targeted in 22 call topics in Horizon 2020 Work Programme (WP) 2018-20 (see Annex). Horizon 2020 participation so far is mainly in the areas of the Marie Sklodowska-Curie Actions that promote researchers' mobility; Environment research; Nanotechnologies and Advanced materials (NMBP); and Nuclear research cooperation through Euratom.

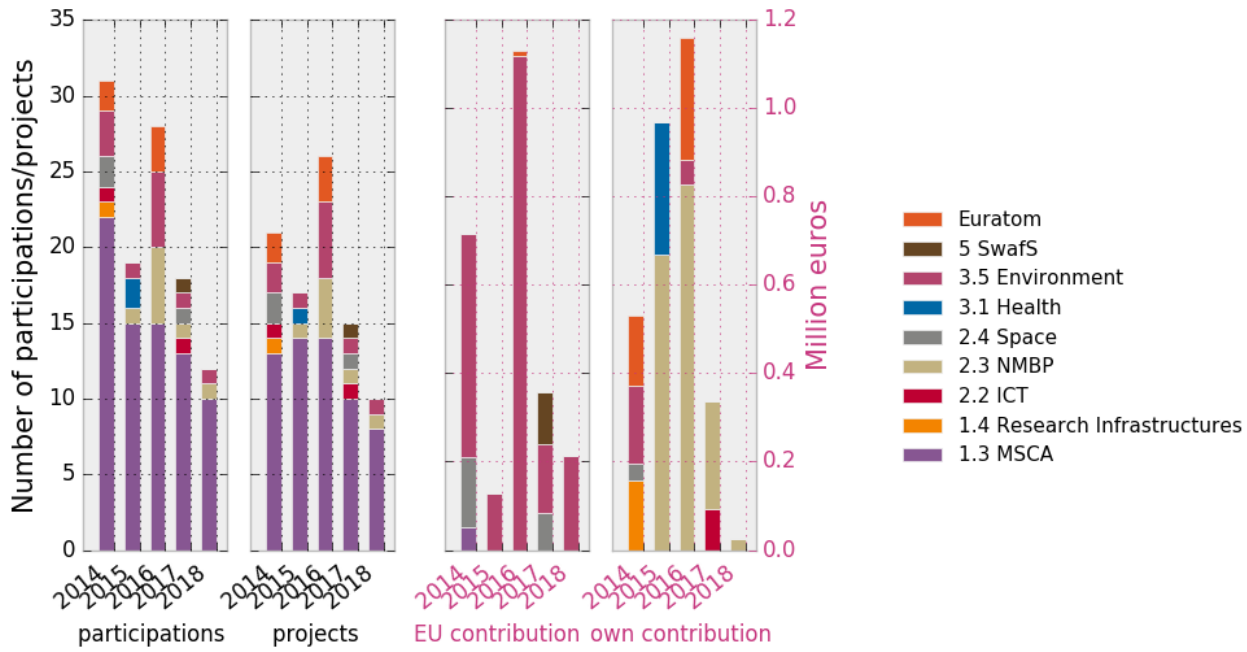
As regards the Horizon 2020 Marie Skłodowska-Curie Actions (MSCA), Japanese applicants are involved 377 times in 313 eligible proposals. Japanese entities have participated 75 times (of which 1 as beneficiary) in the MSCA (7 in Individual Fellowships (IF), 46 in the RISE, 20 in the ITN and 2 in the COFUND programme), receiving EUR 0.1 million from the European Commission. Furthermore, a total of 113 researchers of Japanese nationality have participated in the MSCA. As regards ERC, a total of 16 Japanese nationals have acquired an ERC grant.

In **FP7** (2007-2013), Japanese entities participated 179 times to 153 grants of collaborative, ERC and Marie Curie Actions (MCA), receiving EUR 8.9 million from the EU while EUR 21.1 million is the non-EU budget. Regarding collaborative actions (excluding ERC and MCA**)**, Japanese applicants were involved 397 times to 332 eligible proposals, leading to 101 funded projects that involved 119 Japanese participations. Japanese participants have received EUR 8.6 million from EU while EUR 21.1 million was the non-EU budget. Regarding MCA, Japanese entities have participated 59 times to 51 signed MCA grants, receiving EUR 0.2 million from the European Commission. Also, a total of 358 researchers of Japanese nationality have participated in the MCA. As regards the ERC, 1 Japanese entity has participated, receiving EUR 0.1 million from the EU, and a total of 14 Japanese nationals have acquired an ERC grant.

EU-based branches of Japanese companies have participated actively in the framework programme. In Horizon 2020, there are more than 200 participations by more than 70 different Japanese companies based in Europe, notably in the field of ICT, Transport and Energy.

In addition, there have been 33 projects financed through 10 coordinated calls launched jointly by the EC and Japanese ministries/agencies between 2011 and 2017 in the areas of energy, aeronautics, materials, ICT and health/ICT robotics (see details in thematic cooperation areas below).

Figure 2: Participation of Japan in Horizon 2020 and in Euratom Programme



Note: Participations of beneficiaries, third-parties and partner-organisations.
Source: DG Research and Innovation - International Cooperation
Data: CORDA (JRC, EIT and art.185 not included); extraction date: 15/10/2018

2.2 Current framework conditions for EU-Japan S&T cooperation

Framework Conditions for R&I cooperation with Japan are good, as could be expected from one of the world's leading scientific 'powerhouses'. As a WTO and OECD member, Japan offers a predictable legal framework, in particular regarding IPR protection. However, European companies may still encounter non-tariff barriers in the form of limitations related to public procurement, lack of competition and licensing costs, and Japan has a relatively challenging market for foreign investment. The Economic Partnership Agreement (EPA) is focusing on the removal of non-tariff barriers as well as on the opening up of public procurement in Japan to EU businesses. A closer harmonisation of standards, called for by the EU-Japan Business Round Table, and which has been discussed in the context of the EPA, would be beneficial for both sides.

Efforts are being made to consolidate framework conditions that facilitate R&I cooperative activities between the EU and Japan. Promoting opportunities for increasing the mobility of researchers between the two is important. The Implementing Arrangement between the European Commission and the Japan Society for the Promotion of Science (JSPS), signed in May 2015, provides opportunities for Japanese researchers to pursue research collaboration with European Research Council (ERC) grantees in Europe.[2] So far, 1085 ERC grantees

[2] JSPS and JST also fund long-term visits to Japan by overseas researchers. A number of bilateral schemes are in place.

have expressed an interest in hosting Japanese researchers, whereas 18 Japanese researchers have explored this opportunity. On 7 October 2018, an implementing arrangement was signed between the European Commission and the Japan Science and Technology Agency (JST). The arrangement provides opportunities for Japan-based researchers supported by active JST projects to pursue research collaboration with European researchers already supported through active EU-funded ERC grants. The Marie Skłodowska-Curie Actions provide further opportunities for increasing the mobility of researchers. Japanese researchers have been very actively involved, in particular through the Research and Innovation Staff Exchange (RISE) action.

The 23rd EU-Japan Summit in May 2015 acknowledged the importance of establishing streamlined mechanisms for the joint funding of R&I projects to fully exploit the potential of EU-Japan cooperation. The funding scheme developed by the Japan Science and Technology Agency (JST) in close collaboration with the European Commission, which was implemented for the first time in Horizon 2020 WP 2016-17, and again in WP 2018-20, is an important step forward. The Ministry of Education, Culture, Sports and Science and Technology (MEXT) announced in 2018 it will co-fund Japanese partners in a call related to Arctic research.

The Horizon 2020 **National Contact Point** (NCP) in Japan at the EU-Japan Centre for Industrial Cooperation plays an important role in providing guidance, practical information and assistance on all aspects of participation in Horizon 2020.

3. Priorities for the Future in S&T Cooperation

3.1 Areas of future S&T cooperation agreed at latest Joint Committee/High Level Dialogues

On the basis of the 4th EU-Japan Joint S&T Committee (JSTC) in November 2017 the following areas are considered to be priority areas for future cooperation with Japan:

- ICT

ICT has long been one of the most active areas of EU-Japan S&T cooperation, both at policy and project level. Four coordinated calls have been launched since 2013 with the Ministry of Internal Affairs and Communication (MIC) and the National Institute of Information and Communications Technology of Japan (NICT) on 5G, Internet of Things, Cloud and Big Data. Four projects of the latest joint call kicked-off in July 2018. A joint call on healthy ageing was launched in 2016. Another area of joint ICT research where cooperation with Japan is encouraged is the international cooperation (INCO) flagship on "Unconventional Nanoelectronics". In the Horizon 2020 LEIT WP 2018-2020, Japan is also mentioned under Societal Challenge 1 of the WP 2018-2020 encouraging cooperation on digital transformation of health and care. Work is underway to set up a joint call/targeted opening on the topic of eHealth for Robotics in 2020. ICT Dialogues have long been established between DG CNECT of the European Commission and MIC. The 24th such Dialogue is scheduled to take place in December 2018 on the margins of the ICT 2018 event in Vienna. These dialogues are usually complemented by a series of industry-government workshops.

– Transport including Aeronautics

Aeronautics research is a strategic area for cooperation with Japan, providing EU industry with opportunities to reinforce links with Japanese industrial partners and improve access to the Japanese market and vice versa. The EC-METI (Ministry of Economy, Trade and Industry) Working Group on Aviation research was launched in June 2013, providing a platform to manage on-going projects, define joint priorities, and prepare future cooperation. There have so far been two coordinated calls between the EU and METI/NEDO (New Energy and Industrial Technology Development Organisation) leading to projects in the following areas: high-speed aircraft, anti-icing system, passenger-friendly cabins, heat exchanger systems for engines, composite structure manufacturing, and smarter flight control. Support actions have been launched twice to support these activities. In Work Programme (WP) 2018-2020 Japan is explicitly encouraged to participate in the multinational International Cooperation (INCO) flagship "*Safer and Greener Aviation in a smaller world*", notably in the topics on icing (2018), hybrid-electric propulsion (2019) and high-speed aviation (2020). Regarding other transport areas, there is a trilateral dialogue (EU, Japan, US) in the field of automated vehicles. As a consequence, automated road vehicles and maritime transport can be expected to play a role in EU-Japan S&T cooperation. This is reflected in the Horizon 2020 WP 2018-2020, where Japan is a targeted country in four call topics covering the INCO Flagship on "*Road automation and safety*". In addition, Japan is encouraged to participate in the INCO Flagship on "*Integrated multimodal, low-emission freight transport systems and logistics*", and in the INCO flagship on "*Reduction of transport impact on air quality*". Finally, Japanese cooperation in the multimodal topic “Human Factors in Transport Safety” is encouraged.

– Nanosafety, Advanced Materials (including Critical Raw Materials) and Regulatory Science

The area of critical material is in many ways a model for EU-Japan cooperation, both at the policy level (common strategic interest), as well as at project level (coordinated calls). There have been two successful coordinated calls between the EU and Japan Science and Technology Agency (JST) in FP7 on critical raw materials, one call topic in Horizon 2020 WP 2016-2017 on materials research covered by the co-funding scheme of JST, and there is a call on demand-supply forecast and raw materials flow at global level (participation of Japan and US is required). Critical materials continue to be an area of cooperation with Japan but it would be desirable to achieve a better balance between the EU investment and the co-funding scheme provided by Japan to their synchronised projects. In addition, there are opportunities of mutual interest for further cooperation with Japan in the area of materials sustainability and energy efficiency in the building sector.

For medical technologies for global healthcare, cooperation with Japan could lead to a better determination of potential product efficacy as well as an earlier determination of their risk. The possibility of future cooperation in this area should be examined and could be pursued through the Horizon 2020 INCO Flagship on "Technologies for global health care", proposed for multilateral international cooperation.

Nanosafety is of global concern as no country alone can cover the full range of safety research. The participation from Japan is welcome in the development of dedicated harmonised testing guidelines for risk assessment of nanomaterials within the OECD–WPMN (The Malta Initiative). The EU strongly supports the Safe-by-Design approach, where the necessary steps to reduce hazard and exposure to acceptable levels are assessed and would be taken at an early stage of the nanomaterial development process. The EU has three upcoming calls on this topic, forming a part of the INCO Nanosafety Flagship, where multilateral international participation is highly encouraged.

Besides the three areas ICT, Transport including Aeronautics, and Advanced Materials Research, mutually agreed by the JSTC, there is considerable cooperation in the field of nuclear research – both fission and fusion (such as through the multilateral ITER project) – carried out under the international bilateral agreements between Euratom and Japan, and under the Euratom Research and Training Programme. In *fission research*, nuclear safety and security are shared concerns. Japan ranked among the most prominent foreign partners in the fission calls (indirect actions) under the Euratom Programmes (2007-2013), with 16 participations (10 entities) in 12 Euratom consortia. Co-operation with Japan increased strongly after the Fukushima accident in the areas of radiation protection and radioecology, such as through the FP7 OPERRA project on the epidemiology of thyroid cancer. There are on-going projects in radioactive waste management, nuclear fuel reprocessing and reactor safety. Promising areas for future cooperation are: radiation protection, severe accident management, decommissioning and decontamination, as well as Generation-IV (future reactors systems). Under the Euratom Programme (2014-2018), Japanese participation continues also in the field of radioactive waste management. There are 2 participations (1 entity) in 2 Euratom consortia under the first Fission call, indirect actions (Nuclear Fission and Radiation protection, NFRP Call) of the biannual Euratom Work programme (2014-2015). Japan increased its participation under the Second Fission/NRFP Call of the Euratom biannual Work Programme (2016-2017), indirect actions, with three participations in three Euratom projects by two Japanese entities. Japan is expected to follow this positive trend under the new call for 2018, in the topics of the call opened to international cooperation. In the field of direct fission actions of the Euratom programme, the Joint Research Centre (JRC) has long standing collaborations with Japanese research organisations like the Japanese Atomic Energy Agency (JAEA), the Central Research Institute of Electric Power Industry (CRIEPI) and the former Japan Nuclear Energy Safety (JNES), current Japan Nuclear Regulatory Authority (NRA), in the areas of safety of nuclear fuel and fuel cycles, nuclear safeguards and security (including training and education), and nuclear measurements. From this perspective, cooperation with Japan may also be strengthened in the field of nuclear decommissioning. In *fusion research*, Japan is a strategic partner in fusion physics and technology development, in support of ITER and DEMO, and a key international element in the European Fusion Roadmap. This excellent bilateral cooperation and the formal Cooperation Agreement dates back to 1988. Collaboration on ITER started in 1989 and is currently embodied in the ITER Agreement, which foresees the construction and operation of the ITER machine in Cardache (France), together with China, South Korea, India, the Russian Federation and the USA. Through the Broader Approach Agreement in force since 2007, a unique partnership has been established with Japan in the field of fusion energy research. This Agreement supports joint work for the construction of the JT60-SA machine in Naka (Japan) with a substantial EU contribution, joint work for the construction of a

demonstrator of the future International Fusion Materials Irradiation Facility (IFMIF), and joint design and R&D activities on DEMO. Discussions are on-going about an extension of the Broader Approach activities beyond 2020.

Cooperation with Japan is also progressing in the context of the EU FET Flagship on Human Brain (HBP), which aims at developing large-scale simulation of human brain and mouse brain data. The FET Flagship on Graphene is also an area of cooperation. In both areas, regular workshops are taking place with the participation of prominent European and Japanese research organisations to further develop this cooperation. In 2018, cooperation was also initiated in relation to the FET flagship on Quantum Technologies, with workshops organised (by JST) with European and Japanese researchers.

3.2 Other areas of future S&T cooperation proposed at latest Joint Committee/High Level Dialogue, through SFIC, or by thematic services

In addition to the areas of substantial cooperation above, there was a mutual interest at the 4th JSTC to look into increasing cooperation in the coming years in a number of other areas, including:

- Renewable energy (non-nuclear)

Cooperation with Japan on non-nuclear energy research and innovation has been discussed in areas such as hydrogen fuel cells, energy storage, carbon capture and storage, electric vehicles, and critical materials for energy. A successful coordinated call on photovoltaics was launched between the EU and NEDO in 2011. It is hoped that joint activities will further develop following the adoption of Japan's latest National Energy and Environmental Strategy for Technological Innovation towards 2050, under which the development of low-carbon energy is a priority. Moreover, the European Energy Research Alliance (EERA) JP Wind is interested in cooperation with research institutes in Japan. Japan has a particular interest in floating offshore wind, and both parties have organised a series of workshops. Active participation of Japan and the EU in the International Energy Agency (IEA) Technology Collaboration Programmes (together with the JRC and DG ENER of the European Commission) provides yet another opportunity to hold strategic energy R&D discussions. For biofuels and bioenergy, there are collaboration opportunities in catalyst development for improved conversion to advanced biofuels and alternative renewable fuels and emission reduction, , whereas in the area of batteries, there are collaboration opportunities in batteries' integration in grids and buildings. Japan is further a member of Mission Innovation[3], and is targeted in the Horizon 2020 WP 2018-2020 INCO flagship on "*Mission Innovation*" on clean energy in general.

- Health

The EU and Japan cooperate in multilateral initiatives aimed at addressing global health challenges. These are in particular the International Human Epigenome Consortium (IHEC), the Human Frontier Science Programme

[3] Japan has pledged to double its governmental and/or state-directed clean energy research: http://mission-innovation.net/joint-statement/

organisation (HFSP), the International Human Microbiome Consortium (IHMC), the International Cancer Genome Consortium (ICGC), and the International Mouse Phenotyping Consortium (IMPC). The Japan Agency for Medical Research and Development (AMED), launched in 2015, represents an important interlocutor on health research cooperation with the EU. Between 2015 and 2017, AMED has joined the following initiatives: International Rare Diseases Research Consortium (IRDiRC), the Global Research Collaboration for Infectious Diseases Preparedness (GloPID-R), Global Alliance for Chronic Diseases (GACD) and Joint Programming Initiative on Anti-Microbial Resistance (JPIAMR). These initiatives constitute the frame to ensure cooperation between the EU and Japan in the future via regular meetings among members. Japan is the most significant funder of the HFSP, to which the EU continues to provide an annual contribution of around EUR 5 million. As mentioned above, cooperation with Japan is also targeted in the Horizon 2020 WP 2018-2020 INCO flagship on "*Technologies for global health care*". In the future, neurodegenerative diseases could be exploited, in particular Alzheimer's disease and dementia, brain research, starting with areas such as traumatic brain injury and epilepsy.

- Climate action, environment and resource efficiency

Environment research has been identified as an area where cooperation can be strengthened. Cooperation takes place through multilateral initiatives (Group on Earth Observations, Belmont Forum, Future Earth). A series of High-level EU-Japan workshops on climate change research have been organised over recent years; the 7th which took place in April 2016 being the most recent one. In the future it is proposed to focus them towards the issue of climate services. Another possible area of future cooperation is "Nature-Based Solutions" for disaster risk reduction (DRR) and sustainable urbanisation. In Horizon 2020 WP 2018-2020, cooperation with Japan is targeted in the INCO flagship on "*Operational forecasting of earthquakes and early warning capacity for more resilient cities*". In relation to DRR, the JRC has since 2011 a multi-annual collaboration agreement with the Disaster Prevention Research Institute of Kyoto University, and a long-established collaboration with the Japanese Building Research Institute (BRI), Ministry of Land, Infrastructure, Transport and Tourism in the field of seismic vulnerability and protection of civil engineering structures. In addition, cooperation with Japan is targeted in Horizon 2020 WP 2018-2020 INCO flagship on "*Changing cryosphere/Arctic research*", in relation to which the Ministry of Education, Culture, Sports and Science and Technology (MEXT) has announced it will co-fund Japanese partners. It has also been announced that the Third Arctic Science Ministerial will be held in Japan in 2020, co-hosted by Japan and Iceland (Chair of the Arctic Council).

There is also scope for possible strengthened cooperation in thematic areas not emphasised at the 4th JSTC above, such as:

- Research Infrastructures (RIs)

There is an interest in Japan to cooperate in accelerator-based infrastructure. The two Horizon 2020 projects E-JADE and JENNIFER under the Marie Skłodowska-Curie Action (MSCA)-Research and Innovation Staff Exchange (RISE) have Japanese participation. The CERN led European Circular Energy-Frontier Collider Study (EuroCirCol) funded through the Horizon 2020 Work Programme on Research Infrastructures aimed at exploring different designs of circular colliders for the post-LHC era also involves Japanese participation. Japan and Europe are

mutually benefitting partners, which are both currently leading the world with their excellent HEPs facilities. Horizon 2020 could increase the collaboration in this area.

In addition to High-Energy Physics, dialogues have been ongoing in agriculture, biotechnology and genomics. Japanese facilities are involved in facilities listed on the European Roadmap for Research Infrastructures in the domain of Astro-Physics (Cherenkov Telescope Array CTA), environmental sciences (EISCAT 3D - Europe's Next-Generation Radar for Atmospheric and Geospace Science) and arctic sciences (Svalbard Integrated Earth Observing System - SIOS). Japanese RIs are also collaborating with European partners in the field of population ageing (SHARE) related to Social Sciences and Humanities and in the life sciences domain, such as European Virus Archive (EVA) and BBMRI ERIC.. Collaboration amongst European and Japanese RIs is considered as highly strategic. In Horizon 2020 WP 2018-2020, cooperation with Japan is targeted in the INCO flagship on "*Integrating and Opening activities*". The publication of the 2018 ESFRI Research Infrastructure roadmap provides additional opportunities for collaboration, which could be explored in the frame of dedicated dialogues. In 2018, the International Conference of Research Infrastructures (ICRI) was also a crucial occasion to foster the dialogue on Research Infrastructures with countries such as Japan.

Japan and the European Commission are both members of the Group of Senior Officials (GSO) on Global Research Infrastructures (GRIs). Japan played a historical role in the establishment of the GSO, which was decided at the first G8 Science Ministers' meeting, held in Okinawa on 15 June 2008, to informally explore cooperation opportunities in GRIs. The Commission is in charge of the Secretariat of the Group. The GSO is composed of representatives from Australia, Brazil, Canada, China, the European Commission, France, Germany, India, Italy, Japan, Mexico, Russia, South Africa, UK and USA. Meetings are held, on average, every 6 to 8 months with the hosting country taking up the chairmanship of the Group until the following event. Informal discussions are under way on Japan hosting a future meeting of the GSO, possibly in 2019.

- Space research

The EU and Japan have an advanced space S&T sector and a powerful space industry. The EU-Japan Space dialogue was established in 2014, the third meeting took place in Tokyo in October 2017. There are a number of promising areas for cooperation in the Copernicus programme (Earth observation and climate change, e.g. CO2 monitoring, oceans monitoring, support for the management of natural disasters). Copernicus data and information is made available to all users, including international partners, on a full, open and free-of-charge basis. Discussions have started on sharing the Copernicus data with the Japanese side taking into account the principle of reciprocity. As JAXA is in the process of launching GOSAT-2, Japan would be a key partner of the future global carbon monitoring system. Regarding the satellite navigation system, there is a real potential for working together in the area of applications (autonomous driving, 3D mapping, rail, agriculture, Global Navigation Satellite System - GNSS - standardization), receivers and on new services such as the emergency warning service. To that effect, DG GROW of the European Commission and the Japanese National Space Policy Secretariat signed in March 2017 a Cooperation Arrangement. Deepened cooperation is already on-going in the area of autonomous driving/3D mapping and emergency warning services. Japanese organisations have already

participated successfully in EU projects in FP7 and are also present in proposals submitted to Horizon 2020. Three possible areas for EU-Japan cooperation are: Space Technology, Scientific data exploration and Space Weather.

- Security research

There are complementary skills and technologies between EU and Japanese practitioners, research centres and industry in in the field of Crisis Management. There is a strong potential for mutual benefits through an exchange on R&D on the disaster resilience dimension in general, and more specifically on the development of technologies to be used for the equipment of first responders where cooperation with Japan is targeted in the Horizon 2020 WP 2018-2020 call topic on "*Technologies for first responders*". In the frame of this collaboration effort there is a possibility for Japanese partners in successful Horizon 2020 projects to receive dedicated funding by JST. The Cyber Security dialogue with Japan, launched in 2014, also deserves a special reference.

In addition, Japan's National Institute of Advanced Industrial Science and Technology (AIST) and the JRC formalised in May 2017 their cooperation in the fields of nanotechnology, metrology, standardisation and photovoltaic, via a Research Framework Arrangement. In 2018, JST formalised its cooperation with AIST, the Japan Aerospace Exploration Agency and Nagaoka University of Technology on Lithium ion batteries through a new Collaborative Research Arrangement.

3.3 Improvements in framework conditions agreed at latest Joint Committee/High Level Dialogue and additional framework conditions to be addressed at future policy dialogue meetings

As mentioned earlier, efforts will be made to consolidate framework conditions that facilitate R&I cooperative activities between the EU and Japan, such as to implement and extend the co-funding with ministries and agencies in Japan, notably with the Japan Science and Technology Agency (JST) and the Ministry of Education, Culture, Sports, and Science and Technology (MEXT); to promote opportunities for increasing the mobility of and cooperation between researchers in Europe and Japan, such as through the European Commission's implementing arrangements with the Japan Society for the Promotion of Science (signed in 2015) and the Japan Science and Technology Agency (signed in October 2018), which allow Japanese researchers to team up with European Research Council grantees in Europe , and through opportunities involved in the Marie Sklodowska-Curie Actions.

Besides cooperation in thematic areas, the importance of extending the partnership to cover regular consultation and possible collaboration on major STI policy issues is recognised. In particular, recent opportunities to exchange views on areas such as Open Science, and to reaffirm the usefulness of deepening mutual understanding of each other's STI policy frameworks, is emphasised. In Open Science, consultations and discussions have taken place on open access to publicly funded research, including peer-reviewed published research and research data (open data) through joint participation in workshops. At the G7 S&T Ministerial

meeting in Tsukuba in May 2016, it was agreed to establish a G7 working group on Open Science, which the EU and Japan are co-leading.

Another cooperation area is outreach to society, highlighting the benefits of EU-Japan cooperation in STI. An example of this is the European Participation in "Science Agora 2018", the major science communication event organised annually by JST in Tokyo.

Annex:

Horizon 2020 Work Programme 2018-2020: International flagships where Japan is targeted

- **ICT**: Bilateral Flagship through "*Coordinated Call on 5G communication networks, security, cloud, IoT, Big Data*". Targeted in flagship on "*Unconventional Nanoelectronics*".
- **Transport**: Targeted in Flagships on "*Greener and safer aviation*", "*Automated road transport*", "*Integrated multimodal freight transport systems and logistics*", and "*Reduction of transport impact on air quality*".
- **Energy**: Targeted in Flagship on "*Mission Innovation*" on clean energy in general. Suggested bilateral Flagship on "*Advanced biofuels*".
- **Health**: Cooperation through several multilateral initiatives. Targeted in Flagship on "*Technologies for global health care*".
- **Disaster Risk Reduction**: Targeted in Flagship on "*Operational forecasting of earthquakes and early warning capacity for more resilient cities*".
- **Security**: Targeted in Flagship on "*Technologies for first responders*".
- **Nanotechnologies**: Targeted in Flagship on "*Nanosafety*".
- **Climate Action**: Targeted in Flagship on "*Changing cryosphere/Arctic research*".
- **Research Infrastructures**: Targeted in Flagship "*Integrating and Opening activities".*

Horizon 2020 Work Programme 2018-20: Call topics explicitly encouraging cooperation with Japan

	Identifier	Title
2018	DT-ART-01-2018 (CLOSED)	Testing, validation and certification procedures for highly automated driving functions under various traffic scenarios based on pilot test data
	DT-ART-02-2018 (CLOSED)	Support for networking activities and impact assessment for road automation

	EUJ-01-2018 (CLOSED)	Advanced technologies (Security/Cloud/IoT/BigData) for a hyper-connected society in the context of Smart City
	EUJ-02-2018 (CLOSED)	5G and beyond
	INFRAIA-01-2018-2019	Integrating Activities for Advanced Communities
	MG-2-5-2018 (CLOSED)	Innovative technologies for improving aviation safety and certification in icing conditions
	NMBP-13-2018 (CLOSED)	Risk Governance of nanotechnology (RIA)
	NMBP-14-2018 (CLOSED)	Nanoinformatics: from materials models to predictive toxicology and ecotoxicology (RIA)
	SC1-HCC-03-2018 (CLOSED)	Support to further development of international cooperation in digital transformation of health and care
	SC5-17-2018 (CLOSED)	Towards operational forecasting of earthquakes and early warning capacity for more resilient societies
	SU-DRS01-2018-2019-2020 (CLOSED)	Human factors, and social, societal, and organisational aspects for disaster-resilient societies
	SU-DRS02-2018-2019-2020	Technologies for first responders

2019	DT-ART-03-2019	Human centred design for the new driver role in highly automated vehicles
	DT-ART-04-2019	Developing and testing shared, connected and cooperative automated vehicle fleets in urban areas for the mobility of all
	ICT-06-2019	Unconventional Nanoelectronics
	LC-CLA-07-2019	The changing cryosphere: uncertainties, risks and opportunities
	LC-MG-1-7-2019	Future propulsion and integration: towards a hybrid/electric aircraft
	MG-2-9-2019	Integrated multimodal, low-emission freight transport systems and logistics (Inco Flagship)
	NMBP-15-2019	Safe by design, from science to regulation: metrics and main sectors (RIA)
	SU-SPACE-22-SEC-2019	Space Weather
2020	NMBP-16-2020	Safe by design, from science to regulation: behaviour of multi-component nanomaterials (RIA)
	NMBP-17-2020	Regulatory science for medical technology products (RIA)

Figure 3: Japan – Top scientific areas compared to EU28 in terms of citation impact of publications

	Scientific Area	Share in world output	Share of international co-publications	Citation Impact Difference with EU28	Citation Impact 8-year trend
High publication output	Biochemistry, Genetics and Molecular Biology: Genetics	5,8%	35%	+0.18	↑
	Chemical Engineering: Catalysis	8,8%	26%	+0.12	↑
	Agricultural & Biological Sciences: Ecology, Evolution, Behavior & Systematics	4,1%	43%	+0.11	↑
	Physics and Astronomy: Astronomy and Astrophysics	7,2%	61%	+0.03	↓
	Physics and Astronomy: Nuclear and High Energy Physics	10,5%	45%	+0.03	–
	Chemistry: Inorganic Chemistry	6,1%	28%	+0.01	–
	Physics and Astronomy: Physics and Astronomy (miscellaneous)	8,1%	37%	-0.01	↑
	Medicine: Pathology and Forensic Medicine	6,8%	20%	-0.03	–
	Chemistry: General Chemistry	6,1%	27%	-0.03	–
	Materials Science: Electronic, Optical and Magnetic Materials	8,0%	26%	-0.05	↑
Low publication output	Pharmacology, Toxicology and Pharmaceutics: Miscellaneous	1,2%	18%	+0.78	–
	Nursing: Emergency Nursing	1,3%	17%	+0.72	–
	Social Sciences: Archeology	0,6%	52%	+0.69	–
	Arts and Humanities: Music	0,9%	25%	+0.57	↓
	Nursing: Gerontology	6,0%	12%	+0.54	–
	Earth and Planetary Sciences: Geochemistry and Petrology	4,3%	51%	+0.54	↑
	Earth and Planetary Sciences: Stratigraphy	2,7%	68%	+0.38	↓
	Medicine: Critical Care and Intensive Care Medicine	1,8%	25%	+0.38	↑
	Business, Management and Accounting: Management Information Systems	1,1%	30%	+0.37	↑
	Earth and Planetary Sciences: Geophysics	6,5%	53%	+0.35	↑

Source: DG Research and Innovation – International Cooperation
Data: Elsevier SciVal; extraction date: 6/8/2017; publications' window: 2011-2013; citations' window: 3 years
Note: These tables show scientific areas in which the country's academic publications have a higher citation impact than EU28, and whether this difference has decreased, increased or remained the same in the past 8 years. They are grouped in two tables. The top table focuses on areas with high share of publications in the country's total output of publications and the bottom table on those with low share of publications. Scientific areas are based on Elsevier 'All Science Journal Classification'. For each area, the country's share in the world output of publications and the share of international co-publications are also shown.

Figure 4: Japan – Specialisation compared to EU28 in selected technologies based on PCT patents

	Technology	2014 PCT patents	2014 PCT patents of EU28	2014 Specialisation compared to EU28	8-year trend
OECD classification	ICT	16.988	14.579	1,41	↓
	Selected environment-related technologies	2.874	3.663	0,95	↓
	Medical technology	2.993	3.879	0,93	↑
	Nanotechnology	97	137	0,85	↓
	Biotechnology	1.252	2.745	0,55	↓
	Pharmaceuticals	998	2.524	0,48	↓
WIPO classification	Audio-visual technology	1.902	761	2,91	–
	Semiconductors	2.048	820	2,90	↓
	Optics	2.023	959	2,45	↓
	Surface technology, coating	1.166	635	2,14	↑
	Electrical machinery, apparatus, energy	4.268	3.101	1,60	↑
	IT methods for management	574	425	1,57	↑
	Computer technology	2.274	1.762	1,50	↑
	Materials, metallurgy	1.208	939	1,50	–
	Macromolecular chemistry, polymers	1.119	870	1,50	↓
	Basic communication processes	311	268	1,35	↓
	Telecommunications	851	749	1,32	↓
	Thermal processes and apparatus	839	791	1,23	↑
	Control	788	784	1,17	↑

Source: DG Research and Innovation – International Cooperation
Data: OECD (top table) WIPO (bottom table); extraction date: 6/8/2017
Note: The top table shows the relative specialisation of the 2014 PCT patent output of the country with respect to EU28, calculated as (# of patents of country in technology X / # of patents of country in all technologies) / (# of patents of EU28 in technology X / # of patents of EU28 in all technologies). It also shows whether the relative specialisation has increased, decreased or remained the same in the past 8 years. The selected technologies are classified based on the OECD database. The bottom table shows the same information for the top-13 technologies with the highest specialisation index with respect to EU28 - this time the technology classification is based on the WIPO database. Both tables also show the country's and EU28 total number of PCT patents under each technology in 2014.