



EN

Horizon 2020

Work Programme 2018-2020

2. Future and Emerging Technologies

IMPORTANT NOTICE ON THIS WORK PROGRAMME

This Work Programme covers 2018, 2019 and 2020. The parts of the Work Programme that relate to 2020 (topics, dates, budget) have, with this revised version, been updated. The changes relating to this revised part are explained on the Funding & Tenders Portal.

(European Commission Decision C(2020)1862 of 25 March 2020)

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Introduction

Future and Emerging Technologies (FET) activities aim to create in Europe a fertile ground for responsible and dynamic multi-disciplinary collaborations on future technologies and for kick-starting new European research and innovation ecosystems around them. These will be seeds for future industrial leadership and for tackling society's grand challenges in new ways.

In this work programme FET continues its three lines of activity:

1. FET Open¹: the call text for FET Open in this work programme has been simplified for a clearer scope. FET Open is part of the European Innovation Council pilot. FET Open also calls for coordination and support for communication, innovation and horizon scanning. The FET Innovation Launchpad, which was started in the previous work programme, has been refined to take into account experience from the first call.

2. FET Proactive: this work programme features a selection of ambitious emerging technology topics derived from an extensive consultation and advice from the FET Advisory Group. Topics include: living technologies, socially interactive technologies, technologies related to time, artificial organs, micro-energy technologies, topological matter, future technologies for social experience, sub-nanoscale science for nanometrology, breakthrough zero-emissions energy storage and conversion technologies for carbon-neutrality, digital twins for the life-sciences, and environmental intelligence. Community building and innovation ecosystem development are key elements in FET proactive. Specific actions are foreseen on neuromorphic computing and on future electrical storage. Some further FET Proactive topics are part of the European Innovation Council (EIC) Enhanced Pilot (Horizon 2020, 2019-2020)². These invite for proposals on Human-Centric AI, Implantable autonomous devices and materials, Breakthrough zero-emissions energy generation for full decarbonisation as well as on EIC transition to innovation activities.

The FET Proactive initiative in High-Performance Computing (HPC) is designed in synergy with the LEIT-ICT and e-Research Infrastructures work programmes. It covers the co-design of the exascale machines integrating the European microprocessor part and addresses the development of scientific and engineering applications that will run on extreme scale HPC machines. International cooperation with Brazil and Mexico, and with Latin America is also foreseen. Note that most of the topics under this call have been removed from this work programme due to the transfer of High Performance Computing activities in 2019 and 2020 to the EuroHPC Joint Undertaking.

3. FET Flagships: this work programme supports the continuation of the Graphene and HBP flagships, with a clear shift to innovation and impact. It also provides support to the flagship on Quantum Technologies, and preparatory actions for new Flagships.

¹ Note that 40% of the Horizon 2020 budget for FET is earmarked for FET Open.

² See the H2020 work programme for 2018-2020 of the EIC Enhanced Pilot at http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-eic_en.pdf

FET also kick starts a new large-scale research initiative on Future Battery Technologies featuring in the cross-cutting call "Building a Low-Carbon, Climate Resilient Future: Next-Generation Batteries".³

This FET work programme implements several overall recommendations expressed in the Horizon 2020 interim evaluation as well as of its FET thematic assessment⁴. The oversubscription and underfunding in FET Open is addressed by increased budget, clearer and enforced scoping, and advice on resubmission. The opportunities for exploiting FET results are enhanced through the FET Innovation Launchpad and the participation of FET Open and parts of FET Proactive in the European Innovation Council pilot. The coherence with other parts of Horizon 2020 is strengthened, for example with the implementation of the HPC and Quantum strategies. Following the recommendations from the FET Flagship interim evaluation report, FET Flagships allow for flexibility and responsiveness through an open approach, and enhance internal coherence by greater emphasis on cooperation and sharing between the projects and with related national/regional and international programmes.

Responsible Research and Innovation (RRI⁵) is emphasised in the FET work programme. RRI ensures that projects are ethically founded and societally anchored. RRI is based on outreach to and partnership with potential actors in research and innovation, and from wider stakeholder/public engagement, to maximise the relevance of shared knowledge developed and viability of cooperation. RRI also includes due consideration of aspects such as education, gender differences and long-term societal, ethical and legal implications.

Grant beneficiaries under this work programme part will engage in research data sharing by default, as stipulated under Article 29.3 of the Horizon 2020 Model Grant Agreement (including the creation of a Data Management Plan). Participants may however opt out of these arrangements, both before and after the signature of the grant agreement. More information can be found under General Annex L of the work programme.

Contribution to focus area(s)

³ See the H2020 work programme for 2018-2020 for cross-cutting activities at http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-cc-activities_en.pdf

⁴ http://ec.europa.eu/research/evaluations/index_en.cfm?pg=h2020evaluation

⁵ H2020 has invested in an RRI Toolkit (available at: <https://www.rri-tools.eu/>), Responsibility Navigator (available at: <http://responsibility-navigator.eu/>), and RRI Indicator System (available at: https://ec.europa.eu/research/swafs/pdf/pub_rri/rri_indicators_final_version.pdf); and also with research from the MoRRI project, available at: <http://www.techropolis-group.com/morri/>).

Call - FET Open – Novel ideas for radically new technologies⁶

H2020-FETOPEN-2018-2020

FET Open aims to establish European leadership in the early exploration of future technologies. It looks for opportunities of long-term benefit for citizens, the economy and society. It aims to mobilise Europe's most creative and forward thinking researchers from all disciplines to work together and explore what may become the leading technology paradigms of the future.

FET Open supports early stage science and technology research exploring new foundations for radically new future technologies by challenging current paradigms and venturing into unknown areas. A bottom-up selection process widely open to any research idea builds up a diverse portfolio of new research directions. Early detection of promising new areas, developments and trends, along with attracting new and high-potential research and innovation players, are key factors.

FET Open combines high scientific ambition with concrete technological implications. It aims to attract interdisciplinary consortia that do not shy away from exploring connections between remote disciplines in order to open-up new and potentially game changing technological directions that FET as a whole aims to develop into the leading technology paradigms of the future, including through FET-Proactive projects and FET-Flagship initiatives. In spite of the high initial risk, the long-term impact can be enormous: these new technologies can become the core for new high-growth companies, for new industries or for radically new ways of tackling societal challenges.

The FET-Open call is a part of the European Innovation Council (EIC) pilot. It provides the EIC with a bold exploratory engine that shatters the frontiers of current thinking. All FET-Open projects, even if far from today's markets, are full of great ideas to inspire the entrepreneurial minds that the EIC attracts. While keeping its own identity of excellence in science and technology research, the exposure of FET Open within the EIC allows new and sometimes unexpected opportunities to be detected and picked up early on. For those cases, the FET Innovation Launchpad is designed to assist in the first steps to accelerate the real-world impact of a result from FET research – a win-win for both research and innovation. Other parts of the EIC provide further tools for achieving high impact on society and/or the economy. Furthermore, by being part of the EIC pilot, FET-Open participants have access to the assistance, networking and financing possibilities offered by the EIC thus further increasing the leverage and increased impact from the initial high-risk investment in FET projects.

Proposals are invited against the following topic(s):

⁶ This call is part of the European Innovation Council pilot.

FETOPEN-01-2018-2019-2020: FET-Open Challenging Current Thinking

Specific Challenge: to lay the foundations for **radically new future technologies** of any kind from visionary interdisciplinary collaborations that dissolve the traditional boundaries between sciences and disciplines, including the social sciences and humanities. This topic also encourages the driving role of new actors in research and innovation, including excellent young researchers, ambitious high-tech SMEs and first-time participants to FET under Horizon 2020 from across Europe.

Scope: proposals are sought for cutting-edge **high-risk / high-impact interdisciplinary research with all of the following essential characteristics** ("FET gatekeepers"):

- **Radical vision**: the project must address a clear and radical vision, enabled by a new technology concept that challenges current paradigms. In particular, research to advance on the roadmap of a well-established technological paradigm, even if high-risk, will not be funded.
- **Breakthrough technological target**: the project must target a novel and ambitious science-to-technology breakthrough as a first proof of concept for its vision. In particular, blue-sky exploratory research without a clear technological objective will not be funded.
- **Ambitious interdisciplinary research** for achieving the technological breakthrough and that opens up new areas of investigation. In particular, projects with only low-risk incremental research, even if interdisciplinary, will not be funded.

The inherently high risks of the research proposed shall be mitigated by a flexible methodology to deal with the considerable science-and-technology uncertainties and for choosing alternative directions and options.

The Commission considers that proposals requesting a contribution from the EU of up to EUR 3 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Scientific and technological contributions to the foundation of a new future technology
- Potential for future social or economic impact or market creation.
- Building leading research and innovation capacity across Europe by involvement of key actors that can make a difference in the future, for example excellent young researchers, ambitious high-tech SMEs or first-time participants to FET under Horizon 2020⁷.

Type of Action: Research and Innovation action

⁷ First time participation here refers to the individuals involved, not their institution or organisation.

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETOPEN-02-2018: FET-Open Coordination and Support Actions⁸

Specific Challenge: to promote excellent collaborative research and innovation on future and emerging technologies to secure and renew the basis for future European competitiveness and growth, and that will make a difference for society in the decades to come.

Scope: Proposals for Coordination and Support Actions (CSA) should be driven by relevant actors in the research field and address only one of the following sub-topics:

a. FET Communication and Outreach: Support communication activities on the FET programme and its achievements and outreach actions targeting a wide range of audiences including the general public, and going well beyond the world of academia and research. This shall stimulate the emergence of a FET community and its connection to relevant multipliers and other stakeholder networks. The activities shall use a diversity of channels and interventions (for example news items, social media, interviews, workshops, exhibitions, competitions, code camps and participatory actions for wider engagement).

b. FET Innovation: Stimulate the impact on innovation from FET-funded research and improving the innovation readiness levels of FET results, for example by providing a kind of “market place” for FET technologies, by connecting the world of research with that of, potential users, technology leaders, technology transfer organisations, entrepreneurs, investors or alternative financing channels.

c. FET Observatory: Ongoing and systematic identification of new and emerging technologies from FET portfolio analysis, trends analysis (using for instance bibliometric tools, media watch, consultations and workshops) and broader horizon scanning (beyond research), including also consideration of ethical implications, gender differences and long-term impacts on society and humankind.

Specificity to the nature of FET is a must (e.g., upstream positioning, interdisciplinarity, high-risk, novelty, long-term impact,...).

The Commission considers that proposals requesting a contribution from the EU of up to EUR 0.5 million (and up to 0.7 million for a.) would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

⁸ This activity directly aimed at supporting the development and implementation of evidence base for R&I policies and supporting various groups of stakeholders is excluded from the delegation to the Research Executive Agency (REA) and will be implemented by the Commission services.

- Strengthening globally recognised European leadership in the early exploration of visionary, new and emerging technologies and with a strong engagement of scientists, citizens, innovators and policy makers.
- Improved long-term innovation potential in Europe both from the abundance of novel ideas and the range of actors ready to take them forward.
- Improved readiness across Europe to engage in inter-disciplinary research collaboration and to take up new, open and responsible research and innovation practices, with due attention to aspects such as education, gender differences and long-term societal, ethical and legal implications.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETOPEN-03-2018-2019-2020: FET Innovation Launchpad

Specific Challenge: This topic aims at turning results from FET-funded projects into genuine societal or economic innovations.

Scope: Short individual or collaborative actions focused on the non-scientific aspects and the early stages of turning a result of an ongoing or recently finished project funded through FET under FP7 or Horizon 2020⁹ into a genuine innovation with socio-economic impacts. The precise link with the relevant FET project and the specific result for which a FET Innovation Launchpad proposal is intended, are to be explicitly described in the proposal. This topic does not fund research or activities that are/were already foreseen in the original FET project. Activities proposed should reflect the level of maturity of the result to be taken up. They can include the definition of a commercialisation process, market and competitiveness analysis, technology assessment, verification of innovation potential, consolidation of intellectual property rights, business case development. Proposals can include activities with, for instance, partners for technology transfer, licence-takers, investors and other sources of financing, societal organisations or potential end-users. Limited low-risk technology development (for instance for demonstration, testing or minor adjustment to specific requirements) can be supported as long as it has a clear and necessary role in the broader proposed innovation strategy and plan.

The Commission considers that proposals for actions no longer than 18 months and requesting a contribution from the EU of up to EUR 0.1 million would allow this specific challenge to be addressed appropriately. For grants awarded under this topic as a result of proposals submitted as of 9 October 2019, the costs will be declared based on lump sums of a fixed total amount of EUR 0.1 million for each grant, as authorised by decision of the authorizing officer

⁹ Research and Innovation Actions funded under any call in the FET work programmes under Horizon 2020 for 2014-2015, for 2016-2017, and for 2018-2019-2020; projects funded under the FET part of any of the LEIT-ICT work programmes under FP7. See the Call Conditions for specific eligibility conditions.

responsible.¹⁰ Details of the lump sum funding pilot scheme are published on the [Funding & Tenders Portal](#) together with the specific [Model Grant Agreement for Lump Sums](#) applicable.

Expected Impact:

- Increased value creation from FET projects by picking up innovation opportunities.
- Improved societal and market acceptance of concrete high-potential innovations from FET projects.
- Stimulating, supporting and rewarding an open and proactive mind-set towards exploitation beyond the research world.
- Contributing to the competitiveness of European industry/economy by seeding future growth and the creation of jobs from FET research.

Type of Action: Coordination and support action, Coordination and support action Lump sum

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Conditions for the Call - FET Open – Novel ideas for radically new technologies

Opening date(s), deadline(s), indicative budget(s):¹¹

Topics (Type of Action)	Budgets (EUR million)			Deadlines
	2018	2019	2020	
Opening: 07 Nov 2017				
FETOPEN-02-2018 (CSA)	2.00			11 Apr 2018
FETOPEN-01-2018-2019-2020 (RIA)	181.20	163.30	354.20	16 May 2018 24 Jan 2019 18 Sep 2019 13 May 2020

¹⁰ 'Decision authorising the use of reimbursement on the basis of lump sums for the FET Innovation Launchpad actions under the Horizon 2020 Framework Programme for Research and Innovation' (17/05/2019). See http://ec.europa.eu/research/participants/data/ref/h2020/other/legal/lump_sum/lumpsumdecision-fet-innovation-launchpad_en.pdf

¹¹ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts for the 2020 budget are subject to the availability of the appropriations provided for in the draft budget for 2020 after the adoption of the budget 2020 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

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FETOPEN-03-2018-2019-2020 (CSA)	2.50	2.70		16 Oct 2018 08 Oct 2019
Opening: 09 Oct 2019				
FETOPEN-03-2018-2019-2020 (CSA-LSP)			3.00	14 Oct 2020
Overall indicative budget	185.70	166.00	357.20	

The call opens at 17.00.00 Brussels local time on the opening date.

The total indicative budget for the FET-Open topic FETOPEN-01-2018-2019-2020 is EUR 641,20 million. The indicative funding budgets available per cut-off date for this topic are as follows:

1. Cut-off date 16/05/2018: EUR 123,70 M€
2. Cut-off date 24/01/2019: EUR 160,65 M€
3. Cut-off date 18/09/2019: EUR 160,65 M€
4. Cut-off date 13/05/2020: EUR 196,20 M€

EUR 57,50 million from the 2018 budget is used to fund in part the last cut-off of the Horizon 2020 FETOPEN-2016-2017 call under the FET workprogramme 2016-2017.

Indicative timetable for evaluation and grant agreement signature:

For single stage procedure:

- Information on the outcome of the evaluation: Maximum 5 months from the final date for submission; and
- Indicative date for the signing of grant agreements: Maximum 8 months from the final date for submission.

Eligibility and admissibility conditions: The conditions are described in General Annexes B and C of the work programme. The following exceptions apply:

FETOPEN-03-2018-2019-2020	Proposals must build on results from an ongoing or recently finished project, funded as a result of call in any FET topic under FP7 or Horizon 2020 and clearly identified in the proposal. For a project to be considered "recently finished" in the context of this call topic its actual end date must be at most one year before the deadline for proposal submission to this topic. For a project to be considered "ongoing" in the context of this call topic the deadline for proposal submission to this topic must be within the period limited by the contractual start date and end date of the
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	<p>project.</p> <p>Proposals must include a declaration by the coordinator of the necessary rights and ownership of results to be exploited, as described in the proposal. Applicants that are not the owner of the result to be taken up in the proposal must provide a letter from the relevant beneficiary or beneficiaries of the previous FET project that own(s) the result that confirms the existence of the necessary agreements with the coordinator of the current proposal, including on IPR.</p>
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Evaluation criteria, scoring and threshold: The criteria, scoring and threshold are described in General Annex H of the work programme. The following exceptions apply:

<p>FETOPEN-01-2018-2019-2020</p>	<p>Excellence</p> <p>Adherence to the "FET gatekeepers" as described in the call text:</p> <ul style="list-style-type: none"> • Clarity of the radical vision of a science-enabled technology and its differentiation from current paradigms. • Novelty and ambition of the proposed science-to-technology breakthrough that addresses this vision. • Range of and added value from interdisciplinarity for opening up new areas of research; non-incrementality of the research proposed. • High-risk, plausibility and flexibility of the research approach. <p>Threshold: 4/5, Weight: 60%</p> <p>Impact</p> <ul style="list-style-type: none"> • The extent to which the outputs of the project would contribute to the expected impacts listed in the work programme under this topic. • Effectiveness of measures and plans to disseminate and use the results (including management of IPR) and to communicate about the project to different target audiences. <p>Threshold: 3.5/5, Weight: 20%</p> <p>Quality and efficiency of the implementation</p>
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	<p>The following aspects are taken into account:</p> <ul style="list-style-type: none"> • Coherence and effectiveness of the research methodology and work plan to achieve project objectives and impacts, including adequate allocation of resources to tasks and partners. • Role and complementarity of the participants and extent to which the consortium as a whole brings together the necessary expertise. <p>Threshold: 3/5, Weight: 20%</p>
<p>FETOPEN-03-2018-2019-2020</p>	<p>Excellence</p> <p>The following aspects are taken into account:</p> <ul style="list-style-type: none"> • Clarity and quality of the innovation idea and its link with the previous or ongoing FET project indicated in the proposal. • Concreteness of objectives and their pertinence for moving the output of FET research through the initial steps of a process leading to a commercial or social innovation. • Suitability and necessity of the proposed activities to reach the stated objectives, including their complementarity to actions already foreseen or expected from the previous or ongoing FET project. <p>Threshold: 3/5, Weight: 40%</p> <p>Impact</p> <p>Contributions to the impacts listed under this topic in the work programme:</p> <ul style="list-style-type: none"> • Added innovation potential with respect to the FET project from which this innovation originates. • Extent of economic and/or societal benefits resulting from this innovation as identified in the proposal. • Suitability of measures for taking the innovation beyond the research world, including through engagement with prospective exploitation partners, other stakeholders, users or society.

	<p>Threshold: 3.5/5, Weight: 40%</p> <p>Quality and efficiency of the implementation</p> <p>The following aspects are taken into account:</p> <ul style="list-style-type: none"> • Quality of workplan and management. • Relevance of expertise in the consortium. • Appropriate allocation of resources (person-months). <p>Threshold: 3/5, Weight: 20%</p>
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Evaluation Procedure: The procedure for setting a priority order for proposals with the same score is given in General Annex H of the work programme. The following exceptions apply:

FETOPEN-01-2018-2019-2020	<p>The following specific page limits apply. Sections 1 to 3 of the part B of the proposal should consist of a maximum of 15 A4 pages. The limits will be clearly shown in the "proposal templates" in the Funding & Tenders Portal electronic submission system. Sections that are not subject to limits will be indicated.</p> <p>A proposal that, according to the evaluator's assessments, does not convincingly satisfy all FET gatekeepers as described under this topic will be declared out of scope. The communication to the applications will include the evaluators' assessments, or relevant extracts from them.</p> <p>At consensus stage, the consensus score for each evaluation criteria will be the median of the corresponding scores attributed by the individual evaluators. The consensus report will comprise a collation of the comments from individual reports, or extracts from them. The final review panel will decide on the final score based on its consensus discussions. The panel will also decide on any additional comments, possibly including advice not to resubmit the proposal.</p>
FETOPEN-02-2018	<p>Grants will be awarded to proposals according to the ranking list. However, in order to ensure a balanced portfolio of supported actions, at least the highest-ranked proposal per sub-topic will be funded provided that it attains all thresholds.</p>
FETOPEN-03-2018-2019-2020	<p>The following specific page limits apply. Sections 1 to 3 of the part B of the proposal should consist of a maximum of 7 A4 pages. The limits will be clearly shown in the "proposal</p>

	<p>templates" in the Funding & Tenders Portal electronic submission system. Sections that are not subject to limits will be indicated.</p> <p>At consensus stage, the consensus score for each evaluation criteria will be the median of the corresponding scores attributed by the individual evaluators. The consensus report will comprise a collation of the comments from individual reports, or extracts from them. The final review panel will decide on the final score based on its consensus discussions. The panel will also decide on any additional comments, possibly including advice not to resubmit the proposal.</p> <p>For deciding the priority order for proposals with the same score, the procedure for Innovation actions will apply.</p>
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The full evaluation procedure is described in the relevant [guide](#) published on the Funding & Tenders Portal.

Grant Conditions:

FETOPEN-03-2018-2019-2020	For grants awarded under this topic as a result of proposals submitted as of 9 October 2019, the costs will be declared based on lump sums of a fixed total amount of EUR 0.1 million for each grant, as authorised by decision of the authorizing officer responsible. ¹² Details of the lump sum funding pilot scheme are published on the Funding & Tenders Portal together with the specific Model Grant Agreement for Lump Sums applicable.
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Consortium agreement:

FETOPEN-01-2018-2019-2020	Members of consortium are required to conclude a consortium agreement, in principle prior to the signature of the grant agreement.
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¹² 'Decision authorising the use of reimbursement on the basis of lump sums for the FET Innovation Launchpad actions under the Horizon 2020 Framework Programme for Research and Innovation' (17/05/2019). See http://ec.europa.eu/research/participants/data/ref/h2020/other/legal/lump_sum/lumpsumdecision-fet-innovation-launchpad_en.pdf

Call - FET Proactive – Boosting emerging technologies

H2020-FETPROACT-2018-2020

FET Proactive aims to identify the future and emerging technological paradigms with highest potential for Europe's economy and society. For each of them, it looks to establish a broad and solid European basis in terms of knowledge, key technological building blocks and interdisciplinary communities. By reaching out well beyond the research world, it ensures that Europe has the best 'first mover' position to capitalise rapidly and effectively on emerging societal and industrial opportunities.

FET features with 4 FET Proactive topics in the European Innovation Council enhanced pilot (2019-2020). Two topics that are called for in 2019 (FETPROACT-EIC-05-2019 and FETPROACT-EIC-06-2019) are published in the EIC work programme part of Horizon 2020¹³. They invite for proposals on **Human-Centric AI, Implantable autonomous devices and materials, Breakthrough zero-emissions energy generation for full decarbonisation** as well as on **EIC transition to innovation activities**. Two further topics that are called for in 2020, FETPROACT-EIC-07-2020 and FETPROACT-EIC-08-2020, are detailed in this call below.

Proposals are invited against the following topic(s):

FETPROACT-01-2018: FET Proactive: emerging paradigms and communities¹⁴

Specific Challenge: To explore and consolidate a new technological direction in order to put it firmly on the map as a viable **paradigm for future technology**. To foster the interdisciplinary communities that are able to drive this forward, extending from the participating consortia to a wider European pool of expertise. To stimulate the emergence of a European innovation ecosystem around a new technological paradigm, well beyond the world of research alone.

Scope: proposals are sought for cutting-edge **high-risk / high-reward research and innovation projects** that aim to demonstrate a new technological paradigm within the scope of one of the following sub-topics:

a. Artificial organs, tissues, cells and sub-cellular structures. Merging the growing understanding of genome, proteome, metabolome and cell behaviour with strategies for the engineering and use of biological and hybrid functional constructs is the core of this initiative. Proposals should build on recent advances in integrative biology (including modelling and simulation) and bio-engineering for engineering biological, artificial or hybrid sub-cellular systems (e.g., synapses, organelles, vesicles), highly specific cell assemblies (including microbial) and proper differentiation, tissues, organs or multi-organ systems. Examples of long-term research targets include synthetic cell building, cell assembly, and organ

¹³ See the H2020 work programme for 2018-2020 of the EIC Enhanced Pilot at http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-eic_en.pdf

¹⁴ A second series of sub-topics under FET Proactive will be called for in 2020

reproduction, replacement, control or repair of vital organ functions (e.g., following ageing, trauma or disease), their use in the development of personalised treatment, drugs or vaccines, and high-throughput organ- and body-on-chip technologies.

b. Time. This initiative seeks new technological possibilities inspired by notions of time, not seen as a given and singular background against which things unfold, but rather as a resource that can be experienced and used in different ways. Highly interdisciplinary research could address, for instance, technologies for subjective time awareness (and its neural basis) and distortion (e.g., contextual, emotional, pathological); for studying the role of time in processes like aging, healing, learning or evolution and how this can be influenced (e.g., stimulation) or changed in different 'materialities' (combining insights from biological or computational evolution, for instance); or modeling to understand and better anticipate non-linear temporality in complex systems (such as in economies, societies, climate ...). Technologies in, for instance, extreme electronics/photonics, data-streams analytics, time aware artificial intelligence, virtual and augmented reality, bio-engineering or neuroprosthetics could demonstrate new ways to represent, modulate, duplicate or differently experience and use time, thus altering our relationship with time (at individual and collective but differentiated level – e.g., according to gender or culture) and with impacts on, for instance, quality of life, therapy, learning, productivity, social and environmental awareness or the better understanding and management of natural hazards.

c. Living technologies. This initiative seeks to build on the emerging understanding from evolutionary biology, ethology, micro-, plant- and animal biology of essential features of living systems such as physical autonomy, growth, interaction and enaction, adaptation and evolution, among others. The aim is to create new functional biological, technological or hybrid artefacts, with similar capabilities of purposeful stability and change. This can also lead to hybrid materials and systems with programmable features of shape, structure, functionality and evolvability (including for their use in bio-robotics or bio-engineering), potentially constructed from naturally existing complexes, through synthetic biology, systems biology and /or chemical biology. New insights into the multi-level mathematics and complexity of living systems or the boundaries/characteristics of life may also emerge from this. Work on ethical implications should be included.

d. Socially interactive technologies. There is a growing understanding of the changes at cognitive, neural and physiological levels from group interactions in realistic settings, from pairs to large groups and crowds. Based on this, this initiative seeks new technologies for deeper social interaction involving, for instance, context, culture, emotion, and factors of embodiment and cognition. Realistic and larger contexts require new experimental tools and paradigms, combining social sciences and humanities with neuroscience, engineering and computing in new ways. This will lead to new socially interactive media with radical improvement for building trust and understanding, social integration, engagement, collaboration, learning, creativity, entertainment, education and wellbeing, among others. Work on ethical implications and gender should be included.

e. Disruptive micro-energy and storage technologies. This initiative seeks radically new approaches to energy for embedded, personal or local use (including bio-mimicking, the use of soft or intelligent materials to generate, capture or store energy or the development of new types of batteries). Proposals could target in particular the lower end (i.e., micro-energy or nano-scale energy transfer, dissipation and conversion) and/or new technologies for optimal local (close to where-needed) energy storage/release and their smart integration within hybrid/distributed energy systems. Proposals should also address aspects of sustainability and environmental impact.

f. Topological matter, strongly based on topology and quantum physics, is a rapidly emerging area that after an initial focus on insulators now touches the whole range of material properties, providing advances in spintronics, photonics, plasmas, mechanics, superconductivity, elasticity, acoustics and their combinations, among others. Here concept development together with design, realisation and testing of topological devices are called for to unleash the promise of topological matter beyond the pure physics and mathematics aspects. The much expected robustness, wide spectral range and topologically-protected spin- and transport properties call for an engineering approach to apply the multi-physics of wave-matter interactions to novel, potentially lossless communication components and circuits. Challenges to be addressed include compact designs and fabrication technologies, setting figures of merit and benchmarks relevant to functions.

FET Proactive projects shall establish a solid baseline of knowledge and skills and assemble the interdisciplinary communities around them. They shall further foster the emergence of a broader innovation ecosystem and create a fertile ground for future take-up of its new technological paradigm (e.g., public engagement, informal education, policy debate).

The Commission considers that proposals requesting a contribution from the EU of EUR 4 to 7 million (but up to EUR 5 million for proposals on the sub-topics of 'Time' and 'Topological matter') and with a duration of up to 5 years would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals of different size and duration.

This topic allows for the provision of financial support to third parties established in an EU member state or country associated with Horizon 2020 in line with the conditions set out in General Annex K, either to enhance impacts through punctual small scale experimentation and use of project results by third parties, or to award a prize following a contest organised by the beneficiaries.

Expected Impact:

- Scientific and technological contributions to the foundation and consolidation of a radically new future technology.
- Potential for future returns in terms of societal or economic innovation or market creation.

- Spreading excellence and building leading innovation capacity across Europe by involvement of key actors that can make a difference in the future, for example excellent young, researchers, ambitious high-tech SMEs or first-time participants to FET under Horizon 2020¹⁵.
- Build-up of a goal oriented interdisciplinary community (within and beyond the consortium).
- Emergence of an innovation ecosystem around a future technology in the theme addressed from outreach to and partnership with high potential actors in research and innovation, and from wider stakeholder/public engagement, with due consideration of aspects such as education, gender differences and long-term societal, ethical and legal implications.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETPROACT-02-2018: Community building in Neuromorphic Computing Technologies

Specific Challenge: To network and coordinate the efforts of the European academic and industrial research and innovation communities in neuromorphic computing (NMC) technologies. To showcase a wide variety of NMC technologies and their applicability in cognitive computing, capitalising on their key benefits such as greater flexibility, efficiency and their adaptive and permanent learning capabilities. To stimulate wide industrial interest and further public-private investment in the field, accelerating technology transfer, take-up and innovation within an expanding European NMC eco-system.

Scope: Proposals should aim at networking and coordinating the efforts of the relevant NMC stakeholders, notably academia, RTOs and industry by addressing the following: constituency/eco-system building, through dedicated events, and the fostering of collaboration among related research and innovation projects in Europe to facilitate the matching of NMC technologies with industrial needs; joint research and innovation road mapping of NMC technologies and solutions in different application domains; pre-normative and education activities and; pre-normative and education activities and harmonised benchmarking of NMC solutions in the different application domains; and wide diffusion of NMC technologies, including by supporting the promotion of technology cases and eye-opening demonstrators in promising industry sectors such as automotive, robotics, manufacturing and more generally for big data analysis, learning and adaptation to evolving contexts of operation.

Expected Impact: Proposals should address the following impact criteria, providing metrics to measure success where appropriate:

¹⁵ First time participation here refers to the individuals involved, not to their institution or organisation.

- Increased synergies and collaboration between research and innovation projects in Europe;
- Increased synergies across national and European Programmes supporting NMC technologies;
- Increased industrial support and engagement in jointly developing NMC solutions in key applications domains backed up by a high-quality research and innovation roadmap in the related areas;
- Availability of NMC technologies demonstrating their applicability and innovation potential in relevant industry sectors;
- Development of NMC innovation programmes and communities in Europe including dissemination and education aspects.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETPROACT-03-2018: FET ERA-NET Cofund

Specific Challenge: to advance the construction of the European Research Area in the FET domain by sharing a common vision of the various relevant efforts in Europe and fostering cooperation towards the coordinated development of radically new future technologies.

Scope: Proposals should coordinate and pool the necessary financial resources from the participating national (or regional) research programmes in the FET domain by implementing a joint transnational call for proposals resulting in grants to third parties with EU co-funding, possibly followed by further transnational calls for proposals without EU co-funding. The action may also organise additional joint activities in the FET domain between the participating funding agencies. Two activities are mandatory:

1. Identifying future and emerging technologies where transnational cooperation and community structuration is needed, in complementarity and synergy with FET;
2. Developing strategic agendas for these topics and accompanying the structuration of the related communities through workshops and transversal activities.

The partnership is expected to aim at being pan-European and as inclusive as possible.

Expected Impact: Closer coordination and greater mobilisation and pooling of resources between regional, national and EU research programmes in the FET domain.

Type of Action: ERA-NET Cofund

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETPROACT-04-2019: Community building and roadmapping for high performance and smart electrochemical energy storage

Specific Challenge: To network and coordinate the efforts of the European academic and industrial research and innovation communities from multiple disciplines towards developing a roadmap for long term research into radically new technologies for electrochemical energy storage. This area is critical for the development of a world-class European industry and for addressing the needs of many sectors, including e-mobility and renewable energy storage.

Scope: Proposals should aim at networking and coordinating the efforts of the relevant stakeholders, notably academia, RTOs and industry and preparing a long term research roadmap for radically new electrochemical energy storage technologies, devices and smart systems. Such systems should aim at major performance gains (in terms of e.g. energy and power density, lifetime, energy efficiency, cost, fast charging and safety) and environmental sustainability. The roadmap should take account of relevant national and regional programmes, and complement the short/medium term research activities on battery technologies foreseen at European level and in the Strategic Energy Technology (SET) Plan¹⁶. It should show what the major milestones are, position the proposed research in the global landscape and elaborate a clear path towards societal impact, technology development, innovation and exploitation.

The Commission considers that proposals requesting a contribution from the EU of up to EUR 0.5 million and for a duration of 12 months would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts or for a different duration.

Expected Impact:

- Increased synergies and collaboration between the relevant research and innovation stakeholders in Europe as well as with major initiatives that already exist or are under preparation
- Increased industrial support and engagement in key energy application domains for the implementation of the research and innovation roadmap in the related areas.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FET Proactive topics in the EIC Enhanced Pilot (2019-2020)

FET features with 4 FET Proactive topics in the European Innovation Council enhanced pilot (2019-2020).

¹⁶ See <https://ec.europa.eu/en/topics/technology-and-innovation/strategic-energy-technology-plan>

Two topics that are called for in 2019 are published in the EIC work programme part of Horizon 2020¹⁷. They are:

- FETPROACT-EIC-05-2019 inviting for RIA proposals on **Human-Centric AI, Implantable autonomous devices and materials**, and **Breakthrough zero-emissions energy generation for full decarbonisation**.
- FETPROACT-EIC-06-2019 inviting for RIA proposals for **EIC transition to innovation activities**.

The two topics that are called for in 2020, FETPROACT-EIC-07-2020 and FETPROACT-EIC-08-2020 are detailed below.

FETPROACT-EIC-07-2020: FET Proactive: emerging paradigms and communities¹⁸

Specific Challenge: To explore and consolidate a new technological direction in order to put it firmly on the map as a viable **paradigm for future technology**. To foster the interdisciplinary communities that are able to drive this forward, extending from the participating consortia to a wider European pool of expertise. To stimulate the emergence of a European innovation ecosystem around a new technological paradigm, well beyond the world of research alone.

Scope: proposals are sought for cutting-edge **high-risk / high-reward research and innovation projects** that aim to demonstrate a new technological paradigm within the scope of one of the following sub-topics:

a. Artificial Intelligence for extended social interaction. This sub-topic explores the combination of new Artificial Intelligence and immersive interaction technologies to enhance the social dimension in future virtual social spaces. It aims to lay the basis for a new flavour of social media in which Europe can mark a difference. In 10-15 years from now, Virtual, Augmented and Mixed Reality (eXtended Reality, XR) will be as ubiquitous as Smart Phones are today, leading to new kinds of social media in which, on the one hand, interaction with others will become more natural while, on the other hand, entirely new experiences and ways of sharing become possible. The sub-topic addresses the redefinition of a person's social interaction space in light of increasing virtualisation, unprecedented social scale information load and ubiquitous intelligence, leading to currently acute issues of trust, the nature of social relationships (beyond 'friends' and 'followers'), believe formation, crowd- and organisation dynamics, the permeation of private and public spheres, or social exclusion and divides, among others. New human-centric and responsible Artificial Intelligence technologies can address these by bringing more social intelligence in the interaction environment and greater user-, contextual- and social awareness, and also through a tighter coupling with sensori/motor- and cognitive processes using, for instance, multimodal XR setups, or minimally invasive interfaces like spatial audio, smart skins, haptics, robotic devices and

¹⁷ See the work programme of the EIC Enhanced Pilot at http://ec.europa.eu/research/participants/data/ref/h2020/wp/2018-2020/main/h2020-wp1820-eic_en.pdf

¹⁸ This topic is part of the European Innovation Council (EIC) Enhanced Pilot (Horizon 2020, 2019-2020).

wearables. Projects will also investigate whether and how the perceptual- and sociocultural parameters implicit in natural, context-rich social interaction carry over to such virtual or hybrid settings. Influence on self-perception, well-being (addiction), acceptance, learning and brain-development/adaptation should also be considered, especially in scenarios of extensive and always-on use. Ethics, age- and gender differences, safety and health should be taken into account.

b. Breakthrough zero-emissions energy storage and conversion technologies for carbon-neutrality. Provisioning clean and sustainable energy is one of the major challenges for Europe to meet its climate ambition. This sub-topic aims at multidisciplinary research (starting from TRL 1-3) for breakthroughs in energy storage and conversion that is clean, compact and ultimately low-cost, aimed at decentralised and/or mobile or portable uses in specific application contexts, for instance, in industry as substitutes to fossil fuels or raw materials for chemistry, in the transport sector (road, air, water and either for motive or auxiliary needs), for portable uses, in sustainable housing, remote places or in emergency situations. Novel concepts and breakthrough techniques with zero emissions of greenhouse gasses and a minimal use of rare or toxic materials have to be explored. Research areas could include storage and conversion of clean energy (e.g., solar, wind, geothermal), solar fuels and solar chemicals, possibly based on recycled and atmospheric CO₂ or other. Research on electro-chemical batteries is not addressing this sub-topic. Where relevant, circular design and/or high degree of recyclability must be addressed. Clear and ambitious performance targets and milestones to achieve them shall be provided.

c. Digital twins for the life-sciences. The sub-topic aims at the close integration and real-time interaction of computational models of biological structures and systems (from biochemical pathways to cells, tissues, organs and individuals), with non-destructive analysis, advanced imaging and sensing techniques for such biological systems, mechanisms and processes. It extends concepts and technologies of digital twins beyond their industrial versions, which are typically supporting the life-cycle of engineered products, into the domain of the life sciences. The core challenge is to derive and update the digital twin from longitudinal and individual data, and using information from the cutting-edge non-destructive analysis, imaging, sensing and monitoring of its biological counterpart, using advanced Artificial Intelligence techniques and taking the achievements of systems biology, mechanobiology, metabolomics and systems medicine into account. This can be done in vivo at whole-body (e.g., using wearable and implantable sensors) or organ level; or in vitro (e.g., for interacting cells and organoids, 3D cell co-cultures, organ/body-on-chip). A further challenge is to include dynamics at multiple spatio-temporal scales (e.g. for deriving predictive values or simulating adaptation processes, or by evolving the twin itself into a better model through evolutionary or adaptive AI techniques), through new principles of molecular mapping, imaging, sensing and data analysis or Artificial Intelligence that take the time-dimension into account. Biological dynamics can be observed in the non-manipulated state (normal, diseased) or under manipulation (altered, perturbed, diseased) by chemical, biological or physical interventions such as gene-editing, pharmaceuticals, viruses, acoustic waves, electromagnetic fields, light, forces, or altered temperature. This will offer

unprecedented insights into the molecular, cellular and extra-cellular dynamics underlying human disorders such as developmental, metabolic, cardiovascular, neurological, oncological or rare pathologies, where personalised precision medicines and advanced diagnostic and therapeutic approaches but also prevention measures (lifestyle, nutrition, environmental factors) are needed to make healthcare more effective, more convenient, cheaper and uniquely tailored to each patient. Work on ethical implications should be included.

d. Measuring the unmeasurable — Sub-nanoscale science for Nanometrology. This sub-topic seeks to find and test new approaches for nano- and sub-nano metrology. Proposals should target new techniques, for example, physics-, biochemistry- and chemistry-based methods incorporating nano- and picometre-length scales in the spatial domain with femto- and atto-seconds in the temporal domain. The proposal must address research from a novel measurement concept up to a technique and/or method including prototype measuring devices/setups and procedures, and sound metrological aspects like quantification of uncertainty or traceability. Proposals should seek to approach theoretical limits in challenging domains (physical, chemical, biological) while minimising any potential damage or change to the object being measured. Full three-dimensional characterisation (tomography) or the application of metrological procedures to transient phenomena on a sub-nanosecond time-scale could push the limits in metrology. Research on refining existing techniques is excluded. Proposals will address emerging issues of nano-metrology in spatial and temporal dimensions, including for example morphology, composition, reactivity, energy, dynamics or relevant optical, electronic, chemical and biochemical properties. Challenges in measurement that could be used as test cases are, e.g., understanding and controlling changing morphology impacting chemical properties in nano-photonic devices or battery electrodes; integrating metrology with sub-nanoprinting, nano-engineering or self-characterisation techniques; the measurements of heat transfer across interfaces down to the atomic size level; or the characterisation of the dynamics of molecular interactions in or with biological systems for health or smart materials. The use of advanced modelling, statistical methods, big data and machine learning methods is welcome where appropriate.

Projects should establish a solid baseline of knowledge and skills and assemble the interdisciplinary communities around them, including from the social sciences and humanities. They should further foster the emergence of a broader innovation ecosystem and create a fertile ground for co-design of the new technological paradigm and its future take-up (e.g., wider stakeholder/public engagement, informal education, policy debate), in line with the discussion on Responsible Research and Innovation (RRI) in the introduction of the FET part of the work programme.

The Commission considers that proposals requesting a contribution from the EU of EUR 4 to 4.50 million and with a duration of up to 4 years would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts or project duration.

This topic allows for the provision of financial support to third parties established in an EU member state or country associated with Horizon 2020 in line with the conditions set out in

General Annex K, either to enhance impacts through punctual small scale experimentation and use of project results by third parties, or to award a prize following a contest organised by the beneficiaries.

Expected Impact:

- Scientific and technological contributions to the foundation and consolidation of a radically new future technology.
- Potential for future returns in terms of societal or economic innovation or market creation.
- Spreading excellence and building leading innovation capacity across Europe by involvement of key actors that can make a difference in the future, for example excellent young, researchers, ambitious high-tech SMEs or first-time participants to FET under Horizon 2020.¹⁹
- Build-up of a goal oriented interdisciplinary community (within and beyond the consortium).
- Emergence of an innovation ecosystem around a future technology in the theme addressed from outreach to and partnership with high potential actors in research and innovation, and from wider stakeholder/public engagement, with due consideration of aspects such as education, gender differences and long-term societal, ethical and legal implications.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETPROACT-EIC-08-2020: Environmental Intelligence²⁰

Specific Challenge: new synergies between the distant disciplines of environmental modelling, advanced sensor research, social sciences, and Artificial Intelligence can lead to radically new approaches for creating and using dynamic models of the environment, including predictive modelling, scenario testing and real-time tracking. The ultimate goal is to build a systemic understanding of the socio-environmental inter-relationships, for instance to regulate or design policies and incentives for environmental sustainability and to track their effectiveness over time and to provide intelligible options for adjusting them.

Scope: Proposals are expected to have their main focus in only one of the following sub-topics:

¹⁹ First time participation here refers to the individuals involved, not to their institution or organisation.

²⁰ This topic is part of the European Innovation Council (EIC) Enhanced Pilot (Horizon 2020, 2019-2020).

a. new techniques for modelling and predicting socio/environmental evolution across different temporal and spatial scales. These will combine, analyse and interpret data from in-situ and remote (e.g., satellite) sensing technologies, other public data sources (e.g., historical data, planning documents, legislation), and data or models/theories from human behaviour (including gender differences), economics and the social sciences by making recourse to advanced artificial intelligence techniques, if/as needed. The focus is on modelling and tracking of the interplay between natural and societal systems, for example on how policies and economics modelling predict human behaviours' impact on the environment, how explicit or implicit incentives and social norms interact with the environment's evolution and exploitation, how real-time environmental awareness and intelligence can improve behaviour towards more sustainability, or how the decisions based on changes in the environment in turn affect the state of the natural environment.

b. radically novel approaches to resilient, reliable and environmentally responsible in-situ monitoring. In-situ sensing technologies (physical, chemical, biological, behavioural) for environmental monitoring, in particular favouring sensors for parameters and environments that are currently under-sampled but at the same time critical for improving predictive models for understanding environmental processes. Proposals should look for ground-breaking concepts of affordable sensor design and deployment, maintenance, retrieval and/or recycling, based on concepts such as self-deployment, self-awareness, adaptation, artificial evolution, self-repair and controlled decomposition; or using edge computing, distributed Artificial Intelligence or new concepts from micro-robotics to optimise sensing or monitoring frequency. Advanced research on the networking aspects is not addressing this sub-topic.

Projects are to focus on one or a few critical resources (e.g., water, air) and to establish fundamental advances on the most critical challenges that will underpin a step improvement in monitoring, analysis and management of important social/environmental processes for improving quality of life and environmental sustainability (possibly including aspects of waste, noise, ...). Citizen involvement, for example for prioritizing resource challenges, data collection, raising awareness towards environmental issues or better understanding of behavioural change in relation to environmental sustainability, is encouraged, in line with the discussion on Responsible Research and Innovation (RRI) in the introduction to this FET work programme. The collected and simulated data should adhere to the FAIR data principle and be compliant with European Standards.

Selected projects under this topic will be expected to collaborate, jointly aiming at delivering a blueprint for a full-fledged system for environmental intelligence.

The Commission considers that proposals requesting a contribution from the EU of up to EUR 4 million and with a duration of up to 4 years would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts or project duration.

Expected Impact:

- Enabling new approaches to monitoring, analysis and management of critical resources in Europe;
- Availability of reliable data and models at multiple levels of granularity for environmental policy making;
- Reduced environmental footprint for environmental ICT;
- Increased local and citizen awareness of environmental impacts.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

The topic(s) below are not part of the European Innovation Council Enhanced Pilot

FETPROACT-09-2020: Neuromorphic computing technologies

Specific Challenge: The potential of neuromorphic computing has been only partially explored so far. Compared to biological neural networks, current neuron/dendrite models are simple, the networks small and learning models appear to be rather basic. The implementations are often VLSI-based CMOS with little resemblance to the substrate of their biological counterparts, and too power-hungry. The challenge is to exploit a wider range of biological principles from the hardware level up (e.g., neuro-mimicking materials and principles – electronic, photonic, ionic,... – , 3D networks, higher degrees of connectivity, cross-connectivity, spiking, rate-based and population-level neuronal dynamics, oscillations, plasticity, parallelism, etc.) and from the cognitive level down, by developing the related algorithms and programming framework, in order to create neuromorphic technologies that can outperform current systems in terms of size, scalability, connectivity, power consumption, ease of training, flexibility, reliability or any other relevant metrics.

Scope: proposals will target new computational substrates and engines, based on new materials and engineering principles for efficient and low-power neuromorphic computing; together with new theories, architectures and algorithms for neuromorphic computation (classification, control,...), learning (including unsupervised, incremental, single-shot and/or event-based) and adaptation/plasticity for and in such new neuromorphic hardware.

These should be brought together in systems or artefacts that demonstrate clear advantages for replacing or complementing state-of-the-art conventional approaches in challenging end-to-end scenarios of use (e.g., on-line edge computing, personalisation, embedded, robotic/agent control,...) in various fields of applications.

The Commission considers that proposals requesting a contribution from the EU between EUR 4 and 5 million and with a duration of up to 4 years would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact: The action will contribute to:

- Bring neuromorphic engineering at the level where it can be benchmarked in terms of performance, power consumption, size, latency or other relevant metric e.g., for learning capacity, speed or plasticity, and its interfaces be standardised;
- Pave the way to market take-up of neuromorphic computing in a range of existing and new application areas, with demonstrable advantages, either as stand-alone or complementing more conventional solutions;
- Stimulate the emergence of a European innovation ecosystem around neuromorphic engineering, well beyond the world of research alone.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Conditions for the Call - FET Proactive – Boosting emerging technologies

Opening date(s), deadline(s), indicative budget(s):²¹

Topics (Type of Action)	Budgets (EUR million)			Deadlines
	2018	2019	2020	
Opening: 31 Oct 2017				
FETPROACT-01-2018 (RIA)	88.00			22 Mar 2018
FETPROACT-02-2018 (CSA)	0.50			
Opening: 05 Jun 2018				
FETPROACT-03-2018 (ERA-NET-Cofund)	6.00			18 Dec 2018
Opening: 26 Jul 2018				
FETPROACT-04-2019 (CSA)		0.50		06 Nov 2018
Opening: 19 Nov 2019				
FETPROACT-09-2020 (RIA)			15.00	22 Apr 2020

²¹ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts for the 2020 budget are subject to the availability of the appropriations provided for in the draft budget for 2020 after the adoption of the budget 2020 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

*Horizon 2020 - Work Programme 2018-2020
Future and Emerging Technologies*

Opening: 26 Mar 2020				
FETPROACT-EIC-07-2020 (RIA)			56.00	02 Jul 2020
FETPROACT-EIC-08-2020 (RIA)			18.00	
Overall indicative budget	94.50	0.50	89.00	

The indicative funding budgets per sub-topic under FETPROACT-01-2018 are as follows: EUR 15.00 million for sub-topic a., EUR 13 million for sub-topic b., EUR 20 million for sub-topic c., EUR 15 million for sub-topic d., EUR 15 million for sub-topic e., and EUR 10 million for sub-topic f.

From the budget for FETPROACT-EIC-07-2020, at least EUR 12 million will be allocated to each of the sub-topics ‘a. Artificial Intelligence for extended social interaction’, ‘b. Breakthrough zero-emissions energy storage and conversion technologies for carbon-neutrality’ and ‘c. Digital twins for the life-sciences’.

Indicative timetable for evaluation and grant agreement signature:

For single stage procedure:

- Information on the outcome of the evaluation: Maximum 5 months from the final date for submission; and
- Indicative date for the signing of grant agreements: Maximum 8 months from the final date for submission.

Eligibility and admissibility conditions: The conditions are described in General Annexes B and C of the work programme.

Evaluation criteria, scoring and threshold: The criteria, scoring and threshold are described in General Annex H of the work programme. The following exceptions apply:

FETPROACT-01-2018, FETPROACT-09-2020, FETPROACT-EIC-07-2020, FETPROACT-EIC-08-2020	<p>Excellence</p> <p>The following aspects are taken into account:</p> <ul style="list-style-type: none"> • Clarity of long-term vision of a science-enabled technology. • Concreteness and ambition of the proposed science-to-technology breakthrough that addresses this vision. • Range and added value from interdisciplinarity, novelty and non-incrementality of the research proposed. • High-risk of the research proposed and plausibility and flexibility of the approach.
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	<p>Threshold: 4/5, Weight: 60%</p> <p>Impact</p> <ul style="list-style-type: none"> • The extent to which the outputs of the project would contribute to the expected impacts mentioned in the work programme under the relevant FET topic. • Effectiveness of measures and plans to disseminate and use the results (including management of IPR) and to communicate the project to different target audiences. <p>Threshold: 3.5/5, Weight: 20%</p> <p>Quality and efficiency of the implementation</p> <p>The following aspects are taken into account:</p> <ul style="list-style-type: none"> • Coherence and effectiveness of the work plan to achieve project objectives and impacts, including adequate allocation of resources to tasks and partners. • Appropriateness of the research and innovation management structures and procedures. • Role and complementarity of the participants and extent to which the consortium as a whole brings together the necessary expertise. <p>Threshold: 3/5, Weight: 20%</p>
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Evaluation Procedure: The procedure for setting a priority order for proposals with the same score is given in General Annex H of the work programme. The following exceptions apply:

FETPROACT-01-2018	<p>The following specific page limits apply. Sections 1 to 3 of the part B of the proposal should consist of a maximum of 30 A4 pages. The limits will be clearly shown in the ‘proposal templates’ in the Participant Portal electronic submission system. Sections which are not subject to limits will be indicated.</p> <p>Grants will be awarded to proposals according to the ranking list. However, in order to ensure a balanced portfolio of supported actions, within the indicative funding budgets per sub-topic, at least each of the two highest-ranked proposals for each sub-topic will be funded provided that it attains all thresholds. Any remaining funding budget will then be allocated according to the ranking list.</p>
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FETPROACT-03-2018	<p>Given the specific nature of the ERA-NET Cofund instrument, and the specific challenge of developing the European Research Area in the context of FET, at most one ERA-NET Cofund action will be funded under this topic.</p>
FETPROACT-EIC-07-2020	<p>The following specific page limits apply. Sections 1 to 3 of the part B of the proposal should consist of a maximum of 30 A4 pages. The limits will be clearly shown in the ‘proposal templates’ in the Funding & Tender Portal electronic submission system. Sections which are not subject to limits will be indicated.</p> <p>Grants will be awarded to proposals according to the ranking list, respecting where applicable the minimal budget allocation per sub-topic. At least each of the two highest-ranked proposals for each sub-topic will be funded provided that it attains all thresholds. Then, respecting the ranking, the third ranked proposal (if any) from each of the sub-topics a, b and c is awarded within available funding budget. Finally, any remaining funding budget is allocated according to the ranking list. For sub-topic d at most two proposals will be funded.</p>
FETPROACT-EIC-08-2020	<p>The following specific page limits apply. Sections 1 to 3 of the part B of the proposal should consist of a maximum of 30 A4 pages. The limits will be clearly shown in the ‘proposal templates’ in the Funding & Tender Portal electronic submission system. Sections which are not subject to limits will be indicated.</p> <p>Grants will be awarded to proposals according to the ranking list. At least each of the two highest-ranked proposals for each sub-topic will be funded provided that it attains all thresholds. Then, respecting the ranking, the third ranked proposals (if any) from each sub-topic is awarded within available funding budget. Finally, any remaining funding budget is allocated according to the ranking list.</p>
FETPROACT-09-2020	<p>The following specific page limits apply. Sections 1 to 3 of the part B of the proposal should consist of a maximum of 30 A4 pages. The limits will be clearly shown in the ‘proposal templates’ in the Funding & Tender Portal electronic submission system. Sections which are not subject to limits will be indicated.</p>

The full evaluation procedure is described in the relevant [guide](#) published on the Funding & Tenders Portal.

Grant Conditions:

FETPROACT-01-2018, FETPROACT-EIC-07-2020	For grants awarded under this topic, beneficiaries may provide support to third parties established in a EU member state or country associated with Horizon 2020 and as described in General Annex K of the Work Programme either in form of grants or prizes and within the limitations as described in the call text of this topic. The respective options of Article 15 of the Model Grant Agreement will be applied.
FETPROACT-EIC-07-2020	Grants awarded under each of the sub-topics shall be implemented through the use of complementary grants and the respective options of Article 2, Article 31.6 and Article 41.4 of the Model Grant Agreement will then be applied. In particular the projects are required to conclude a collaboration agreement, in principle prior to the signature of the grant agreement.
FETPROACT-EIC-08-2020	Grants awarded under this topic shall be implemented through the use of complementary grants and the respective options of Article 2, Article 31.6 and Article 41.4 of the Model Grant Agreement will then be applied. In particular the projects are required to conclude a collaboration agreement, in principle prior to the signature of the grant agreement.

Consortium agreement:

FETPROACT-01-2018, FETPROACT-09-2020, FETPROACT-EIC-07-2020, FETPROACT-EIC-08-2020	Members of consortium are required to conclude a consortium agreement, in principle prior to the signature of the grant agreement.
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Call - FET Proactive – High Performance Computing

H2020-FETHPC-2018-2020

The HPC FET Proactive initiative aims to create a world-class European HPC ecosystem, by developing leading-class technology and solutions towards exascale performance for ambitious scientific/engineering applications and services. By benefiting from the convergence of HPC, Big Data and Cloud Computing technologies, the HPC ecosystem will provide innovative, usable and competitive solutions that will upraise Europe's scientific capabilities and industrial competitiveness.

In April 2016, as part of its Digitising European Industry²² strategy, the Commission adopted the communication *European Cloud Initiative - Building a competitive data and knowledge economy in Europe*²³, which was endorsed by the European Council in June 2016. The initiative aims to create, a **leading European High Performance Computing and Big Data (HPC/BD) research and industrial ecosystem by 2023** underpinned by a world-class European Data Infrastructure offering high performance computing and data capabilities, fast connectivity and high-capacity cloud solutions.

A synergetic approach for HPC technologies is promoted, which is complementary to relevant activities covered in the LEIT and eINFRA work programmes 2018-2020 and are called in the framework of the Public Private Partnership (PPP) on HPC with the ETP4HPC Association (European Technology Platform in HPC).

The topics 'FETHPC-02-2019: Extreme scale computing technologies, methods and algorithms for key applications and support to the HPC ecosystem' and 'FETHPC-03-2019: International Cooperation on HPC' have been removed from the Work programme in view of the transfer of High Performance Computing activities in 2019 and 2020 to the EuroHPC Joint Undertaking.

Proposals are invited against the following topic(s):

FETHPC-01-2018: International Cooperation on HPC

Specific Challenge: The aim is to develop strategic partnership in HPC with Brazil and Mexico that enables advancing the work on HPC applications in domains of common interest. Brazilian and Mexican partners will not be funded by the EU and they are expected to participate in the project with their own funding.

Scope: a) Cooperation with Mexico: in the frame of the Bilateral Agreement on Science and Technology between the European Union and the United States of Mexico²⁴, collaboration for the development of state-of-the-art HPC applications (codes, algorithms, software tools, etc.)

²² COM(2016) 180 final

²³ COM(2016) 178 final

²⁴ Communiqué of the 8th Joint Steering Committee of 27th May 2016 in Brussels

in domains of common interest such as energy (including oil, renewables, wind, etc.), life sciences, earth sciences, climate change and air pollution, and natural disasters, among others.

b) Cooperation with Brazil: developing state-of-the-art HPC applications in domains of common interest, such as in eHealth and drug design (e.g., related to diseases such as Zika and Dengue) or energy (e.g., renewables or management of natural resources). Proposals should put emphasis on application development towards exascale performance, develop codes, algorithms, other software tools, big data analytics, and hardware where appropriate. Proposals should ensure access to and using relevant big data suites as needed.

The Commission considers that proposals requesting a contribution from the EU of up to EUR 2 million for the cooperation with Mexico and up to EUR 2 million for the cooperation with Brazil would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Improved international cooperation of EU-Mexico and EU-Brazil research and industrial communities on advanced HPC application development.
- Improved sharing of information and expertise to solve common societal problems with the use of advanced computing.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETHPC-04-2020: International Cooperation on HPC

Specific Challenge: The aim is to develop a strategic partnership in HPC with Latin America enabling closer research cooperation in HPC.

Scope:

- Develop a roadmap for increased future research cooperation in HPC
- Identify key HPC application areas and hardware/system requirements per Latin-American country
- Identify relevant national, regional and international funding schemes of HPC in Latin America
- Organise meetings, thematic workshops and summer schools in areas of common interest
- Promote the exchange of best practices between the European and Latin-American HPC research communities

- Improve links between the European and Latin-American HPC research communities

The Commission considers that proposals requesting a contribution from the EU of up to EUR 0.50 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Development of a realistic HPC research cooperation roadmap with clearly identified application areas, hardware/system requirements and funding schemes
- Improved international cooperation of EU and Latin American research and industrial communities on advanced HPC application development.
- Improved sharing of information and expertise to solve common societal problems with the use of advanced computing.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Conditions for the Call - FET Proactive – High Performance Computing

Opening date(s), deadline(s), indicative budget(s):²⁵

Topics (Type of Action)	Budgets (EUR million)		Deadlines
	2018	2020	
Opening: 01 Feb 2018			
FETHPC-01-2018 (RIA)	4.00		15 May 2018
Opening: 19 Nov 2019			
FETHPC-04-2020 (CSA)		0.50	22 Apr 2020
Overall indicative budget	4.00	0.50	

Indicative timetable for evaluation and grant agreement signature:

²⁵ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts for the 2020 budget are subject to the availability of the appropriations provided for in the draft budget for 2020 after the adoption of the budget 2020 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

For single stage procedure:

- Information on the outcome of the evaluation: Maximum 5 months from the final date for submission; and
- Indicative date for the signing of grant agreements: Maximum 8 months from the final date for submission.

Eligibility and admissibility conditions: The conditions are described in General Annexes B and C of the work programme. The following exceptions apply:

FETHPC-01-2018	<p>Due to the specific objectives of this call topic, in addition to the minimum number of participants as set out in the Rules of Participation, proposals shall include at least two participants from the country or region targeted by the action.</p> <p>Participants in the EU actions are required to conclude a coordination agreement with the participants in the corresponding coordinated third-country activities. A final draft of these agreements has to be provided with the proposal.</p> <p>Proposals will only be selected on the condition that the proposers provide evidence of the eligibility of Mexican and Brazilian partners to receive funding for their proposed activities from their respective funding authorities (e.g. in the form of a letter from the corresponding funding authority) prior to the evaluation of the proposals.</p>
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Evaluation criteria, scoring and threshold: The criteria, scoring and threshold are described in General Annex H of the work programme.

Evaluation Procedure: The procedure for setting a priority order for proposals with the same score is given in General Annex H of the work programme.

The full evaluation procedure is described in the relevant [guide](#) published on the Funding & Tenders Portal.

Consortium agreement:

FETHPC-01-2018	Members of consortium are required to conclude a consortium agreement, in principle prior to the signature of the grant agreement.
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Call - FET FLAGSHIPS – Tackling grand interdisciplinary science and technology challenges

H2020-FETFLAG-2018-2020

FET Flagships tackle grand Science and Technology challenges expected to result in 'game changing' impacts on economy and society, benefitting European citizens and paving the way for global technological and industrial leadership. Because of their ambition, their scale and their interdisciplinary nature, FET Flagships can only be realised through a long-term and sustained effort at European level, by building on large scale research cooperation across academia and industry and across national research programmes, and by mobilising Europe's best researchers around an ambitious R&D roadmap.

Under the first work programme of Horizon 2020, a Framework Partnership Agreement (FPA) has been established for each of the two running Flagships, Graphene and the Human Brain Project (HBP).

Activities in this work programme will: (i) further support the two running Flagships on the basis of their FPAs, following Specific Grant Agreements (SGAs) and other actions launched under previous work programmes; (ii) kick-start the support to the new Flagship on Quantum Technologies (QT); (iii) further support the FLAGERA and QUANTERA ERA-NETs that bring together national and regional funding agencies from the Member States and Associated Countries in support respectively of the two running Flagships and the QT one; and (iv) include preparatory actions to prepare the ground for new candidate FET Flagship initiatives.

A large-scale research initiative on Future Battery Technologies

In addition to the topics listed below, this work programme also kick starts a large scale, long-term research initiative on Future Battery Technologies that will ensure the European knowledge base in long term battery research and contribute to the EU Battery Alliance. Such a coordinated effort is crucial, given that at the dawn of a new, connected, green era reliable and safe batteries with ultra-high performance are becoming essential. Novel cross-disciplinary approaches empowered by digital technologies can accelerate research on the next generations of smart, safe and high-performing batteries. They will provide Europe with a competitive advantage in the fast growing market of electro-chemical energy storage and will be key for the development of a world-class European industry capable of addressing the needs of many sectors, including e-mobility and renewable energy storage.

The topics relevant to this large scale research initiative on Future Battery Technologies are to be found in the dedicated cross-cutting Call 'Building a low-carbon, climate resilient future: Next-Generation Batteries' in the part "Cross-cutting activities" of the Horizon 2020 Work Programme 2018-2020. In particular, four topics in this Call (from LC-BAT-12-2020 to LC-

BAT-15-2020) tackle long-term research challenges that are expected to result in 'game changing' impacts on future battery technologies²⁶

Proposals are invited against the following topic(s):

FETFLAG-01-2018: Preparatory Actions for new FET Flagships

Specific Challenge: FET Flagships are science- and technology-driven, large-scale, multidisciplinary research initiatives built around a visionary unifying goal. They tackle grand science and technology (S&T) challenges requiring cooperation among a range of disciplines, communities and programmes. FET Flagships should provide a strong and broad basis for future innovation and economic exploitation, as well as novel benefits for society of a potential high impact. The overarching nature and magnitude implies that they can only be realised through a collaborative, long-term sustained cooperation effort. This topic aims at launching Coordination and Support Actions (CSA) to prepare new candidate FET Flagships.

Scope: Proposals should contain a description of a potential FET Flagship and how this is to be matured over the course of the preparatory action into a more complete blueprint.

Firstly, proposals should describe the FET Flagship initiative they propose to further develop through this preparatory action, by specifically addressing the following three key issues:

- **What makes this a FET Flagship:** what is the unifying goal, the grand S&T challenge and the underlying vision; why is this a grand challenge and what makes it a "game-changer"; what are its main goals and objectives; and what are the technologies, including digital technologies, that it would advance.
- **Impact (why it is good for Europe):** will it bring major impact on economy and society as well as on science and technology; why and how is it relevant for the European industry; how does it build on existing scientific excellence in Europe; what is its innovation potential that would benefit Europe's economy and/or society; how would it uniquely position Europe with respect to relevant developments and initiatives existing in other regions in the world.
- **Integration and European added value:** is it well positioned to address its grand S&T challenge in terms of large-scale integration across disciplines and the involvement of relevant stakeholders from academia, industry and society at large; does critical mass in terms of research excellence and industrial capabilities exist in Europe needed to address the challenge; what is the estimated scale of the effort required to reach the objectives and how long will it take to do so; and, are there similar initiatives existing at regional, national or European level and what is the added value of such an effort.

Secondly, proposals should describe how the activities of the preparatory action will involve stakeholders over the course of up to 12 months (indicative), to arrive at a complete design

²⁶ See Manifesto for a long-term research initiative to create the batteries of our future: <http://battery2030.eu/>

and description of a candidate FET Flagship initiative. Specifically, they should describe the proposed activities for further developing the Flagship's unifying goal and its underlying S&T roadmap; attracting industry's endorsement and participation; further developing their consortium and its governance structure and attracting large public support.

Proposals should consider multidisciplinary aspects, including where relevant social sciences and humanities. They must also describe a clear strategy for dissemination and citizen engagement; and, in close cooperation with other proposals for preparatory actions that will be selected from this call, jointly organise and participate in an event addressing stakeholders including scientific communities, policy makers and the wider public and aiming at disseminating the main objectives and findings of the actions.

At the end of the action, the design and description of the candidate Flagship should include the following elements:

- **A consolidated vision** based on a well-defined unifying goal articulated in terms of S&T objectives and of its targeted impact on economy and society.
- **A strategic long-term research roadmap**, showing how the unifying goal can be realised and what the major milestones are, situating the Flagship in the global landscape and demonstrating a credible path towards societal impact, technology development, innovation and exploitation.
- **A blueprint for the Flagship's implementation** setting out the overall collaboration and S&T framework, the identification of necessary competencies and resources including infrastructure aspects, and openness of the initiative.
- **An effective scientific leadership and governance structure** based on lessons learned from the present Flagships, describing the coordination and decision-making structures of the Flagship, the role of industry and the relations with Member States and countries associated with Horizon 2020, with the Commission and with the relevant funding agencies and national research initiatives.
- **Support from and involvement of industry**, giving a view on avenues for exploitation and further strengthening of European industry in the global landscape, including stimulating the emergence and growth of innovative value chains.
- **An approach to address responsible research and innovation**, in particular aspects such as education, gender aspects and societal, ethical and legal implications.

Proposals for candidate FET Flagships must target a visionary unifying goal within one of the following three main areas: **ICT and Connected Society; Health and Life Sciences; or Energy, Environment and Climate change**. They should present a multidisciplinary approach that brings together the relevant communities to address their unifying goal. Proposals must clearly specify which of the three areas they target. In each of these areas at least one and at most two proposals for Flagship preparatory actions will be selected for funding.

(1) ICT and Connected Society

The proposal should address any of the following sub-areas in part or in whole:

- **Smart Materials and Nanoscale Engineering:** Novel nano-engineered materials and systems with properties enabling the design and manufacturing of radically new ICT components and devices creating disruptive technologies and market opportunities, for example in energy efficiency, data processing, smart manufacturing, smart interfaces, nano-bio devices, etc.
- **Robotics, Interfaces and Artificial Intelligence:** a new generation of robotics technologies including soft and flexible robotics, bio-inspired robotics, new approaches to human-machine interaction and cooperation, cognition and artificial intelligence, giving rise to much smarter systems performing sophisticated functions opening radically new opportunities to address societal and economic challenges.
- **ICT for Social Interaction and Culture:** new ICT technologies and approaches for empowering deep social interactions across diverse cultures, languages, goals, values, etc.; for understanding large-scale complex socio-technical systems and their interactions, interdependencies and evolutions and avenues for exploiting this understanding; and/or for collecting, preserving, studying and promoting Europe's unique cultural heritage and exploiting these to achieve major societal or economic benefits.

(2) Health and the Life Sciences

The proposal should address any of the following sub-areas in part or in whole:

- **Disruptive technologies to Revolutionise Healthcare:** New technologies and approaches aiming at a paradigm shift in the field of individualised prevention, prediction and treatment of diseases. This includes among others bioinformatics and modelling approaches to use patients' genetic expression patterns, metabolism and derived systems; novel and innovative nano-medicine approaches (e.g. technologies for novel sensors and imaging, organ-on-a-chip and bio-electronic medicine, drug delivery, ...); network medicine; neuro-prosthetic technologies; regenerative medicine and biofabrication techniques to reprogram or replace human cells, tissues and whole organs and to integrate these in functioning body systems.
- **Understanding Life by Exploring the Genome and the Cell:** Novel technologies and approaches that enable a paradigm shift in studying and understanding the foundational building blocks of life, for example the functioning of the cell, and of cells within organisms, including structure and dynamics, and the full multi-omics (genome/epigenome/proteome/metabolome/connectome etc.) and their interactions. This will open up radically new opportunities such as developing novel nano-bio devices and technologies, advanced screening methods and analytical and morphological

technologies, advanced therapies and contribute to the understanding of biological processes and pathological mechanisms.

(3) Energy, Environment and Climate change

The proposal should address any of the following sub-areas in part or in whole:

- **Earth, Climate Change and Natural Resources:** New technologies and approaches for high-precision modelling and simulation, including the necessary data integration, that enable an in-depth understanding of the earth, natural hazards and climate change. Their exploitation and use should open up new opportunities for helping to manage/mitigate their effects and impacts on human activity and natural resources in a sustainable way in specific areas such as: agriculture (ensuring food security and sustainable farming), forestry, fisheries, protecting/restoring natural ecosystems, energy supply and demand, etc.
- **Radically new Energy Production, Conversion and Storage devices and systems:** Disruptive technologies aiming at a paradigm shift in renewable energy by exploring and exploiting radically new principles and novel materials that can substantially reduce Europe's dependence on fossil fuels and open new industrial opportunities for their exploitation and sustainable development.

The Commission considers that proposals requesting a contribution from the EU of up to EUR 1 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact: For the CSA:

- Fully developed candidate FET Flagship initiatives supported by key stakeholders (e.g., academic research communities, industry, public authorities ...).

For the proposed Flagships:

- Key benefits for economy and society based on significant advances on science and technology. This should be demonstrated by e.g. potential for S&T breakthroughs, industrial support, added value for Europe, potential for increasing European competitiveness, potential for societal benefits, etc.
- Long-lasting structuring effect on research efforts in Europe, anchor point for international cooperation and the nurturing of talent through the training of a new generation of researchers.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETFLAG-02-2018: ERA-NET Cofund for FET Flagships

Specific Challenge: To fund partnering projects (PPs) and coordinate the national activities and support of Member States and Associated Countries (MS/AC) to the Graphene and HBP Flagships. PPs are projects funded from other sources (e.g. by national/regional funding) which address areas relevant for the Flagships and contribute to their objectives.²⁷

Scope: One follow-up action to the FLAG-ERA II ERA-NET Cofund action (<http://www.flagera.eu/>) aiming to coordinate and pool the necessary financial resources from the participating national and regional research programmes to fund PPs of the two Flagships by implementing a joint transnational call for proposals resulting in grants to third parties, possibly followed by further joint calls without EU co-funding. The action may also organise additional joint activities between the participating funding agencies in support of the two Flagships.

Expected Impact: Closer coordination and greater mobilisation and pooling of resources between regional, national and EU research programmes for realising the research goals of the FET Flagships.

Type of Action: ERA-NET Cofund

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETFLAG-03-2018: FET Flagship on Quantum Technologies

Specific Challenge: To build a strongly networked European Quantum Technologies (QT) community around the common goals defined in the Strategic Research Agenda²⁸. To create the European ecosystem that will deliver the knowledge, technologies and open research infrastructures and testbeds necessary for the development of a world-leading knowledge-based industry in Europe, leading to long-term economic, scientific and societal benefits. To move advanced quantum technologies from the laboratory to industry with concrete prototype applications and marketable products while advancing at the same time the fundamental science basis, in order to continuously identify new applications and find better solutions for solving outstanding scientific or technology challenges.

Scope: A. Research and Innovation Actions

Proposals are expected to address a mix of quantum technology challenges addressing one or more of the following areas, integrating different aspects like physics, engineering, computer science, theory, algorithms, software, manufacturing, control, infrastructures, etc. Each

²⁷ See SWD(2014) 283 final of 16.9.2014

²⁸ building on the Quantum Manifesto (<http://europa.eu/manifesto>), the Commission Expert Group on Quantum Technologies – High Level Steering Committee has delivered on 28 June 2017 a first version of the Strategic Research Agenda in its final report (<https://tinyurl.com/QT-HLSC-report>).

activity should clearly move the technology up the TRL scale²⁹. For areas a. to d., proposals can integrate various activities covering the whole value chain, from fundamental to applied research, and with other types of activity, including demonstrators, etc., as appropriate.

a. Quantum Communication³⁰ : Development of state-of-the art network devices, applications and systems (memories, quantum repeaters, network equipment, high throughput miniaturised quantum random number generators, etc.) for quantum communication mesh-networks. Proposals should target cost-effective solutions, devices and systems compatible with existing communication networks and standard cryptography systems, as well as device-independent protocols. Each proposal should address aspects like engineering, protocols, certification, software, algorithms. Actions should include validation of the proposed solution, proof of its suitability for the targeted application and benchmarking with respect to relevant targets set by the CSA³¹ in this area.

b. Quantum Computing Systems: The development of open quantum computer experimental systems and platforms³², integrating the key building blocks such as quantum processors (>10qubits) with limited qubit overhead, control electronics, software stack, algorithms, applications, etc. Work should address the scalability towards large systems (>100 qubits), the verification and validation of the quantum computation, fault-tolerance and solving a concrete computational problem to demonstrate the quantum advantage. Projects should foresee benchmarking activities. Benchmarks will be identified by the CSA³³ for all the platforms selected in this area.

c. Quantum Simulation: Proposals should aim at delivering operational demonstrators, based on existing physical platforms that have shown a clear perspective to achieve more than 50 interacting quantum units and / or full local control. They should work towards demonstrating a certified quantum advantage for solving difficult scientific or industrial problems (e.g. material design, logistics, scheduling, machine learning, optimisation, artificial intelligence, drug discovery, etc.). The proposed solutions need to include the development of protocols, validation schemes and control, simulation software, system configuration and optimisation. Work should address the scalability towards larger systems with more qubits. Projects should foresee benchmarking activities related to real life applications. Benchmarks will be identified by the CSA³⁴ for all the platforms selected in this area. Hybrid architectures are also to be considered under this area when relevant.

d. Quantum Metrology and Sensing: Quantum sensors for specific application areas such as imaging, healthcare, geo-sciences, outdoor and indoor navigation, time or frequency,

²⁹ See the definition of Technology Readiness Levels (TRLs) in the General Annexes to the work programme.

³⁰ See also the dedicated topic on Quantum Key Distribution Testbed in the LEIT ICT work programme (topic SU-ICT-04-2019).

³¹ See item B. under this call topic.

³² Including, if relevant, hybrid approaches linking quantum and classical systems or linking different quantum platforms.

³³ See item B. under this call topic.

³⁴ See item B. under this call topic.

magnetic or electrical measurements, etc. ... as well as novel measurement standards³⁵, making use of the advances in controlling the fundamental quantum properties. It is expected that the work will lead to practical sensing devices, imaging systems and quantum standards that employ quantum coherence and outperform classical counterparts (resolution, stability) targeting TRL 3 and 4 and showing potential for further miniaturisation/integration into industrial systems.

e. Fundamental science: Research and development of basic theories and components, addressing a foundational challenge of relevance for the development of quantum technologies in at least one of the four areas a.-d. described above, to improve the performance of the components or subsystems targeted in those areas. Proposals must clearly indicate how they support a challenge for one or more of these areas.

For areas a. to d., proposals should be based on a close cooperation between academia and industry, define output and impact KPIs³⁶, include technology benchmarking against other approaches, and include user requirements.

For areas a. to c. above, proposals should seek synergies with relevant national / regional research and innovation programmes running in these areas. They shall clearly specify how they are connected to the programmes and / or how they will incorporate the platforms, testbeds and infrastructures existing in Europe, how they will attract and build communities around them for openly promoting further technology developments as well as testing and benchmarking in the field and how they build on top of these to create European added value. Proposals combining different sources of financing should include a concrete financial plan detailing the use of these funding sources for the different parts of their activities.

The Commission considers that proposals for Research and Innovation Actions of a 3-year duration and requesting a contribution from the EU up to EUR 10 million would allow the areas a. to d. to be addressed appropriately; and proposals requesting a contribution from the EU between EUR 2 and 3 million would allow the area e. to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals of another duration and/or requesting other amounts.

When appropriate, proposals may provide financial support to third parties established in a EU member state or country associated with Horizon 2020 and in line with the conditions set out in General Annex K, for example to access specific expertise or infrastructure. The consortium will define the selection process of third parties for which financial support will be granted (with a maximum of EUR 100 000³⁷ per party). A maximum of 10% of the EU funding requested by the proposal should be allocated to this purpose.

All projects shall make provisions to actively participate in the common activities of the Quantum Flagship and in particular: coordinate technical work with the other selected

³⁵ Measurement standards used in metrology for electrical quantities, mass, length, time, frequency, etc...

³⁶ KPI = Key Performance Indicator.

³⁷ In line with Article 23 (7) of the Rules for Participation the amounts referred to in Article 137 of the Financial Regulation may be exceeded, since this is necessary to achieve the objectives of the action.

projects of the Flagship; and contribute to the activities of the Coordination and Support Action defined under item B. below.

Note that special Grant Conditions will apply for projects granted under this topic. Please see under Call Conditions.

B. Coordination and Support Action

Proposals should aim at coordinating the relevant stakeholders, notably academia, RTOs and industry participating in the Flagship initiative. In particular, it is expected to establish a communication platform, facilitate dialogue, promote the objectives of the Flagship and monitor the progress, support the governance structure, organize outreach events (including addressing the impact of technology development on economy and society), identify training and education needs and promote European curricula in quantum engineering, identify and coordinate relevant standardisation, IPR actions, and international collaboration and help networking of respective national and international activities in the field. The action will also identify, together with the community, benchmarks for all communication/computing/simulation platforms selected under areas a. to c. of the Research and Innovation Actions described under item A. above.

It is expected that such an activity is driven by the relevant actors of the field including academia, RTOs and industry.

The Commission considers that proposals for Coordination and Support Actions requesting a contribution from the EU of up to EUR 2 million would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact: A. Research and Innovation Actions

- Contribute to the strategic objectives of the Flagship;
- Expand European leadership and excellence in quantum technologies;
- Scientific breakthroughs that form the basis for future technologies;
- Synergetic collaboration with existing European platforms and infrastructures;
- Kick-start a competitive European quantum industry;
- Availability of open platforms and infrastructures accessible to the European Quantum technologies Community.

B. Coordination and Support Action

- A well-coordinated European initiative on Quantum Technologies, involving all relevant stakeholders and linked with relevant international, national and regional programmes, while assuring an efficient support to the governance of the Flagship;

- Spreading of excellence on Quantum Technologies across Europe, increased awareness of European activities and availability of European curricula in the field.

Type of Action: Coordination and support action, Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETFLAG-04-2020: Quantum Flagship - ERA-NET Cofund

Specific Challenge: Support to transnational projects in quantum technologies, fostering synergy between European, national and regional initiatives and promoting broader partnerships between the European stakeholders in quantum technologies.

Scope: The aim is to support the networking and coordination of national activities in support of the Quantum Flagship by implementing a joint call for proposals resulting primarily in grants to third parties with EU co-funding in this area, in accordance with the provisions of the General Annexes. Of importance is how the ERA-NET addresses the gaps in the Strategic Research Agenda, not covered by the Flagship activities. Proposers are encouraged to implement other joint activities related to the coordination of public research and innovation programmes in quantum technologies, such as transnational networking, training, technology transfer and additional joint calls without EU co-funding. The proposal should demonstrate that these co-funded other activities exclude any overlaps with related on-going actions co-funded by the EU under the Horizon 2020 FET Programme.

Expected Impact: Closer coordination and greater mobilisation and pooling of resources between regional, national and EU research programmes for realising the research goals of the FET Flagship in the area of quantum technologies.

Type of Action: ERA-NET Cofund

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETFLAG-05-2020: Complementary call on Quantum Computing

Specific Challenge: In order to kick-start a European industry in quantum computers, breakthroughs in miniaturization and scalability of quantum computing devices are needed, in particular for producing high-quality qubits that can be efficiently interconnected or scaled towards thousands of qubits, compatible with the fabrication techniques of the semiconductor industry. Moreover, Europe needs quantum software environments for quantum computers in order to address concrete industrial and scientific applications with expected quantum advantage.

Scope: Proposals are expected to address a mix of quantum technology challenges integrating different aspects like physics, engineering, computer science, theory, algorithms, software, manufacturing, control, infrastructures, benchmarking and verification etc. Each activity

should clearly move the technology up the TRL scale³⁸. Proposals can integrate various activities covering the whole value chain, from fundamental to applied research, and with other types of activity, including demonstrators, etc., as appropriate.

(a) Hardware:

Hardware proposals are expected to develop a miniaturised qubit platform mass-manufacturable, and compatible with semiconductor processing, integrating quantum processors (>10qubits) of good-quality qubits. Work should address the verification and validation of the quantum computation, fault-tolerance, demonstrating high-fidelity (>99%) single and two-qubit gates. Proposals should demonstrate fast and efficient, high-fidelity (>99%) qubits operations including read, write, data transfer, etc..., and address the scalability towards large systems.

Work should include investigations into the industrial design, engineering and manufacturing processes necessary for mass-manufacturing the qubit platform and provide first experimental production lines. Proposals should aim at the development of open quantum computer experimental systems, and work on the reduction of their form factor. Proposed platforms should build on qubit technologies complementing the approaches of the running projects of the Quantum Technologies Flagship.

(b) Software:

Software proposals should target the development of quantum applications and the development of industrial use cases for the quantum computers of the Quantum Technologies Flagship. Furthermore, proposals should target the development of quantum software stacks, libraries, etc., that facilitate the link from a high-level description of algorithms to a low-level implementation with quantum gates, for solving concrete problems and applications expected to demonstrate quantum advantage. The developed applications and software should be independent of the underlying qubit platform and their correct functioning should be tested on all the quantum computing platforms of the Quantum Technologies Flagship.

All proposals should be based on a close cooperation between academia and industry, define output and impact KPIs³⁹, include technology benchmarking against other approaches, and include user requirements. In addition, for the hardware proposals, they should include benchmarking against different technologies. Relevant benchmarks will be identified by the Coordination and Support Action of the Quantum Technologies Flagship.

The Commission considers that proposals for Research and Innovation Actions of a 4-year duration and requesting a contribution from the EU up to EUR 15 million for Hardware and up to EUR 4,70 million for Software, would allow the challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

³⁸ See the definition of Technology Readiness Levels (TRLs) in the General Annexes to the work programme.

³⁹ KPI = Key Performance Indicator.

As indicated in the grant conditions, all projects shall conclude a written collaboration agreement with the Quantum Technologies Flagship funded projects to actively participate in the common activities of the Quantum Technologies Flagship and in particular: Coordinate technical work with the other selected projects of the Flagship; and contribute to the activities of the Coordination and Support Action.

Expected Impact:

- Contribute to the strategic objectives of the Flagship;
- Expand European leadership and excellence in quantum computing technologies;
- Kick-start a competitive European quantum hardware and software industry;
- Achieving practical quantum computing systems for relevant applications.

Type of Action: Research and Innovation action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETFLAG-06-2020: International Cooperation on Quantum Technologies

Specific Challenge: Quantum technologies is an emerging key enabling technology. In order to achieve its objectives, the Quantum Technologies FET Flagship could benefit from international cooperation activities with non-European partners having competences complementary to those or that are not available within Europe. Such activities will aim at providing a clear win-win situation for all parties involved. Target countries are the USA, Canada and Japan.

Scope: The action should deliver a roadmap for international cooperation that outlines where Europe's strengths are, the competences missing in Europe, and in which of the target regions those can be found. The action should map the corresponding national innovation strategies in the 3rd countries and the available funding schemes and involved funding agencies. The action should give concrete recommendations on international cooperation actions, including how these can be established applying the funding instruments available, and should identify target region in which areas there is a win-win. The analysis and recommendations derived from the roadmap should be based on a clear methodology taking also into account benchmarking activities currently conducted in the Flagship. Close coordination of the action with the existing Flagship Coordination and Support Action is regarded as key for the successful implementation.

The activities should include public consultations with the relevant stakeholders, workshops with the lead persons from science, industry and policymakers and fact-finding missions.

The Commission considers that proposals requesting a contribution from the EU of up to EUR 500.000 and a duration of 36 months would allow this specific challenge to be addressed

appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts or durations.

Expected Impact:

- Increased effectiveness of the European Quantum Flagship by having a focused strategy on international cooperation.
- Increased networking between European and international stakeholders excelling in quantum technologies;
- Increased scientific and technical knowledge
- Improve competitiveness of European industry by opening up international cooperation possibilities and gaining access to future markets.

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

FETFLAG-07-2020: Training and Education on Quantum Technologies

Specific Challenge: Quantum technology (QT) is a rapidly accelerating field of research and development with a strong potential for economic growth. While quantum physics is included in all university curricula as well as school curricula in some European countries, this does not satisfy the needs for quantum awareness, a quantum-ready workforce, and modern quantum education. This topic aims at creating a pan-European agenda for the development of modern quantum technology education serving the necessary key-actors to reach industrial target groups.

Scope: The action should propose a pilot programme that aims to develop a quality-controlled educational master programme for quantum engineering and industrial applications of pan-European reach. It should be developed and launched in close cooperation with the relevant European industry players in order to provide a programme that addresses concrete industry needs in QT. The action should also facilitate companies to host students of the QT master programme for a period of 3 to 6 months. One outcome should be a network of the training programme pilots based on well-documented best practices, tools and reusable training material, and linked with the industrial target group(s). Another outcome should be a concrete set of lessons learned in launching a pan European educational activity in QT inspired by such pilot programme, including a roadmap and concrete recommendations for achieving it.

The scope of the activities of the pilot programme of the action should include at least five EU Member States or countries associated with Horizon 2020, along with a plan to reach the whole of Europe. The consortium should demonstrate a good mix of excellence in education research and in quantum technologies and engineering, with solid links to the emerging QT industry in Europe. It should have a clear strategy on how to stimulate the cooperation

between education stakeholders and the emerging quantum industry in Europe. The action shall further contribute to raising awareness in QT, building on the CSA funded under topic FETFLAG-03-2018.

The Commission considers that proposals requesting a contribution from the EU of up to EUR 300.000 would allow this specific challenge to be addressed appropriately. Nonetheless, this does not preclude submission and selection of proposals requesting other amounts.

Expected Impact:

- Development of a European quantum education community and of a European education research agenda towards modern, quality- controlled education in quantum technologies and engineering
- Establishment of high quality quantum engineering programmes across the union addressing industry needs
- First generation of joint MSc students connected to industry and more broadly preparing a skilled young future workforce in quantum technologies and engineering ready to be employed by the European industry

Type of Action: Coordination and support action

The conditions related to this topic are provided at the end of this call and in the General Annexes.

Conditions for the Call - FET FLAGSHIPS – Tackling grand interdisciplinary science and technology challenges

Opening date(s), deadline(s), indicative budget(s):⁴⁰

Topics (Type of Action)	Budgets (EUR million)		Deadlines
	2018	2020	
Opening: 31 Oct 2017			
FETFLAG-03-2018 (CSA)	2.00		20 Feb 2018
FETFLAG-03-2018 (RIA)	130.00		
FETFLAG-01-2018 (CSA)	6.00		20 Feb 2018 (First Stage)

⁴⁰ The Director-General responsible for the call may decide to open the call up to one month prior to or after the envisaged date(s) of opening.
The Director-General responsible may delay the deadline(s) by up to two months.
All deadlines are at 17.00.00 Brussels local time.
The budget amounts for the 2020 budget are subject to the availability of the appropriations provided for in the draft budget for 2020 after the adoption of the budget 2020 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

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			18 Sep 2018 (Second Stage)
FETFLAG-02-2018 (ERA-NET-Cofund)	10.00		17 Apr 2018
Opening: 09 Jul 2019			
FETFLAG-05-2020 (RIA)		19.70	13 Nov 2019
FETFLAG-06-2020 (CSA)		0.50	
FETFLAG-07-2020 (CSA)		0.30	
Opening: 06 Feb 2020			
FETFLAG-04-2020 (ERA-NET-Cofund)		15.00	07 May 2020
Overall indicative budget	148.00	35.50	

The indicative funding budget for area e. – Fundamental Science – under FETFLAG-03-2018 (RIA) is up to EUR 20 million.

Indicative timetable for evaluation and grant agreement signature:

For single stage procedure:

- Information on the outcome of the evaluation: Maximum 5 months from the final date for submission; and
- Indicative date for the signing of grant agreements: Maximum 8 months from the final date for submission.

For two stage procedure:

- Information on the outcome of the evaluation: Maximum 3 months from the final date for submission for the first stage and maximum 5 months from the final date for submission for the second stage; and
- Indicative date for the signing of grant agreements: Maximum 8 months from the final date for submission of the second stage.

Eligibility and admissibility conditions: The conditions are described in General Annexes B and C of the work programme.

Evaluation criteria, scoring and threshold: The criteria, scoring and threshold are described in General Annex H of the work programme. The following exceptions apply:

FETFLAG-01-2018	For the evaluation of the first-stage proposals, only the criteria ‘excellence’ and ‘impact’ will be evaluated and, within these criteria, only the aspects in bold will be considered.
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Excellence

- **Degree of adherence to the FET Flagship concept as specified in the work programme**
- **Soundness of the proposed Flagship's vision, scientific concept, quality and pertinence of the objectives and of its targeted technologies and progress beyond the state-of-the-art**
- **Existence of excellence and critical mass in Europe to reach the Flagship goals in the long term and extent to which these are considered in the proposed Flagship**

Threshold: 4/5

Impact

Contributions to the impacts listed under this topic in the work programme:

- **Key benefits for economy and society based on significant advances on science and technology. This should be demonstrated by e.g. potential for S&T breakthroughs, industrial support, added value for Europe, potential for increasing European competitiveness, potential for societal benefits, etc.**
- **Long-lasting structuring effect on research efforts in Europe, anchor point for international cooperation and the nurturing of talent through the training of a new generation of researchers.**
- **Extent to which the proposed Flagship creates EU added value by making use of complementarities and exploiting synergies, and enhances the overall outcome of regional, national, European and international research programmes.**
- **Contribution of the proposed CSA to a fully developed candidate FET Flagship initiative supported by key stakeholders (e.g., academic research communities, industry, public authorities ...).**
- **Quality of the proposed CSA approach to disseminate the project results, and to attract large public support**

Threshold: 4/5

	<p>Quality and efficiency of the implementation</p> <ul style="list-style-type: none"> • Quality and effectiveness of the methodology, work plan, and coordination activities of the proposed CSA (including milestones, metrics to monitor progress, and deliverables) • Quality and effectiveness of the approach to engage with relevant research initiatives in the Member States and countries associated with Horizon 2020, industry and interdisciplinary research communities, as well as initiatives at European level • Appropriateness of the proposed CSA management structures and procedures, including risk management • Quality of the Consortium as a whole, including complementarity of the participants and extent to which the consortium as whole brings together the necessary expertise to carry out the tasks foreseen in the CSA • Appropriateness of the allocation of tasks and resources, ensuring that all participants have a valid role and adequate resources in the CSA project to fulfil that role <p>Threshold: 3/5</p>
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Evaluation Procedure: The procedure for setting a priority order for proposals with the same score is given in General Annex H of the work programme. The following exceptions apply:

FETFLAG-01-2018	This evaluation will be done in two stages. The proposal for the first stage is maximum 20 pages (part B, only sections 1 and 2 are required at stage 1) and should address the questions what makes this a FET Flagship, what will be the impact on European economy and society, and what is the European added value, following the instructions in the template provided. Only proposals that pass stage 1 will be invited to submit a full proposal.
FETFLAG-02-2018, FETFLAG-04-2020	Given the specific nature and strategic objective of the ERA-NET Cofund instrument, at most one ERA-NET Cofund action will be funded under this topic.
FETFLAG-03-2018	The following specific page limits apply for proposals addressing area "e. fundamental science". Sections 1 to 3 of the part B of the proposal should consist of a maximum of 15 A4 pages. The limits will be clearly shown in the "proposal

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	<p>templates" in the Participant Portal electronic submission system. Sections that are not subject to limits will be indicated.</p> <p>Grants will be awarded to proposals according to the ranking list and, where applicable, within the indicative funding budget per area. However, in order to ensure a balanced portfolio of supported actions, at least each of the two highest-ranked RIA proposals per area a. to d. will be funded provided that it attains all thresholds. Proposals under area e. will be selected for funding according to their own ranking list. At most one CSA proposal will be funded under this topic.</p>
FETFLAG-05-2020	<p>Grants will be awarded to proposals according to the ranking list. However, in order to ensure a balanced portfolio of supported actions and within the available funding limits, at least each of the highest-ranked RIA proposal per area (a) Hardware and (b) Software will be funded provided that it attains all thresholds.</p>

The full evaluation procedure is described in the relevant [guide](#) published on the Funding & Tenders Portal.

Grant Conditions:

FETFLAG-03-2018, FETFLAG-05-2020	<p>Grants awarded under this topic shall be implemented as a programme through the use of complementary grants and the respective options of Article 2, Article 31.6 and Article 41.4 of the Model Grant Agreement will then be applied. In particular the projects are required to conclude a collaboration agreement, in principle prior to the signature of the grant agreement.</p>
FETFLAG-03-2018, FETFLAG-05-2020	<p>For grants awarded under this topic for Research and Innovation Actions the Commission or Agency may object to a transfer of ownership or the licensing of results to a third party established in a third country not associated to Horizon 2020. The respective option of Article 30.3 of the Model Grant Agreement will be applied.</p>
FETFLAG-03-2018, FETFLAG-05-2020	<p>For grants awarded under this topic beneficiaries may provide support to third parties established in a EU member state or country associated with Horizon 2020 and as described in General Annex K of the Work Programme. The support to third parties can only be provided in the form of grants, within the limitations set out in the call text for this topic. The respective</p>

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	options of Article 15.1 and Article 15.3 of the Model Grant Agreement will be applied.
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Consortium agreement:

FETFLAG-01-2018, FETFLAG-03-2018, FETFLAG-05-2020	Members of consortium are required to conclude a consortium agreement, in principle prior to the signature of the grant agreement.
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Other actions⁴¹

1. External Expertise

This action will support:

1. The use of appointed independent experts for the monitoring of actions (grant agreements, grant decisions, procurements, financial instruments).
2. The use of appointed independent experts to advise on, or support, the design and implementation of EU research and innovation policy or programmes as well as the achievement and functioning of the European Research Area. Specifically, this may include, when needed, an 'expert group' as defined in the SG horizontal rules C(2016)3301 to act as Steering Board for the FET Flagship on Quantum Technologies. The activities carried out by this group will be essential to the development and monitoring of the Union policy on Research, technological development and demonstration. The advice provided by these experts will be on any matter relevant to the optimal achievement of the Quantum Technologies Flagship objectives as set out in this workprogramme under topic FETFLAG-03-2018 - Specific Challenge, and in the related policy and staff working documents. The experts will be highly qualified, specialised, independent experts selected on the basis of objective criteria, following a call for applications published in accordance with Article 10 of Decision C(2016)3301. In view of these requirements, these experts, who will be appointed in a personal capacity, are entitled to a payment of EUR 450 in the form of a daily unit cost for each full working day spent assisting the Commission in terms of article 21 of Decision C(2016)3301. This amount is considered to be proportionate to the specific tasks to be assigned to the experts, including the number of meetings to be attended and possible preparatory work.

Type of Action: Expert Contracts

Indicative timetable: As needed

Indicative budget: EUR 1.00 million from the 2018 budget and EUR 1.50 million from the 2019 budget and EUR 1.50 million from the 2020 budget

2. Graphene FET Flagship core project

The Graphene Framework Partnership Agreement (FPA) consortium will be invited to submit a proposal for a Specific Grant Agreement (SGA) that will implement the next three years (indicative) of the action plan defined in the Graphene FPA.

⁴¹ The budget amounts for the 2020 budget are subject to the availability of the appropriations provided for in the draft budget for 2020 after the adoption of the budget 2020 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

The proposal should adhere to the FPA programme of activities and address key parts of the S&T roadmap, taking into account the Technology & Innovation roadmap and the state of the art. It should focus on those areas that have the greatest innovation potential and impact on Europe's economy and society. The bulk of the research efforts should address technologies at TRL 4-5 or above, and be reflected by an increased industrial participation in the Consortium, as well as by an intensive cooperation with industry players and increased technology transfer activities.

The proposal should describe the coordination and management activities of the Flagship (including research activities with and services provided to an increasing number of partnering projects); the collaboration with other research initiatives or programmes at regional, national, European or international level; and updating S&T and Technology & Innovation roadmaps. The proposal should also detail activities in areas such as education and training, dissemination and science- and citizens-oriented outreach activities, safety, ethics and societal aspects.

Any modification to the FPA Consortium partners should be sufficiently motivated and based on the highest standards of scientific and technological excellence and on open and transparent criteria.

This action allows for the provision of financial support to third parties in line with the conditions set out in General Annex K.

Expected impact: Contribution to the targeted impacts defined in the action plan of the FPA.

Type of Action: Specific Grant Agreement

Indicative timetable: Second quarter of 2019

Indicative budget: EUR 150.00 million from the 2019 budget (SGA-RIA)

3. HBP FET Flagship core project

The Human Brain Project (HBP) Framework Partnership Agreement (FPA) consortium will be invited to submit a proposal for a Specific Grant Agreement (SGA) that will implement the next three years (indicative) of the action plan defined in the HBP FPA.

The proposal should adhere to the FPA programme of activities and ensure that the activities focus on the essential elements for producing impactful results in neuroscience, medicine and computing. It should describe how ongoing HBP activities or other related S&T developments in Europe will be further developed and integrated, while taking into account the state of the art, maintaining a multi-disciplinary approach and involving the relevant scientific communities.

The facilities of the HBP Service Research Infrastructure (SRI) should reach at least TRL 8 ('deployment', as defined in the HBP FPA Action Plan) by the end of this SGA. The proposal should explain how this will be achieved and measured; how it will engage relevant actors from established RI and ICT infrastructures and ensure that a sufficient number of scientists,

RTOs, industry or healthcare users actively validate the SRI functionalities and operation modalities for preparing its wide adoption and use by the R&D communities; and how further innovation by relevant industry and other stakeholders will be nurtured from the HBP techniques and technologies.

The proposal should describe the coordination and management activities of the Flagship including activities, such as: (i) governance, including cooperation with an increasing number of partnering projects; (ii) updating the HBP strategic research roadmap for research, development and innovation in ICT, medicine and neuroscience; (iii) the collaboration with other research initiatives or programmes at regional, national, European or international level; and (iv) the plans and course of action to ensure the sustainability of the HBP SRI and how to start validating it. The proposal should also detail activities in areas such as human capital, education and training, dissemination and attracting large public support, international collaboration, ethics and societal aspects.

Any modification to the FPA Consortium partners should be sufficiently motivated and based on the highest standards of scientific and technological excellence and on open and transparent criteria.

This action allows for the provision of financial support to third parties in line with the conditions set out in General Annex K.

Impact: Contribution to the targeted impacts defined in the action plan of the HBP FPA.

Type of Action: Specific Grant Agreement

Indicative timetable: Second quarter of 2019

Indicative budget: EUR 150.00 million from the 2019 budget (SGA-RIA)

4. FET Conference and Events

The organisation of public conferences and events in the context of FET and, if appropriate, with the support of the European Presidency.

Type of Action: Public Procurement - Service contract

Indicative budget: EUR 0.80 million from the 2018 budget and EUR 0.20 million from the 2020 budget

5. Experimental pilot line for devices based on graphene, related 2d materials and heterostructures

The Graphene Framework Partnership Agreement (FPA) consortium will be invited to submit a proposal for a Specific Grant Agreement (SGA) aiming to establish a dedicated graphene and related materials (GRMs) experimental pilot line.

The target of this experimental pilot line is to have a simple baseline process ready in two years (from start of the project) and the full flow should be ready during the lifetime of the Graphene Flagship. The development and operation of the experimental pilot line will be coordinated closely with the core project of the Flagship.

This action must build the tool kit and design manual necessary for creating prototype devices and integrated circuits, and assess their performance and their ability to cover the device requirements of the targeted applications. The action should be capable of multiple wafer runs per year.

The action will require expertise in the area of manufacturing flows, with two-dimensional materials and with issues regarding reliability, versatility, process control and minimizing lead times. Where necessary such expertise should be brought into the consortium.

The aim is to establish a first of its kind GRMs experimental manufacturing facility, where European companies, research centres and academic institutions, also those outside the Flagship, can produce novel devices on a pilot scale based on a shared cost model between users and service providers. This pilot line would be used for all-on-chip applications in areas such as opto-electronics, sensors, and data communication, and should be able to cover the device requirements of most of these applications. It should be built on existing activities under the Flagship FPA, and approaches pursued in the pilot line should be complementary to those developed in other parts of the Flagship. Indicators should be provided to put in place an effective monitoring of the action in the context of the Flagship. The proposal should describe a sustainable model of functioning beyond the project lifetime and include activities during the lifetime of the project that would pave the ground for transferring the pilot to an industrial production environment; examples include addressing issues such as roadblocks to overcome for achieving a full industrial line, relevant cost issues and market perspectives, potential business partners; etc.

Expected Impact:

- Enabling system prototype demonstration on an operational environment (moving to an 80% yield after three years), speeding up significantly the adoption of the technology, in particular by the semiconductor industry;
- Supporting start-ups and spin-offs by enabling prototyping, pilot studies and small-volume production of integrated systems;
- Creating a shared process production platform, manufacturing flow and process design kit, creating synergy across European research efforts and fostering knowledge accumulation, IPR creation and collaboration;
- Catalysing the expertise existing in Europe regarding growing, transferring and encapsulation;
- A greater diversity of sectors able to take advantage, reflected in the users of the experimental pilot line.

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Type of Action: Specific Grant Agreement

Indicative timetable: Q1 2020

Indicative budget: EUR 20.00 million from the 2020 budget (SGA-RIA)

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Budget⁴²

	Budget line(s)	2018 Budget (EUR million)	2019 Budget (EUR million)	2020 Budget (EUR million)
Calls				
H2020-FETOPEN-2018-2020		185.70	166.00	357.20
	<i>from 09.040101</i>	<i>185.70</i>	<i>166.00</i>	<i>357.20</i>
H2020-FETPROACT-2018-2020		94.50	0.50	89.00
	<i>from 09.040101</i>	<i>94.50</i>	<i>0.50</i>	<i>89.00</i>
H2020-FETHPC-2018-2020		4.00		0.50
	<i>from 09.040101</i>	<i>4.00</i>		<i>0.50</i>
H2020-FETFLAG-2018-2020		148.00		35.50
	<i>from 09.040101</i>	<i>148.00</i>		<i>35.50</i>
Contribution from this part to call H2020-LC-BAT-2019-2020 under Part 20 of the work programme				42.00
	<i>from 09.040101</i>			<i>42.00</i>
Contribution from this part to call H2020-FETPROACT-2019-2020 under Part 17 of the work programme			113.40	
	<i>from 08.020102</i>		<i>113.40</i>	
Other actions				
Expert Contracts		1.00	1.50	1.50
	<i>from</i>	<i>1.00</i>	<i>1.50</i>	<i>1.50</i>

⁴² The budget figures given in this table are rounded to two decimal places. The budget amounts for the 2020 budget are subject to the availability of the appropriations provided for in the draft budget for 2020 after the adoption of the budget 2020 by the budgetary authority or, if the budget is not adopted, as provided for in the system of provisional twelfths.

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	<i>09.040101</i>			
Specific Grant Agreement			300.00	20.00
	<i>from 09.040101</i>		<i>300.00</i>	<i>20.00</i>
Public Procurement		0.80		0.20
	<i>from 09.040101</i>	<i>0.80</i>		<i>0.20</i>
Contribution from this part to Grant to Identified beneficiary under Part 17 of the work programme				0.25
	<i>from 09.040101</i>			<i>0.25</i>
Estimated total budget		434.00	581.40	546.15