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COMMISSION STAFF WORKING DOCUMENT

EX-ANTE EVALUATION

Accompanying the document

Proposal for a Council Decision

amending Decision 2007/198/Euratom establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it

{COM(2018) 445 final} - {SWD(2018) 326 final}

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Glossary

<i>Term or acronym</i>	<i>Meaning or definition</i>
BA	Broader Approach
DA	Domestic Agency
DEMO	Demonstration reactor
DG	Director General
ESA	European Space Agency
EU	European Union
F4E	Joint Undertaking “Fusion for Energy”
GB	Governing Board
GNI	Gross National Income
GVA	Gross Value Added
IC	ITER Council
IFMIF/DONES	International Fusion Materials Irradiation Facility - DEMO Oriented Neutron Source
ICRG	ITER Council Review Group
IO	ITER Organization
JU	Joint Undertaking
KPI	Key performance indicator
MFF	Multiannual financial framework
R&D	Research and Development
SMEs	Small and medium enterprises
TFEU	Treaty on the Functioning of the European Union

1. PROBLEM ANALYSIS AND NEEDS ASSESSMENT

This staff working document has been drafted to satisfy the requirements of the Financial Regulation with respect to ex ante evaluation of proposals for activities requiring budget expenditure and concerns the future funding of Europe's participation in the ITER project and the associated activities ensured by F4E (notably Broader Approach (BA) activities and preparation of DEMO) under the post-2020 Multi-Annual Financial Framework (MFF).

This ex ante evaluation aims to support the activities dictated by the new ITER project's baseline and the need to complete the construction of ITER following the project's recent turnaround.

1.1. Scope and context of ITER

1.1.1. Context

ITER is an international scientific collaboration project between seven global partners (ITER Parties - EU, United States, Russia, Japan, China, South Korea, and India). The project, implemented on the basis of the ITER Agreement¹ aims at demonstrating the scientific and technological feasibility of fusion energy for peaceful purposes, an essential feature of which would be achieving sustained fusion power generation (Article 2 of the ITER Agreement). No single country has the capacity to develop a project the size of ITER, whose scale is necessary for the expected breakthrough on the way to mastering fusion as an energy source².

Whilst the level of ambition and effort required to build ITER calls for wide international cooperation, Europe is in the driving seat as the host of this project and its biggest contributor. Under the ITER Agreement, the stake of the other six international partners in ITER construction is around 9% each, and Europe bears the remaining 45% of the construction costs. After the construction of ITER, Europe will cover 34% of the cost of operation, deactivation and decommissioning of ITER.

In this context, neither ITER nor the European participation therein can be fully regarded as a programme in the usual sense of Commission programmes. European activities in ITER represent a contribution to an internationally agreed collaborative effort to which Europe has committed itself (through the ITER Agreement) for at least 35 years starting in 2007, i.e. across multiple MFF periods. This is a fundamental difference relative to normal EU programmes, which are usually established for a single MFF (even if repeatedly) and for which a decision on the scope of the action, its launch and its duration are within the EU's sole discretion.

While the legal commitments under the ITER Agreement bind the EU, the participation in ITER should not be seen as a mere obligation but also as a unique opportunity for the EU to benefit - both from ITER's future results and from the present business opportunities it creates for European suppliers. These, in turn, entail not only the usual impacts in terms of job creation and direct economic stimulus but also deliver important spin-off effects and synergies.

¹ ITER Agreement, 25th April 2007

² Fusion is projected to play an important role in Europe's future energy landscape as a climate friendly energy source, since it does not produce greenhouse gases and the fuel used is widely available. The investment in ITER aims to support enabling practical exploitation of fusion as an energy source in the future and thus contributes to the significant energy transformation in Europe set out in the Energy Union strategy.

The contribution of each ITER Member is provided both in cash, through contributions to the budget of the ITER Organization (IO) for its functioning, and (mostly – ca. 90%) in kind through the delivery of components of the ITER machine and facility. The ITER Agreement foresees that each Member shall provide its contribution to the ITER Organization through a Domestic Agency (DA).

For Europe, the Domestic Agency is the Joint Undertaking "Fusion for Energy" (F4E) that was set up by a Council Decision (Council Decision 2007/198/Euratom³ – also referred to as F4E's Statutes) on 27 March 2007 for a period of 35 years and has its headquarters in Barcelona, Spain. F4E discharges the obligations of EU to the ITER Organization, both in-cash and in-kind. Furthermore, F4E coordinates EU participation in collaborative fusion activities with Japan under the Broader Approach⁴ and carries out preparations for DEMO.

The European Commission (DG ENER) represents EU in the governance structures of the ITER Organization (ITER Council and subsidiary bodies) and in the governance of F4E⁵ (F4E Governing Board and subsidiary bodies).

The budget of F4E is composed of contributions from the EU budget, France as Host State, and from the Members of Fusion for Energy. The European contribution to ITER's construction (provided through Fusion for Energy's budget) is funded 80% by the EU budget and 20% by France. In addition, the EU budget provides the contribution to F4E for its running cost and the other operational activities (Broader Approach⁶ and DEMO). The overall budget of Fusion for Energy also benefits from an additional less than 1% paid directly by the F4E Members.

The 20% French contribution for the *construction* costs of ITER was established by an exchange of letters between France and the Commission in 2006 and reflected in the terms under which F4E was set up by the Council Decision in 2007 (the financial statement accompanying the Commission proposal for the Council Decision). As stated in the Commission Communication of June 2017 on "the EU Contribution to a reformed ITER Project", the continuation of France's contribution to the operation costs is assumed also for the *operation* phase when Europe's share in ITER costs shifts from the current 45% to 34%.

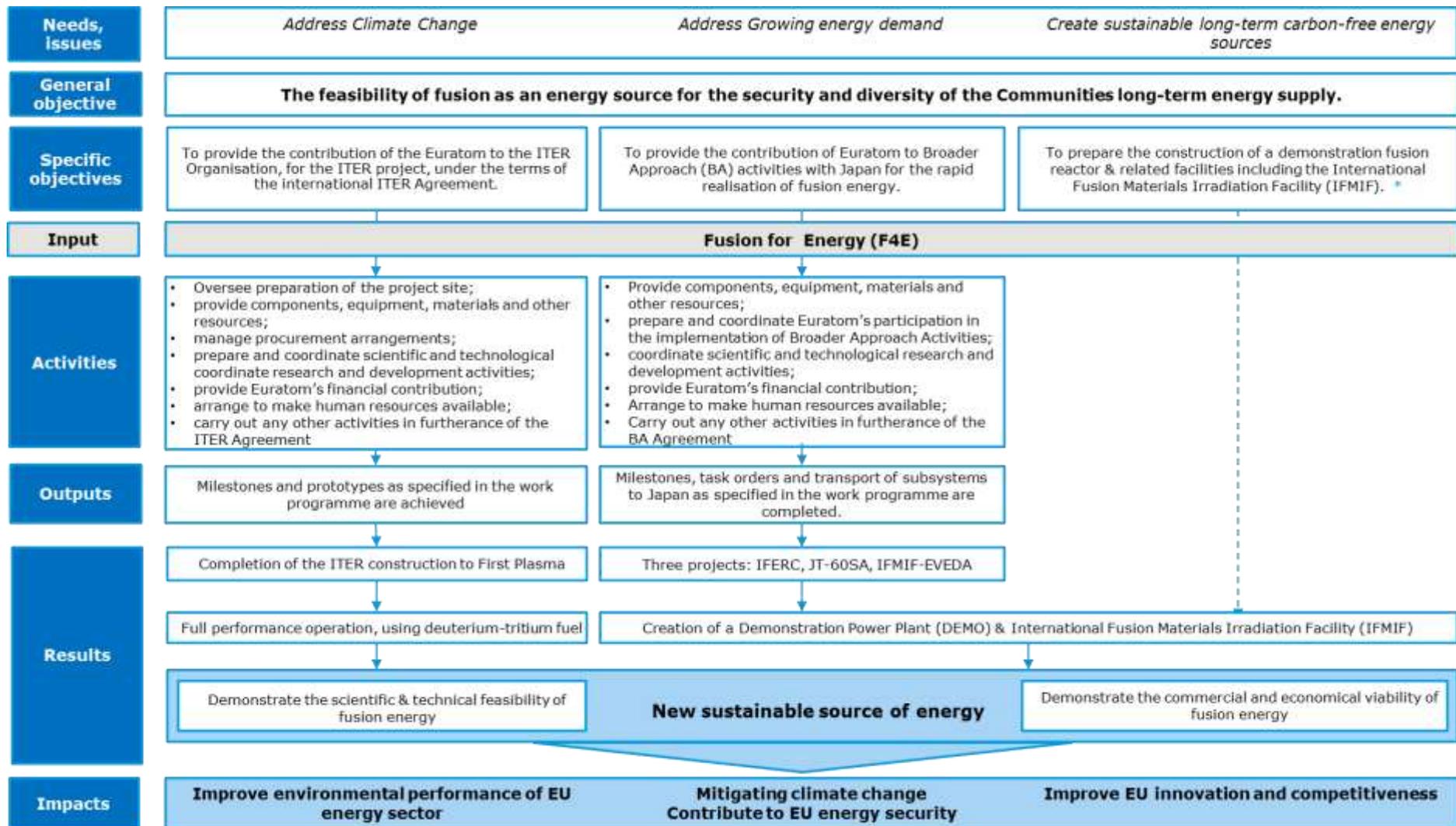
The intervention logic of the European contribution to ITER is presented in the following diagram.

³ Amended by: Council Decision 2013/791/Euratom of 13 December 2013 and Council Decision (Euratom) 2015/224 of 10 February 2015.

⁴ In order to secure the siting of the ITER project in Europe, the EU concluded a bilateral agreement with Japan – the Broader Approach Agreement (BA) - on collaboration in specific corollary fusion projects and experiments located in Japan. As result, three projects are currently under development in Japan, with European participation coordinated by Fusion for Energy and provided by several EU Member States as Voluntary Contributors: the construction of a satellite tokamak facility (JT60SA), the engineering design of a future material irradiation facility (IFMIF-EVEDA), and a supercomputer for modelling plasma behaviour (IFERC).

⁵ F4E's Governing Board (GB) comprises the 28 EU Member States and Switzerland, in addition to the Commission. The Commission's vote in the F4E GB, has the same weight as that of France, Germany, Italy and the UK - 5 votes of a total of 72, whilst it has no veto right. The Commission has the right to make a reservation to a decision by the GB when it considers that the decision may be contrary to EU law ("reservation on legality")

⁶ According to the Broader Approach (BA) agreement, EU and Japan would each make contributions of EUR 339 million to joint BA activities. The European contribution is mainly provided as in-kind contributions by several Members of F4E acting as Voluntary Contributors (Belgium, France, Germany, Italy, and Spain). In addition, F4E contributes to BA activities and ensures the coordination of European participation, with costs of approximately EUR 60 million covered from the funding provided to F4E by Community budget.

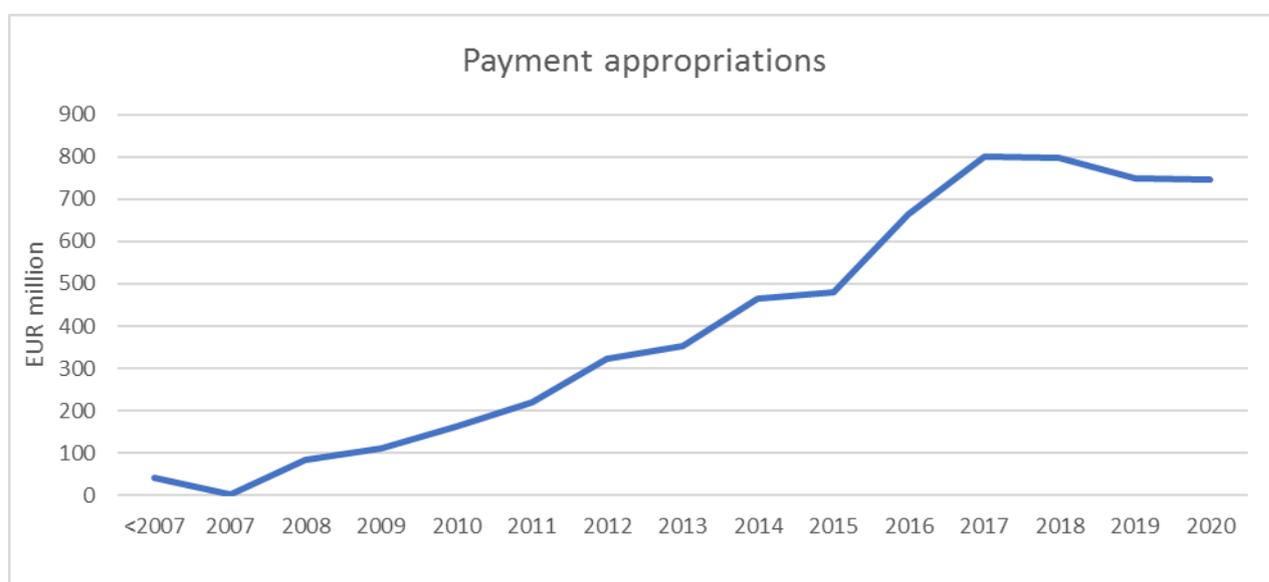


1.1.2. Scope and developments under the current and previous MFFs

The Commission Communication "The EU Contribution to a Reformed ITER Project" and its accompanying Staff Working Document⁷ present in detail the problems faced by ITER at its initial phase, the need for a new baseline in 2010 and the capping by the Council of the budget up to 2020 at EUR 6.6 billion (2008 value). They also present the actions taken in 2015 and 2016 to turnaround the project including changes in the management of both the ITER organization and F4E, and the update in 2016 of the project baseline. The Commission was largely the initiator and agent of these efforts.

In the current MFF, the EU contribution to F4E is funded through its own budget lines under the heading 1a "Smart and inclusive growth" and the total funding for the 2014-2020 period was set at EUR 2.9 billion (in current value)⁸.

The annual evolution of payment appropriations till the end of the current MFF is presented in the diagram below (EUR million in current value). As is demonstrated in the graph, in recent years, the payments have accelerated substantially. The evolution of commitments in the current MFF is also very positive, within the cap of EUR 6.6 billion till 2020 which will be respected.



While the project has undergone a major restructuring, important progress has been achieved:

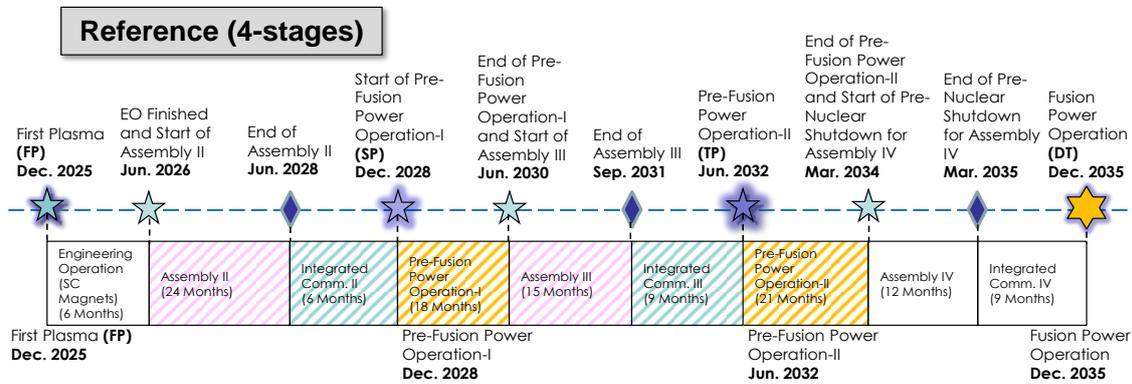
- **All milestones** set up by the ITER Council in 2016 to monitor the project construction under the new baseline and due by December 2017 **have been achieved**.
- The project is as of end-2017 **half-way to First Plasma**: the project reached the completion of 50 percent of the total physical work (design, manufacturing construction, assembly, and installation) for First Plasma.
- A positive project management trend has been recognised by independent experts.

⁷ COM(2017)319 final and SWD(2017)232 final

⁸ As defined in Council Decision of 13th December 2013 amending Decision 2007/198/Euratom establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it (2013/791/Euratom)

- The results of the first in-depth reviews of critical project areas (risk management and interfaces of components) have given confidence that the project is on the right track.

The new schedule currently follows a *staged approach* which focuses first on the construction of the components which are essential to achieving First Plasma, followed by successive series of installation and testing phases before starting full performance. The impact of the staged approach is presented in the diagram below.



1.1.3. Scope of ITER under the next MFF

The execution of the new baseline and its impact on F4E and the European participation in the project are presented in the Commission Communication "The EU Contribution to a Reformed ITER Project" and its accompanying Staff Working Document.

If adequate funds are not ensured so as to allow the EU's participation in the project in accordance with its commitments, the EU will be in breach of its international obligations undertaken by the signature of the ITER Agreement. Furthermore, not providing adequate funding for EU participation would increase the risk of further delays and associated cost increases. This entails further risks of losing international partners in a major project where Europe has the lead and stands to gain from hosting its operations, while it cannot - under the terms of the ITER Agreement - itself step out of the project, and would thus have to absorb the consequences of other Parties departing and/or not contributing.

The role of fusion and the role of ITER in its development are well recognized from a scientific point of view, by both the European and the global scientific community and are recognized, from a political perspective, by the European decision-makers. Besides the lead in the ITER project, European efforts in developing fusion technologies also entail support of research and development activities under the Euratom research and training programme. The funding for fusion research and ITER are **complementary** to each other but separate in terms of objectives, implementation and governance. They both jointly contribute to the long-term objective of developing fusion as an energy source in accordance with the **European Fusion Roadmap**⁹.

⁹ <https://www.euro-fusion.org/eurofusion/roadmap/>

Continued participation in the ITER project is in line with the Commission's **vision for the next MFF (2021-2027)**, highlighting a growing call to support the **shift to a low-carbon economy**.

In the **follow-up to the publication of the Commission Communication**, the inter-institutional discussions with the Council of Ministers and the European Parliament on the new ITER baseline reveal that the Council and the European Parliament see the revision of the baseline together with the management changes as significant ways to ensure the necessary turnaround of the project's past pace. The Council of the EU and the European Parliament recognize that the new ITER baseline is a solid basis for further EU engagement in ITER.

On 12 April, the **Council of the European Union** mandated the Commission to approve the new ITER baseline on behalf of Euratom at an ITER Council meeting at Ministerial level. Europe's political support to the new baseline will provide needed stability and reassurance to the project and the companies and research centres involved, allowing current contracts to be completed and necessary new ones to be launched. It will also allow for continued participation of the EU in ITER and the continuation of cooperation with ITER Members and their domestic agencies under the terms of the ITER Agreement.

The **European Parliament (EP)** decides on the **discharge** to F4E for every financial year. The latest discharge decision¹⁰ by the EP was granted in April 2018 for the financial year 2016. With this decision, the EP reconfirmed its support to the ITER project and recognised the significant improvements and efforts undertaken by F4E in collaboration with the European Commission, the ITER IO and the other ITER domestic agencies. With this positive discharge decision and associated resolution, the EP reconfirms its support and renewed confidence in the ITER project and F4E.

The Parliament's Budgetary Committee has in its own-initiative report on the next MFF included ITER amongst expenditures, which the EU budget should continue to fund.

1.2. Lessons learned from evaluations of previous programmes

1.2.1. Key findings and lessons learned from evaluations

Both the ITER Organization and F4E were recently subject to various evaluations either assessing operational capacity/performance in general (e.g. ITER Organization bi-annual management assessments and F4E annual assessments) or targeting specific key topics (e.g. risk management review, freezing of interfaces review). Detailed information on these evaluations is provided in Annex 1. The lessons learned from these reviews/evaluations can be summarized as follows:

- The technical complexity of a unique project where many components are first-of-a-kind have led, in its initial stages, to a significant underestimation of the time needed for the completion of the construction and of the associated cost for both the ITER Organization and the Domestic Agency responsible for ensuring the procurement and delivery of the in-kind contributions.

¹⁰ European Parliament decision of 18 April 2018 on discharge in respect of the implementation of the budget of the European Joint Undertaking for ITER and the Development of Fusion Energy for the financial year 2016 (2017/2180(DEC))

- Procurement decisions were in earlier stages taken forward despite immature and incomplete design which precluded a sufficiently robust procurement and construction process, leading to frequent modifications of contracts or their amendments during execution; this led to further cost increases and delays.
- Significant changes and improvements have taken place both in the ITER Organization and in Fusion for Energy since 2015, accomplishing a very profound turnaround in both organizations. They addressed inter alia the process organization and project management in both IO and F4E, which had until 2015 shown important weaknesses, in particular low project management focus on cost and schedule and limited industrial expertise.
- Changes by ITER Parties and particularly Europe have since 2015 brought changes to the governance structures and processes which at the earlier stages of the project did not provide for effective oversight of the ITER Organization and Fusion for Energy nor appropriate coordination and collaboration between the Domestic Agencies and the ITER Organization.
- The changes in the management and governance of the project have been reflected in the new baseline of the project elaborated in 2015 and approved by the ITER Council ad referendum in 2016, following reviews by independent experts.
- To ensure schedule reliability, a reasonable contingency should be considered. As stated in the Commission Communication on ITER, in line with existing experience with large international projects of similar complexity and maturity, the Commission estimates that a contingency of up to 24 months in terms of schedule and 10-20% in terms of budget appears appropriate.

1.2.2. New ITER baseline – key strengths

A positive appreciation of ITER's progress in the last three years and of its turnaround by the new management have been confirmed by the ITER Council Review Group and by the 2015 and 2017 Management Assessments of the ITER Organization, as well as by the US Department of Energy report on "US participation in the ITER project".

A high-level assessment confirmed the capacity of F4E to deliver the European contribution to the new ITER schedule on time and coherent with the staged approach. The positive progress made in the management of the project, as expressed also in several independent reviews, provides confidence that the ITER Organization and F4E (and also the other Domestic Agencies) are working together towards the success of the project and are better armed to manage any future project challenges.

Compared to the previous period of the project, the new baseline's credibility and realism is driven by the following elements:

- **“Staged approach”** to the project construction, reflected in the new schedule which aims to achieve First Plasma in December 2025 (earliest technically achievable date), followed by successive series of installation and testing phases before starting the full performance phase (Deuterium-Tritium operations) in 2035.
- **High design maturity/stability**, with most procurement arrangements decided and contracted and designs of components and the definition of their interfaces progressively completed and frozen.

- New management in IO and in F4E, with industrial expertise from implementing large project and with experience in nuclear safety matters and construction and operation of fusion installations.
- Closer integration of IO and Domestic Agencies, with Integrated Project Teams (IPTs) for items on the critical path, and a schedule formulated through iterations between the IO and DAs.
- A realistic schedule respecting the budgetary and technical limitations of the Parties and their Domestic Agencies.
- Creation of a Reserve Fund which introduces a tool to compensate ITER Members for cost overruns due to design changes and creates an incentive for the ITER Organization to minimize changes as much as possible. This is because it has to reimburse the DAs whenever changes are triggered by IO; the Reserve Fund therefore acts as a risk mitigation tool.

As confirmed at the ITER Council meetings since the elaboration of the new baseline in early 2016, works at the ITER site are now progressing well within the baseline and the project remains on schedule for First Plasma as per the new baseline schedule. Equally, the meetings of the Governing Boards of F4E in 2016 and 2017 have received regular reports from F4E senior management showing the compliance with the EUR 6.6 bn cap for 2020 as well as F4E's cost and schedule projections prepared in mid-2016 on the basis of the new ITER baseline.

1.3. Motivation and interests of the key actors

While the project did not progress from the start of the current MFF in accordance with the 2010 baseline and has increasingly accumulated delays and cost overruns, it has been nevertheless producing benefits for European industry and economy as evidenced in evaluations, data on F4E activities and stakeholder consultations. Furthermore, ITER offers European industries a valuable opportunity to innovate and develop products for exploitation in areas outside fusion.

This has also been recognized in recent evaluations and stakeholder feedback. Stakeholders have been consulted in multiple ways, ensuring the collection of a representative set of information regarding ITER project implementation and impacts.

The MFF open public consultation is accompanied by a number of targeted stakeholders' consultation activities.

In the context of the recent "Value for Money" study around 80 contractors across sectors and geographies highlighted the important benefits brought to the European industry and research community. The expectations of the industry are in line with those of the research community and national administrations as discussed in the Governing Board of F4E and the General Assembly of Eurofusion.

In addition, an industry event was organised by the European Commission in December 2017 providing an opportunity to collect feedback from senior company executives, policy makers, and energy experts from Europe and the rest of the world.

The various consultation activities are presented in more detail in Annexes 2 and 2a.

2. EU ADDED VALUE

2.1. EU added value

The initiative falls under the exclusive competence of the EU according to Article 101 of the Euratom Treaty. Therefore, the subsidiarity principle does not apply.

ITER is a unique, first-of-a-kind, long-term project which greatly contributes to the long-term EU strategy for clean energy, security of supply and competitiveness. As such, it cannot be executed through industry initiative at this stage of the technology development and public intervention is warranted. This investment offers European high-tech industries and small and medium enterprises (SMEs) a valuable opportunity to innovate and develop “spin off” products for exploitation outside fusion (such as the broader energy sector, aviation, medical, and hi-tech instruments).

As ITER's legal basis is an international agreement to which Euratom is a Party, action at EU level is more effective (less fragmentation) and efficient (better value for money/economies of scale), and offers coordination of actions (e.g. in addressing externalities) for meeting EU obligations. Pooling of resources and expertise is paramount to the construction of ITER and EU action is particularly needed to achieve the critical mass of resources and knowledge across different fields, technologies, and research infrastructures and industries required for the construction of this first-of-a-kind project. This has also been recognized explicitly in the “Reflection Paper on the Future of EU Finances” of June 2017, which puts forward clear value added when action at European level goes further than national efforts could –this includes *“big projects and key enabling technologies, such as [...] ITER (which) can only be financed by pooling resources at EU level because of their very high financing needs”*.

Accordingly, action at EU level delivers results that uncoordinated national spending could not achieve in terms of a number of strategic priorities: i.) security of supply; ii.) opportunities for long-term growth and development of European science, technology and industry, and structuring of the EU R&D fabric; iii.) improvements in quality and innovation through exposure to EU-wide and global competition, and iv.) mobilizing the EU potential/negotiating power at global level.

Continued EU added value: the EU is the Host Party of the ITER project, which entails specific responsibilities; in particular, pursuant to Article 26.1 of the ITER Agreement, the Host Party cannot withdraw from the project¹¹.

2.2. Coherence and synergies with other policy areas

The ITER project ensures synergies with the following policy areas: i.) research; ii.) industrial policy; iii.) climate change; and iv.) the EU as a global player.

ITER is part of the overall Fusion Roadmap developed by the European scientific fusion community and is aligned with the research efforts in developing fusion technologies

¹¹ An ITER Member other than EU can withdraw after 10 years from the entry into force of the Agreement, but with the obligation to continue providing its contribution for the construction phase and with no possibility of participating in the experimental phase.

funded under the Euratom Research and Training Programme 2014-2018¹². Participation in ITER is thus fully complementary and coordinated with these activities.

The successful construction and operation of ITER is on the critical path of the European fusion roadmap, which represents a comprehensive goal-oriented path to fusion electricity endorsed by all fusion research stakeholders in Europe. The new baseline contains a realistic schedule to achieve the goal of ITER and is essential input to the roadmap.

ITER is complemented by activities carried out together with Japan under the Broader Approach Agreement and the Test Blanket Module programme, as well as the International Fusion Materials Irradiation Facility (IFMIF/DONES). ITER will be followed by a demonstration reactor (provisionally called DEMO), which will build on the experimental achievements of ITER with the aim to demonstrate the economic feasibility of commercial exploitation of fusion power.

Furthermore, ITER offers European high-tech companies a unique opportunity to innovate and develop “spin off” products.

3. POLICY AND MANAGEMENT OBJECTIVES

3.1. Challenges of the programme in the next MFF

3.1.1. Key challenges

While the actual cumulative EU spending by 2020 will be close to the 6.6 billion limit established in 2010 for the construction period, the construction will not be finalized by then. Stemming from the findings and lessons learned from the evaluation activities detailed in section 1.2 above, the challenge will be to make the new baseline deliver its full potential and fund it accordingly, as a radical overhaul of the project has been successfully implemented to prevent future deviations from project planning, and as the EU, as Host Party of the ITER project, cannot withdraw from the project.

Accordingly, the **key challenges for the next MFF** will therefore be to:

- i.) Sustain the positive momentum in the project's performance and management achieved through recent improvements in management, governance and supervision/monitoring;
- ii.) Ensure finalisation of the construction and assembly¹³ enabling the achievement of First Plasma in December 2025 (the earliest technically achievable date) and subsequent complementary construction and advancement of the post-First Plasma components; and
- iii.) Retain the commitment of all ITER Parties to meeting in full their obligations thus enabling the timely and cost-efficient completion of the project.

Meeting these challenges will require sustained EU leadership in the project which needs to be underpinned by excellent performance of F4E and full compliance of the EU with

¹² Proposal for the Euratom Research and Training Programme 2019-2020 is under discussion in the Council (see COM(2017)698)

¹³ The maturity of the design gives increased reliability to the new schedule and associated resources estimates: the final design for components needed for First Plasma has reached 89%, while that for non-First Plasma components stands at 71%.

its share of funding obligations and in-kind contributions (i.e. components under European responsibility, procured and delivered by F4E).

3.1.2. New political priorities or emerging problems needing EU intervention.

Brexit does not change the overall legal commitment of the EU to ITER, which is governed by the international ITER Agreement to which the EU - and not individual EU Member States, is the contracting party. Brexit will not change the EU's financial obligations towards ITER which have been undertaken by the EU as a whole, by the conclusion of the ITER Agreement.

It should be underlined that the UK took commitments, as EU Member State, towards ITER when approving the different project baselines in the Council of the EU. It should also be noted that the UK has expressed its interest in continued involvement in ITER activities.

3.2. Objectives of the programme in the next MFF

In accordance with the key challenges for the next MFF as identified in section 3.1.1, the **general objective** of the ITER-related EU action in the next MFF is to fully support the continuation of ITER construction and to reach the operation of ITER with First Plasma by 2025, to be followed by first experimental operations as well as further installations and upgrades until 2027 and beyond, laying grounds for successful full power operation (so called Deuterium-Tritium stage) by 2035.

These achievements are considered as a necessary step in the development of fusion in order for it to become a possible source of sustainable energy fostering the job, growth and innovation potential of the energy sector in the later part of the century, in accordance with the European Fusion Roadmap.

To achieve this general objective, five **specific objectives for the next MFF** will be as follows:

- i.) provide sufficient performance-based funding to IO for its operations, particularly the assembly of the installation from the components arriving from individual ITER members;
- ii.) ensure delivery of EU components by F4E in line with the project schedule, in particular its construction and assembly strategies, and in close adherence with performance monitoring;
- iii.) offer European high-tech industries and SMEs a valuable opportunity to innovate and develop “spin off” products for exploitation outside fusion, thereby further reinforcing the EU added value of the ITER project activities;
- iv.) secure continued EU leadership in the ITER project by ensuring timely delivery of EU components and active participation in ITER governance processes; and
- v) continue activities with Japan (BA) on the operation of the satellite tokamak JT60SA and on the development of a full scale material testing facility (IFMIF/DONES) to ensure that together with ITER's results, all technical and scientific elements needed for the design of a fusion-based power generation device for demonstration are in place, thereby anchoring the synergetic contribution of ITER to the coherence of fusion development and fostering the common benefits of fusion research under the Fusion Roadmap.

In achieving the above-mentioned objectives care will be taken to consider any possible simplification potential and make use of all available flexibility.

Simplification efforts: An action plan was adopted in 2015, implementing a re-organisation of the ITER Organization, closer cooperation with the domestic agencies, freezing of designs, the establishment of a Reserve Fund, and a new reliable schedule and cost estimates leading to a new baseline. As a result, there is now more attention given to critical in-kind deliverables. This is particularly important for the European in-kind contribution, which represents 45% of the total and has important components on the critical path to First Plasma.

Flexibility: The Commission has been making maximum use of the available flexibility under the terms of the ITER Agreement and within the governance structures of the ITER Organization to affect important changes in the project's management and governance. However, flexibility is limited, as EU is bound by the ITER Agreement and must ensure its contribution to the project is under the collectively agreed baseline.

4. POLICY OPTIONS, INCLUDING ASSOCIATED RISKS

4.1. Options for delivery mechanisms

Based on experience, the following options for delivery mechanisms in the next MFF are conceivable:

Option 1 - Business as usual - dedicated budget line in MFF

The financing of EU participation in ITER project and BA activities within the MFF is ensured through a dedicated budget line - as in the current MFF. This approach would allow some flexibility in terms of the period covered under the next MFF as it could ensure the financing of ITER and ITER-related activities for up to seven years, under the timeframe of the next MFF. It would thus avoid for example the limitation of five years foreseen in Article 7 of the Euratom Treaty for the Research and Training Programmes.

The current status also allows putting in place a mechanism to ensure that the large-scale projects which may suffer from delays and cost overruns do not affect the support of other European policies by ring-fencing the budget for the project and giving clear visibility to it.

It is important to underline that the purpose of the overall European contribution to the project is to finance the current construction phase of ITER in a simple and efficient manner, preparing the grounds for its future operation/exploitation in a subsequent phase. Therefore, keeping the same approach as in the past allows the management of the ITER budget in an appropriate manner through the European domestic agency (Fusion for Energy) set up to implement the European contribution to ITER, avoiding specific implementing provisions in terms of participation, rules, planning, evaluation that are redundant to those applied by the European Domestic Agency.

Option 2 - In a wider programme within MFF

The financing of EU participation in ITER and BA within the MFF is ensured through the Euratom research and training programme or a specific research programme like Horizon 2020. This was the approach adopted in the previous MFF where ITER was financed within a wider programme, together with other research activities.

This financing modality required compliance with a series of requirements in terms of participation, rules, planning, monitoring and evaluation which are specific to EU programmes (in particular the fusion research programme linked to ITER) and overall were not adapted to the specificities of the ITER construction. These requirements were redundant given the competencies and role assigned to Fusion for Energy in its Statutes.

However, it is important to underline that this approach ensured improved synergies between the fusion energy research activities under the Euratom programme and the ITER activities, which are all key elements of the Fusion Roadmap towards the development of fusion energy.

Option 3 - Intergovernmental

The financing of participation in ITER and BA outside the MFF is provided through a dedicated intergovernmental arrangement involving the pooling of contributions from some or all of the EU Member States.

In 2011, in its Communication for the current MFF (“A Budget for Europe 2020”), the Commission proposed to fund ITER outside the MFF. For this reason in December 2011, the Commission adopted a proposal for a Supplementary Research Programme under the Euratom Treaty for the period 2014-2018 to cover ITER funding outside the MFF.

This programme was meant to be funded by the contributions from EU Member States and Associated States to the EU budget, on the basis of the call rate applied to their Gross National Income (GNI) for the contribution to the General Budget of the EU. However, this approach was not accepted by the European Council which in February 2013 decided to reintegrate ITER within the MFF for the period 2014-2020 in line also with the European Parliament request.

Option 4 – Public-Private Partnership (PPP)

The financing of participation in ITER and BA is arranged through a form of public private partnership with its own legal entity and funding, with contributions from Member States, the private sector, and the EU.

A public-private partnership (PPP) is a contractual agreement between a public authority and a private entity. This agreement ensures that the skills and assets of both public and private stakeholders are combined effectively to deliver a utility/service for general public use. PPPs are actually a mechanism for public authorities to procure and implement public infrastructure and services by utilising private sector’s resources and expertise and are usually created to deliver a project or a service traditionally provided by the public sector. A PPP is an appropriate financing scheme to reduce significant up-front funding requirements, and they range from fully-public responsibility to fully-private responsibility, depending on the project. The following figure shows the different options for PPP agreements.

The spectrum of PPP agreements¹⁴



In any of these schemes, value for money is only achieved by exploiting the private sector's competencies and allocating responsibilities and risks between the public and private collaborators.

Although ITER has already had a positive impact on industry, innovation, growth and employment, the project is in an early stage of development, dependant on public funds at a global scale. This is because it is not in a demonstration or pre-commercial phase; yet not attractive enough to private investors that would like to obtain a fast return out of their investment. In addition, in terms of legal structure, the legal provisions should be further analysed to ensure that the PPP, which is broadly used under the TFEU, could also be used for fusion activities.

4.2. The preferred approach, including risk identification and mitigation

In accordance with the general objective of ITER-related EU action in the next MFF to fully support the continuation of ITER construction and to reach the operation of ITER with First Plasma by 2025, funding through a dedicated budget line remains the preferred funding mechanism in the next MFF. This delivery mechanism would imply a clear recognition of the importance of ITER as a large-scale research infrastructure, while ensuring the best synergies with the research fusion activities under the Euratom research programme in the next EU budget. This essential link would ensure the coherence of the whole EU effort for the development of fusion as a source of energy and it would also allow ITER to benefit from certain administrative provisions available only to research-family programmes.

A self-standing budget line within the MFF would furthermore contribute to enhanced visibility, transparency and accountability, subjugating the management of the allocated funds to strict internal discipline and to public scrutiny while appropriately ring-fencing the budget, in line with the objective of simplification.

In fact, the inclusion of the ITER financing in a wider programme within MFF could hamper the overall objective of the European contribution to the project and the financing of the current construction phase of ITER in a simple and efficient manner through the European Domestic Agency.

However, funding through a dedicated budget is also linked to a number of risks. In terms of the organisational side, the MFF offers less flexible conditions that do not allow

¹⁴ <https://ppp.worldbank.org/public-private-partnership/agreements>

an adequate amount of contingency planning. As a consequence, on a project as large and complicated as ITER, this adds a level of uncertainty to the overall management.

The separation between ITER and other EU funded scientific projects (for example those supported under the successor to Horizon 2020) might also impact the potential research synergies between nuclear fusion projects and other scientific programmes.

Finally, political risks are also present under this option linked to the discussion of the European Council and Parliament over annual funding priorities and over the effectiveness and the need for fusion projects, including ITER. These risks could materialise in a reduction of the available funding causing further delays and slowing down the progress towards reaching the stage of First Plasma in 2025.

4.3. Proposed legal basis

As regards the intended **legal instrument**, the implementation of the approved funding would require a modification of the Council Decision establishing F4E in the same way as was done in 2013 for the current MFF.

This modification of the Council Decision adopted as a legal basis for the European participation in ITER for the whole duration of the project (35 years) would replace the provision on the current MFF funding amount with a similar provision reflecting the next MFF figure¹⁵.

In addition to these minimum interventions, one could envisage a more radical revision of F4E Statutes to simplify and improve the functioning of the Governing Board (e.g. by creating an executive committee with a limited number of participants and decision-making powers on clearly defined matters).

5. RESULTS AND IMPACTS

5.1. Programme structure

The scope of the project has not changed and activities have not been added under the new baseline. While de-scoping would affect the ultimate utility and effect of the planned ITER experiments and their relevance for fusion advancement, the rebaselining conducted by the ITER Organization in close collaboration with the ITER Parties' Domestic Agencies, and notably F4E, made every use of possible savings from scope and activities optimization.

5.2. Programme priorities

In light of the above-mentioned general and specific objectives, the first and utmost priority is the construction of ITER (specific objectives n°1 to 4), following the staged approach of the new baseline with the critical path of First Plasma by 2025 and full Deuterium-Tritium operation by 2035. Funding for the construction of ITER below the critical mass ensuring adherence to the new baseline would entail additional delays

¹⁵ On this occasion the Council Decision could cover additional issues like (i) inclusion of the administrative expenditure of the Commission for ITER and the other related activities; (ii) provisions for mid-term evaluation for the next MFF period; and potentially, and (iii) modifications to the governance structure of F4E, including possible recalculation of the UK voting rights, in light of Brexit.

resulting in turn in increased costs and undesirably exposing the EU vis-à-vis the other parties in the joint international legal commitment.

The second priority is the continued provision of the EU contribution to the Broader Approach activities with Japan (specific objective n°5), which also rests on a legal agreement and for which significant funds have already been invested. Exploitation of the facilities built in the current MFF by EU scientists (JT60SA) needs to be actively pursued, in order to capitalize on the value of the investments made so far.

The third priority is the continuation of activities in preparation of the next stages in the development of fusion as an energy source, which follow the completion of ITER and build on its results. At present, these activities notably concern steps towards an International Fusion Materials Irradiation Facility - IFMIF/DONES (specific objective n°5) whose results together with the lessons from ITER will enable the future construction of DEMO.

5.3. Critical mass of funding

The critical mass of funding needed corresponds to the new ITER baseline for the construction of ITER. The updated schedule and associated cost estimates present the earliest technically achievable date for the ITER construction without any contingencies and therefore assumes that all major risks can be mitigated. The critical mass of funding corresponds to a system-critical set of activities:

- (i.) the estimated cost of in-kind contributions due from EU, to be delivered to IO by F4E;
- (ii) EU cash contributions to the funding of IO activities, which in the next MFF period will notably entail the assembly, commissioning and start of operations;
- (iii.) supporting/complementary activities mandated by F4E Statutes (notably those related to cooperation with Japan under the Broader Approach and the preparation of TBM, DONES, DEMO);
- (iv.) overhead: administrative costs of F4E and of requisite COM resources.

The estimated cost of European in-kind contributions to IO has been prepared by F4E on the basis of the new ITER Project baseline and validated by the F4E Governing Board; the Governing Board also acted on the basis of the results of independent reviews. Reduction of funding would thus impact the delivery of these components in accordance with the new baseline, which in case of items on the critical path directly translates into overall project delays and associated future additional costs.

The cash contributions to the IO are set as EU obligations on the basis of the new baseline approved ad referendum by the ITER Council; they have already been rigorously optimized compared to the original baseline proposed by the IO.

“Other F4E activities” ensure successful future progress of fusion development through continued collaboration with Japan, as well as, notably as regards DONES, the preparations for transition from ITER to DEMO along a cost- and time-efficient path, and provide continuity of knowledge and availability of skilled human resources.

Finally, the estimated administrative costs reflect the fact that F4E has to be staffed at appropriate levels to ensure timely design, procurement, delivery, and quality assurance for all components under its responsibility¹⁶.

Overall, adequate provisioning for **contingencies** should be an integral part of decisions with respect to EU participation in ITER so as to allow the EU to deliver on all commitments and avoid reputational risks in case of unexpected adverse developments which cannot be excluded in first-of-a-kind projects. In that spirit, the Commission will insist on internal savings in both IO and F4E where possible during the execution of the project, with the aim to enforce strict budgetary discipline on an enduring basis.

In conclusion, the critical mass of funding needed to make the ITER-related EU action work effectively corresponds to the new ITER baseline for the construction of ITER. Anything below this critical mass leads to less EU added value and generates inefficiencies on the path to fusion power by the end of the century.

5.4. The necessary volume of resources

The resources needed for the completion of the new baseline are presented in detail in the Commission Communication "The EU Contribution to a Reformed ITER Project" and the accompanying Staff Working Document. The key figures are reproduced in Annex 3. In a nutshell, the proposed budget allocation (including the Commission administrative costs) for the period 2021-2027 is EUR 6 070 million (in current prices)¹⁷.

5.5. Economic, social, and environmental impacts

Economic impacts: The Euratom investment in the construction of ITER is bringing important benefits to European industry and research community. Overall, EUR 1.8 billion is expected to be contracted out by the ITER Organization from now to 2025, particularly in areas like diagnostics, remote handling, heating systems and high technology solutions, opening up new opportunities for industries and SMEs in European regions that were so far not featuring prominently amongst the beneficiaries.

Social impacts: An ongoing "Value for Money" study commissioned to an external contractor highlighted that:

- i. The current payments on ITER by F4E are already having significant positive impacts compared to no spending, with 18 000 job years created to date, including 6 000 in 2017 alone; and almost EUR 2.9 billion in Gross Value Added (GVA) to date, with more than €1 billion in GVA estimated in 2017.
- ii. In total, F4E spending is expected to deliver a gross extra GVA of EUR 12.7 billion and 61 000 job years between 2018 and 2030. This does not include benefits from spin-offs, new products, new business opportunities, etc.

¹⁶ Its current establishment plan had to be complemented in the course of the current MFF by provisions for temporary reinforcements in view of the peak in procurement activities necessary for successful completion of the construction. Under the revised schedule within the new baseline, the peak partly shifts into the next MFF period before an expected decline in the second part of the upcoming MFF, as the ITER project transits towards assembly and start of operations, which should prompt a re-evaluation of human resources needs.

¹⁷ This figure represents an estimate without contingency on time or cost.

iii. In the medium to longer term there is likely to be a positive return on investment from the EU commitment to ITER, similar to those based on the evidence from other Big Science projects such as CERN and ESA.

Environmental impacts: ITER is the only project of its kind in the world aiming to enable fusion as a new energy source before the end of the century. It therefore contributes to the strategic agenda of the European Union for clean and secure energy.

Fusion is a climate friendly energy source, as it does not produce greenhouse gases or long-lasting radioactivity and the fuel used is widely available. By the end of this century, fusion energy could become a suitable complement to renewables in the energy mix and provide baseload electricity. This is particularly important following the 2015 Paris Agreement and the EU commitment to lead the way in decarbonising the economy and tackling global climate change in a cost-effective manner.

6. MONITORING AND EVALUATION

Following the radical overhaul of the project deployed in the past three years, various performance monitoring and evaluation tools have been fine-tuned and are in place both at the ITER International Organization level and the F4E level.

6.1. Performance monitoring in ITER Organization

Since the end of 2016, in the context of the proposal of a new baseline for the ITER project, the IO has progressively put in place a number of indicators allowing a thorough monitoring of ITER project progress and identifying potential problems or risks at an early stage.

These indicators are ITER Council milestones, internal project milestones and Key Performance Indicators (KPIs).

The **IC milestones**, covering the period from 2016 through to 2025, are drawn from critical path major achievements and other major component deliveries for First Plasma. They serve to monitor the evolution of the project by alerting if there is an increased risk of missing any critical and near critical path milestones. Conversely, the achievement of these milestones provides increased confidence that the critical and near critical milestones will be met, and that the project is on track. The IC Milestones indicate the achievement of the responsible party and the achievement status relative to its planned date. The IO has committed to the ITER Council to propose additional Milestones on a rolling basis of two years, at the end of each year.

In parallel, the ITER Organization established a much more extensive list of so-called **internal project milestones**, with set threshold dates and an automatic warning when a forecast date goes beyond its threshold. The delay that can occur before the warning is given depends on the criticality of the milestone: for more critical milestones this difference between the threshold date and the reference date is much shorter than for less critical ones. Similarly, the IO also introduced programmatic milestones, which are mainly related to recruitment of staff and implementation of independent reviews.

However, IC milestones having a limited value to understand the project's overall status, the IO also introduced Key Performance Indicators, grouped within nine scorecards which cover the physical progress, finance, staffing, risk and opportunities, health and

safety, earned value management, etc. The Management Committee monitors the choice of KPIs and is observing their performance.

The ITER Organization also regularly reports on risk and opportunities management, which includes top-level risks and the actions taken to address them.

Finally, the other tools that are used to monitor the project are independent focused reviews on specific areas (e.g. risk management, freezing of design interfaces). The reviews aim to identify actual or potential problems, and providing recommendations to the IO on how to handle them. An action plan is established to address these recommendations, with clear indicators and timelines.

Every two years there is a management assessment review, which is appointed by the ITER Council as per the provisions of Article 18 of the ITER Agreement, and charged to conduct an independent assessment of organizational, management, administrative and financial issues arising during the implementation of the ITER project.

6.2. EU participation in the ITER project's governance and supervision

Furthermore, the Commission has designed a comprehensive strategy for EU participation in the ITER project's governance and supervision. The strategy focuses on steps and improvements feasible within the present legal framework. The main objectives of the strategy concentrate on: 1) the IC shall effectively steer the IO by providing strategic directions to achieve the agreed goals; 2) the IC shall closely supervise the IO, based on regular information and in accordance with the ITER baseline (budget and schedule for the intended scope); and 3) the EU will secure its interests in the governance of ITER. This strategy is implemented during 2018.

The Commission is working on streamlining the ITER governance to make it more efficient. In this respect, a group was set up by the ITER Council to analyse and reduce where possible the number of sub-committees. The results led to the abolishment of several sub-committees of the ITER Council and a more effective governance structure. However, further work needs to be undertaken to ensure improved governance of the project, and the EU is working with the other ITER Parties in this field.

6.3. Commission's oversight of Fusion for Energy

The Commission's oversight of Fusion for Energy relies on three different categories of supervision tools: governance bodies (Governing Board and Committees), regular structured monitoring (using reporting as well as regular audit actions), and ad-hoc supervisory tools (mainly for tackling emergency situations).

The Governing Board (of which the Commission is a member together with the EU Member States and Switzerland) and its subsidiary bodies (in some of which the EU is also represented) are responsible for the overall supervision of F4E. Compared to the other members of the Governing Board, the EU has a different role as the largest contributor of the budget, the responsibility to report to the European Council and the European Parliament, and the supervision of Fusion for Energy as a European Joint Undertaking, which means F4E has to follow the financial and staff regulations of the European Commission or regulations specifically set up.

This specific budgetary and institutional role of the European Commission implies a particular responsibility of the Commission with respect to the supervision of Fusion for Energy.

The Commission has recently developed a comprehensive *supervision strategy* for F4E, which sets out the supervision needs, the objectives for the supervision activities, the tools to be used, the working methods and procedures needed to achieve the supervision objectives, and the scope of application of "the reservation on legality principle". The supervision strategy is designed to enable the effective oversight of EU's performance in discharging its obligations to ITER. This proposal is being formalised into the recast of the current Administrative Arrangement between F4E and the Commission.

6.4 KPIs and milestones for next MFF

In the next MFF, DG ENER proposes to use two indicators in relation to ITER. These indicators should report on progress of the project towards the achievement of its general and specific objectives.

The first indicator would be the "percentage of completion of ITER construction" and the second the "percentage of Euratom's in kind obligations discharged by F4E". Both indicators will be based on data reported by the ITER Organization.

The Commission has also formulated a set of KPIs for its supervision of F4E, including Earned Value Management (EVM). Key Performance Indicators, reflecting in a measurable value how effectively key objectives are being attained, are indeed an integral part of F4E's regular reporting. KPIs need to effectively monitor F4E performance and progress in the short (running year) term and long term, in terms of both schedule and budget, and provide objective warnings to management in an early phase.

F4E uses a set of KPIs to monitor its performance against the agreed schedule and budget (project plan milestones, signature of procurement arrangements, calls for tender published, contract and grant signatures, Governing Board milestones, contract execution milestones, risk management, etc.).

ANNEX 1: EVALUATION RESULTS

1. Evaluations

In the context of restructuring the baseline, both the ITER Organization and F4E were subject to various evaluations. Multiple reviews and evaluations of ITER Organization and F4E have been carried out, either assessing operational capacity/performance in general (e.g. ITER Organization bi-annual management assessments and F4E annual assessments) or targeting specific key topics (e.g. risk management review, freezing of interfaces review).

a. ITER Organization evaluations

In accordance with the ITER Agreement, management assessments of IO are undertaken bi-annually by external experts appointed by the ITER Council. These have played a crucial role in the transformation of the project. The 2013 ITER Organization management assessment revealed a number of problems and prompted profound changes in the IO's top management followed by the elaboration of the new baseline. The subsequent bi-annual management assessments of 2015 and 2017 confirmed the positive trend in the reform of the project. The 2017 assessment in particular confirmed the substantial improvement of the ITER Organization management by the current Director-General (DG), contributing to reduced risks of straying from cost and schedule control.

In addition to these statutory bi-annual assessments, the IO has also been subject, for the past two years, to independent ad hoc reviews. The 2016 ITER Council Review Group (ICRG) assessed the processes used for preparing the new baseline¹⁸. It confirmed the validity of the staged approach and the 2025 date as the earliest technically feasible date for First Plasma as well as the robustness of the processes used by IO for the elaboration of cost estimates for the new baseline. On the basis of the input from ICRG, the new baseline was adopted by the ITER Council.

Furthermore, the ITER Council established the instrument of ad hoc independent reviews targeting specific key topics (e.g. risk management, freezing of design interfaces). These are organized under the ITER Council's mandate by the Management Advisory Committee and independent experts engaged by it, aiming at assessing critical areas of the project and IO's activity, and providing recommendations to the IO for improvements where necessary.

b. F4E evaluations

In parallel, F4E is also subject to detailed reviews. Following the request by the Council in its July 2010 conclusions, an assessment of the project progress is performed annually by independent experts and the outcome is reported to the Council and the European

¹⁸ This followed the rejection of a previous suggested baseline, "the Updated Long-Term Schedule", which was proposed in November 2015 and rejected by the ITER Council because it did not address all issues and did not take into account the constraints of the Members. The ITER Council agreed to form the ITER Council Review Group (ICRG) to assess the rejected Updated Long Term Schedule (with the associated costs/resources). The final report of the ICRG on the Updated Long-Term Schedule was fully in line with the concerns raised by the EU delegation in the ITER Council.

Parliament. In June 2016, in the frame of the yearly assessment, the Governing Board asked for a review of the new plan for the delivery of the components under EU responsibility and the associated resource estimates (F4E 2016 Assessment)¹⁹. The results of this high-level independent review confirmed the capacity of Fusion for Energy to deliver the EU contribution to the new ITER schedule on time and in line with the *staged approach*. This review also underlined the capacity of the Joint Undertaking to deliver the required components within the current available budget until 2020 and the cost projections made thereafter.

In the last annual assessment report of 2017, the review Panel²⁰ stated that F4E has made significant progress in management and performance over the past 2-3 years and is positioned to make the transition to a non-“emergency” state. The commitment of the management in reforming the project was recognized, while highlighting further issues that F4E management and governance instances need to focus on to solidify performance.

c. Mid-term evaluation

A mid-term evaluation of European participation in the ITER project is being carried out complementary to the evaluations of F4E and the IO presented above. Its objective is to evaluate the results of the European contribution to the ITER project carried out by F4E in the period 2014-2017. It builds on a value-for-money analysis prepared by an external consultant to DG ENER early 2018. The evaluation report will present a comprehensive overview of the European contribution funded annually from the EU budget, France, and F4E members, and will outline the results obtained through that funding to date, before providing an evaluative analysis of the results. The evaluation covers the Effectiveness, Efficiency, Relevance, Coherence, EU added value, and Acceptability of the European contribution to ITER. It will be completed in Q2/2018 and will be made available to the Council of the EU and European Parliament. Preliminary results of this evaluation indicate that:

- a. All three objectives of F4E are currently pursued according to a planning consistent with the new ITER project baseline, Broader Approach agreement and the EU Fusion Roadmap.
- b. Over the evaluation period the European contribution to ITER was subject to major changes in terms of management structure. The direct results from the changes in management can be considered to be positive and promising of sustained more effective implementation of the project including cost and schedule control and risk management.
- c. The achievement of ITER credits by F4E is mostly in line with the current baseline which is a clear positive change compared to earlier periods. Indirect positive changes are also perceived by surveyed stakeholders such as IO and contractors who state an increased motivation and enthusiasm in the work of F4E.
- d. The new baseline is considered to be realistic and appropriate for the achievement of ITER. The new baseline entails additional costs for the European contribution

¹⁹ F4E Governing Board decided to engage the European experts who have participated in the ICRG panel.

²⁰ The 2017 annual assessment review panel included for the first time a non-European expert (former Undersecretary for Science and Energy of the US Department of Energy who was the head of US delegation to the ITER Council for two years).

to ITER after 2020 while the Euratom cap on expenditure until 2020 will be respected.

- e. Within the limits of methodological difficulties, the data available from stakeholders suggest that the European contribution to ITER is cost-effective, both, for its administrative spending as well as for its operational spending.
- f. Contracts for the major share of Europe's contribution have already been placed with the industry and research institutions. The number and value of contracts and grants awarded by F4E, as well as their geographical spread, provides a clear indication that the European contribution to ITER has benefited the European economy significantly. From a quantitative perspective, significant amounts of contracts and grants have resulted in job creation and turnover increase. Also, the nature of the contracts leading to first-of-a-kind products is considered to provide the participating European companies advantage in terms of innovation and competitiveness.
- g. Europe's participation in ITER is considered fully in line with Euratom research and training programme as well as long-term energy and carbon objectives; the characteristics of fusion energy which as a body makes them unique lead to high complementarity with other carbon neutral energy sources such as renewables or hydrogen. However, given the long timeline for a projected first availability of commercial fusion energy, the project does not directly contribute to current and mid-term needs.
- h. Insights from the available data strongly suggest that an intervention at Euratom as compared to EU Member State level at least until the end of ITER's construction period is crucial in terms of resource availability as well as to reduce project complexity.

2. *Key responses to lessons learned from evaluations*

As a consequence of the Management Assessment of 2013, the project management was significantly restructured in IO and a new top management team was appointed early 2015 with a clear mandate to stabilize the project, prepare a new baseline and implement robust project management culture and practices in the ITER Organization.

This is formally captured in the 2015 **IO DG Action Plan**²¹, which pursues a complete re-organisation of the ITER Organization, reinforcement of IO's cooperative relationship with the domestic agencies²², accelerated freezing of design processes to stabilize the construction of buildings and manufacturing of components, and the establishment of a Reserve Fund to cover additional costs entailed by design changes approved by the ITER Organisation. The action plan also focused on cost control and the establishment of a new reliable schedule and associated cost estimates that should lead to a new baseline.

²¹ A complementary action plan was adopted by the Governing Board of Fusion for Energy in 2015 that led to the creation of a project management department to reinforce planning and control processes, the redeployment of staff to high priority areas and the strengthening of project control, risk management and cost containment measures. To date 80% of the actions have been implemented.

²² In particular, "Joint ITER Organization - Domestic Agencies project teams" were set up in key project areas, supervised by a joint project management body (the Executive Project Board), allowing early identification and resolution of problems.

Changes in the management and organization of Fusion for Energy (F4E) took place in parallel and entailed the change of the Director (early 2016) and the majority of the top management and its organization. In 2015, F4E implemented an internal restructuring of activities and resources (the so-called “Straight Road to First Plasma”) focused on actions in support of the action plan of the ITER Organization. The Straight Road to First Plasma involved an improvement of the contract management tools; merging of configuration management tools with those of the ITER Organization; implementation of a system to manage cost estimates and fund/contingency; and creation of a Project Management Department to reinforce planning and control processes.

Overall, the key findings and lessons learned from the reviews/evaluations allowed the new managements of IO and F4E, and the new baseline, to effectively address the following critical elements:

- Better grasp of the technical complexity of a unique project where many components are first of a kind;
- Focus on completion of design to avoid modifications of procurement contracts or amendments during execution, which lead to further cost increases and delays;
- Process organization and project management, in particular project management focus on cost and schedule and industrial expertise, both in the ITER Organization and F4E;
- Governance structure and processes providing for effective oversight of the ITER Organization and F4E, combined with coordination and collaboration between the domestic agencies and the ITER Organization.

ANNEX 2: STAKEHOLDER CONSULTATIONS

The opinions of stakeholders were collected through a number of stakeholder consultation initiatives:

- The **MFF Open Public Consultation** is organised per policy cluster and ITER is part of the “Strategic infrastructure” cluster. The Open Public Consultations were launched on 10 January for all clusters centrally under the coordination of SG running until 8 March 2018.

The MFF open public consultation is accompanied by targeted stakeholder consultation activities:

- A **targeted stakeholder consultation** was carried out in the context of the “Value for Money” study targeting around 300 contractors. Key findings from the consultation with stakeholders have highlighted that the EU investment in the construction of ITER is bringing important benefits to European industry and the research community giving them the opportunity to engage in cutting-edge R&D, technology, design and manufacture work for ITER components. Between January 2008 (the start of ITER activities) and December 2016, Fusion for Energy awarded 839 contracts and grants for a value of approximately EUR 3.8 billion throughout Europe. Some 300 companies including SMEs from about 20 different EU Member States and Switzerland, as well as some 60 research organisations have benefited from investment in ITER activities. Furthermore, the ITER Organization as well as the domestic agencies and industries of other ITER Parties have also signed contracts with European industry to support the manufacture of their own components for ITER. This investment also offers European high-tech industries and SMEs a unique opportunity to innovate and develop “spin off” products for exploitation outside fusion.
- ***Follow-up to the publication of the Commission Communication:*** With this Communication, the Commission launched inter-institutional discussions with the Council of Ministers and the European Parliament on the new ITER baseline. The Commission adopted the ITER Communication in June 2017 to present the radical changes brought to the project to put it back on track, including the thorough revision of the project’s baseline. The revision of the baseline and the management changes were the most significant requests made by independent experts and stakeholders, including the European institutions, to ensure the necessary turnaround of the project’s past pace. With the adoption of the Communication, the Commission had no intention of pre-empting any future proposal or outcome of discussions on the next MFF, but rather of providing the clear information on the new baseline considered necessary to stabilize the situation of ITER management and ensure a successful finalization of its construction on the basis of the “*staged approach*”, which was recommended by independent experts. The new baseline, agreed ad referendum by the ITER Council in November 2016, will be most effective if it is also politically and formally endorsed by all ITER Parties at a ministerial meeting. The Commission seeks through the communication to obtain a mandate from the Council of the EU to take decisions at such a ministerial meeting on behalf of the EU so as to ensure that the project (contractors, ITER Organization, domestic agencies, etc.) can work under a more reliable schedule and with more accurate cost estimates.

- **Industry stakeholder event:** During the “ITER Industry Day” organized by the European Commission on the 4th December 2017, on the occasion of the 10th anniversaries of the ITER Agreement and Fusion for Energy, around 100 policy-makers, senior company executives and energy experts from Europe and the rest of the world participating in the ITER project highlighted that fusion is already delivering concrete opportunities for industry and is having a positive effect on jobs, economic growth and innovation, with positive impact beyond the fusion and energy fields.

Members of the European Parliament, representatives of the EU Member States and international industrial stakeholders participated in panel discussions which covered the direct benefits for the economy and society as a whole arising from the construction of the ITER project; the cross-cutting effects and indirect benefits from the advanced technologies associated with the ITER project; and the international technology cooperation stimulated by the ITER project that is resulting in unique business opportunities for companies in Europe and in other countries participating in ITER.

Some of the key messages expressed by the participating companies are presented in Annex 2a.

ANNEX 2A: INDUSTRY TESTIMONIALS

To deliver the EU commitments to the project, Fusion for Energy (F4E) has so far signed almost 1000 contracts with over 400 European companies and 60 scientific and research entities in more than 20 European countries, for a total of some EUR 4 billion. Here are some key messages expressed by the companies on the occasion of F4E's 10th anniversary celebration and at the ITER Industry Day in December 2017.

Contracts for deliveries to ITER bring new jobs and growth to European companies

Manufacturing components for ITER represents a good opportunity for European industry to create new jobs, both directly in F4E's contractors and in the supply chain companies involved. OCEM Power Electronics, an Italian company specialized in providing plasma power heating components, is a case in point. As Giuseppe Taddia, General manager of OCEM, said: *"ITER allowed my company to double the jobs, and the same applies for our subcontractors. ITER is an interesting opportunity to do business, even if it is very challenging on technology and very demanding in terms of quality and reactivity."*

While OCEM is working mainly in the particle physics and fusion sectors, Belleli Energy is a company operating predominantly in more traditional sectors, manufacturing components for the oil and gas industry. But through its involvement in the European consortium for the construction of the ITER vacuum vessel (a very sophisticated and crucial component), Belleli Energy has now seen significant growth in turnover and staff levels. The CEO Paolo Fedeli said: *"Thanks to ITER, the company staff grew from 300 in 2010 to 1000 today. This includes a growth in the number of high-skilled engineers from 15 to 100. Although the ITER business represents only 10% of the company's turnover, the ITER business line is the one giving the company the most dynamic growth. Participating in ITER has enabled Belleli Energy to expand its market share in other sectors but also in the oil and gas business which still accounts for 90% of Belleli's business."*

Technologies developed for ITER create new business opportunities in other sectors

Involvement in deliveries to ITER leads to the development of new technologies which find applications, sometimes unexpected, in other business areas. This is the story of Pro-beam, a German company also involved in the manufacturing of the ITER vacuum vessel: *"Pro-beam developed the electron beam welding technology to provide high-quality welds for ITER components. The subsequent use of this technology also in construction, process and plant engineering, increased our competitive advantage in those more traditional industry sectors, boosting the turnover of our company in return"* said Pro-beam's CEO, Thorsten Löwer.

Working on ITER increases the competitiveness of European companies in the global economy

Through collaboration with fusion-related research on superconducting magnets in the 1980s, Bruker developed superior know-how on superconductors. This resulted in business opportunities including, but well beyond, the manufacturing of the world's largest superconducting magnets for ITER. *"Thanks to its involvement in fusion-related research, Bruker has developed from a small research entity into a major manufacturer of superconducting wires and is now a key global supplier for Magnetic Resonance Imaging, a key technology to detect*

cancer and other diseases,” said Bruker Biospin Executive Vice President Falko Busse. Bruker’s innovative and collaborative business approach to fusion activities helped the company gain a 20% share in the global superconducting wire market and a 73% share in the NMR spectroscopy market, supporting life science research with a current annual global market value of over 700 million Euro. As a corporation Bruker has grown 17% since 2013.

Participating in ITER also creates major opportunities for traditional large European companies. With a EUR 20 billion turnover and a 100-year history, Air Liquide is a mature industrial actor. For its involvement in ITER, the company successfully entered the high-tech sector of cryogenics and is building ITER’s cryoplant, which will be largest ever built in the world. It required the different branches of the company to work together and find innovative solutions. Air Liquide’s Vice president, François Daichis, said: *"Our company's participation in ITER resulted in 5 patented innovative solutions in the field of cryogenics and cooling of heavy components, and we are now the world leader in this sector."*

ITER provides an opportunity for traditional companies to enter the high tech market

The German company MAN, part of the Volkswagen group, is involved in several contracts with ITER which allow the traditional transport manufacturer to diversify into new areas of activity, e.g. to manufacture parts for the vacuum vessel and assemble the cryostat. Franz Leher, Business Head of MAN, said: *"People are always surprised to learn that a company member of the Volkswagen group is involved in a very different cutting-edge project such as ITER. But the whole Volkswagen group is benefitting from MAN's participation in ITER. It brings new skills and competencies to the company, creating know-how that would not be acquired otherwise."*

All these stories from European companies show how important ITER is for the European industry, and not just its high-tech sectors. The ITER project is already delivering concrete opportunities for industry and is having a positive effect on jobs, economic growth and innovation in Europe. ITER is pushing technology to its limits but it is already bringing a lot of concrete positive effects for the economy and society at large. Participation in ITER brings multiple benefits, synergies and cross-cutting effects to European industry and research communities, not least through entering new markets and developing their international liaisons and global competitiveness. While about 50% of the value of the planned European contribution to ITER has already been placed, the project offers further opportunities for European companies in high-tech areas as well as traditional industry sectors.

ANNEX 3: VOLUME OF APPROPRIATIONS

The table below presents an overview of the estimated European contribution (from the EU budget, France as Host State, and F4E Members) in current prices (EUR billion). It is based on the figures presented in the Commission Communication “The EU Contribution to a Reformed ITER Project” (COM(2017)319) and its accompanying Staff Working Document (SWD(2017)232).

European contribution	Up to the end of the current MFF		Up to First Plasma	From First Plasma to DT		Total after 2020
	2007-2013	2014-2020	2021-2025	2026-2027	2028-2035	
EU budget	3.36	2.96	4.56	1.51	2.58	8.6
France	0.52	0.84	0.95	0.3	0.5	1.7
F4E Members	0.02	0.03	0.03	0.01	0.06	0.1
Total	3.9	3.8	5.5	1.8	3.1	10.4

The table below presents the annual breakdown of the contribution from the EU budget (commitments) to the ITER project in current prices (EUR million).

	2021	2022	2023	2024	2025	2026	2027	2021-2027
EU budget contribution	934	768	1 103	872	746	926	722	6 070