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**COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN
PARLIAMENT AND THE COUNCIL**

EU CONTRIBUTION TO A REFORMED ITER PROJECT

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EU CONTRIBUTION TO A REFORMED ITER PROJECT

I. INTRODUCTION

Fusion is expected to play an important role in Europe's future energy landscape as a virtually inexhaustible climate friendly energy source. The fusion reaction does not produce greenhouse gases or long-lasting radioactivity and the fuel is widely available and practically unlimited. By the end of this century, as fossil fuels will be phasing out of the energy mix, fusion could become a suitable complement to energy from renewables. 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.

Thanks to advances in fusion research ITER, which means 'the way' in Latin, aims to bring significantly closer the prospect of meeting a large share of our electricity needs through fusion. Launched in 2005 and now involving seven global partners (Euratom¹, United States, Russia, Japan, China, South Korea and India) ITER is a pioneering project to build and operate an experimental facility to demonstrate the scientific viability of fusion as a future sustainable energy source.

Europe has taken the lead in this project with a 45% stake of the construction costs of which 80% is funded from the EU budget and 20% by France as the ITER host country² (the other ITER Members share is around 9% each). This cost distribution will change in the operation phase, with Europe providing 34%. ITER's construction involves over 10 million components being built in factories around the world. About 75 % of its investment is spent on the creation of new knowledge and cutting-edge materials and technology. This offers European high-tech industries and SMEs a valuable opportunity to innovate and to develop 'spin off' products for exploitation outside fusion (such as the broader energy sector, aviation and hi-tech instruments like the NMR - nuclear magnetic resonance - scanners).

In July 2010, the Council of the EU mandated the European Commission to approve on behalf of Euratom the current ITER Baseline³ which was based on the assumption that the construction of ITER would be completed with so called First Plasma⁴ in 2020. The Council of the EU capped the budget for the construction phase at EUR 6.6 billion (2008 values) up to 2020. These resources also cover the administrative costs of the Euratom Joint Undertaking 'Fusion for Energy (F4E)'⁵. The costs for ITER have to be seen in the context of a significant

¹ The European Atomic Energy Community.

² The ITER Organization is set up by the ITER Agreement of 2006 and hosted in Saint-Paul-lès-Durance (France). Euratom, as 'Host Party' cannot withdraw from the project: article 26 of the Agreement allows an ITER Member other than Euratom to withdraw after 10 years from the entry into force of the Agreement (i.e. from October 2017). However, the Member shall continue providing its contribution for the construction phase but cannot participate in the experimental phase.

³ A 'Baseline' refers to the inter-related elements of scope (specifications of the machine to build), schedule (timetable for construction) and projected costs.

⁴ First Plasma represents the stage in the construction of the fusion machine that will allow testing the essential components of the machine; under the terms of the ITER Agreement, it is the point where the construction phase is formally completed and the operation phase starts.

⁵ Fusion for Energy is the European 'Domestic Agency' responsible for delivering the Euratom contribution to ITER. It was established as a Joint Undertaking by the Council Decision 2007/198/Euratom of 27 March 2007 and hosted in Barcelona (Spain). Its Members are the Member States of Euratom, Euratom and Switzerland. It was set up set up to procure

energy transformation in Europe set out in the Energy Union strategy⁶ that is estimated to require about EUR 200 billion annually in the next decade.

Since the adoption of the 2010 baseline delays and cost overruns accumulated, mainly due to design changes and manufacturing challenges owing to the 'first of a kind' nature of the project but also to weaknesses in its management and governance. These delays made impossible the completion of the construction within the expected schedule. In particular, following the appointment of the new Director General of the ITER Organization in 2015, intensive effort made by Euratom in collaboration with the other ITER Members to improve the management of the project and to contain the schedule and cost slippages led to positive overall progress in the construction and manufacturing activities.

Following a positive review by independent experts the ITER Council endorsed *ad referendum*⁷ in June 2016, an updated schedule and associated cost estimates for the completion of the ITER construction to First Plasma estimated in December 2025. This is the earliest technically achievable date for the ITER construction⁸. This schedule does not include contingencies and therefore assumes that all major risks can be mitigated⁹. The detailed schedule from First Plasma in December 2025 to full performance operation, using deuterium-tritium fuel (the so-called Deuterium-Tritium phase) estimated in 2035, was endorsed by the ITER Council in November 2016 (associated costs were endorsed *ad referendum*) as the basis for the new ITER Baseline.

This updated schedule and associated cost estimate enable Euratom to stay within the current budget cap set by the Council of the EU in 2010, i.e. EUR 6.6 billion to 2020 (in 2008 values), thus ensuring that all necessary contracts can continue to drive progress in the construction and that additional delays and cost overruns can be minimised. This Communication specifies the resources needed for the ITER construction after 2020 under the updated baseline.

With this Communication the Commission seeks the support of the European Parliament and a mandate from the Council of the EU for the Commission to approve the new baseline *ad referendum* on behalf of Euratom, at an ITER Council meeting at ministerial level that could take place in 2017. Approval will still be *ad referendum* since the Euratom contribution¹⁰ from the EU budget is without prejudice to the proposals of the Commission, the outcome of

Euratom's components to ITER and implement other activities related to ITER (mainly the activities with Japan under the Broader Approach Agreement and the Test Blanket Module programme) and DEMO (the project after ITER that will demonstrate the first commercial production of fusion electricity, being at the end point of the fusion roadmap and building on the results from the operation of the ITER).

⁶ COM(2015) 80 final of 25.2.2015.

⁷ Approval was *ad referendum* because still subject to a final decision by the Budgetary Authorities of the ITER Members. For Europe, this implies that the Euratom contribution from the EU budget is without prejudice to the proposals of the Commission and the outcome of the negotiations on the Multiannual Financial Framework post 2020.

⁸ This refers to a date before which achievement of First Plasma is considered not technically possible.

⁹ As a date for First Plasma it includes no contingency provision for unscheduled developments and risk-events which however cannot be reasonably excluded, particularly in projects of comparable complexity.

¹⁰ The Euratom contribution is defined as the joint contribution from the EU budget, France as Host State and the Members of Fusion for Energy. This contribution is paid to the budget of Fusion for Energy. The share of the Euratom contribution to ITER (through Fusion for Energy's budget) is funded 80% by the EU budget and ~20% by France. The overall budget of Fusion for Energy also benefits from an additional ~2% paid by its Members.

the negotiations on the withdrawal of the United Kingdom from Euratom (Brexit) and the Multiannual Financial Framework post 2020.

Brexit does not affect the overall legal commitment of Euratom to ITER, which is governed by the international ITER Agreement. However Brexit will have an impact on the decisions taken for the next Multiannual Financial Framework, and consequently could have an indirect impact on the available Euratom financing to ITER¹¹.

It is in this context that Euratom's approval *ad referendum* of the new baseline will provide needed stability to the project, the companies and research centres involved in the project, allowing current contracts to be duly completed and necessary new ones to be launched in the coming years. It will also allow the continuation of cooperation with ITER Members and their Domestic Agencies under the terms of the ITER Agreement.

II. ITER, THE PATH TO A FUTURE LOW CARBON ENERGY SOURCE, BOOSTING EU TECHNOLOGICAL DEVELOPMENT AND GROWTH

Fusion's future as a viable energy source depends on the successful construction and operation of ITER. Already in the present construction phase ITER is having a positive impact on European industries and SMEs involved in the manufacture of thousands of first-of-a-kind technological components required for this complex endeavour. An example of this is the successful fabrication by a European consortium of companies of the superconductors and the winding packs for the ITER Toroidal Field Coils, which is a major technological advance as winding packs of this size have never been manufactured before.

II.1 ITER, a positive investment for the EU

The Euratom investment in the construction of ITER is bringing important benefits to European industry and research community. Between January 2008 (the start of ITER activities) and December 2016, Fusion for Energy has awarded 839 contracts and grants for a value of approximately EUR 3.8 billion spread all over Europe. Some 300 companies including SMEs from about 20 different EU Member States and Switzerland, as well as some 60 research organisations, engaged in cutting-edge R&D, technology, design and manufacture work for ITER components have benefited from this investment on ITER activities. Furthermore, the ITER Organization as well as the Domestic Agencies¹² and industries of other ITER Members have also signed contracts with European industry to support the manufacture of their own components for ITER.

This investment is already visible in the significant progress on the 42-hectare ITER worksite. Among the planned 39 buildings, the Tokamak Complex is rising rapidly with the completion

¹¹ The United Kingdom is an active actor in fusion research and following the withdrawal from Euratom, the United Kingdom as a non-Euratom state may seek to be associated to the Euratom ITER activities through Fusion for Energy, similarly to Switzerland. Whether this will be acceptable and under which conditions will be a matter for consideration of the 27 Euratom Member States and negotiation between Euratom and the United Kingdom. Alternatively, the United Kingdom may seek to participate directly in the ITER project, subject to the unanimous approval of the ITER Members, including Euratom. This latter scenario would require a change in the ITER Agreement.

¹² Each Member has created a Domestic Agency to fulfil its procurement responsibilities to ITER. These agencies employ their own staff, have their own budget, and contract directly with industry. Fusion for Energy is the EU Domestic Agency.

of two basement levels and is now reaching above ground level. Close by, the 60 metre tall Assembly Hall, the Cleaning Facility and the Site Services Building stand complete. There is substantial progress with several other buildings on-site such as the cryoplat and the cooling towers and work has started in the last 18 months on most of the remaining buildings. Six electrical transformers (provided by the United States and China) are now installed. All the base pieces of the cryostat have been delivered by India and are being welded. Fusion for Energy is ready to start the manufacture of four giant poloidal ring-shaped coils (with diameters of 17 and 25 metres) inside a dedicated 250 metre long building.

As the project evolves new procurements and grants will be awarded in the coming years, not only by Fusion for Energy for the Euratom in-kind contribution¹³ but increasingly by the ITER Organization for the assembly and tooling work needed to complete the construction. 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 and heating systems high technology solutions, opening up new opportunities for industries and SMEs in European regions not so far featuring prominently amongst the beneficiaries.

II.2 ITER, anchored in the European fusion roadmap and open to the world

Achieving a future fusion power plant requires sustained scientific, managerial and financial commitment on a scale that no single country can provide. This is the reason why fusion activities are closely integrated at European level and also why seven major partners are supporting ITER construction at international level.

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 and has been endorsed by all fusion research stakeholders in Europe¹⁴. The new baseline contains a realistic schedule to achieve the goal of ITER and is essential input to the roadmap. In order to limit the impact of the new ITER schedule on the fusion roadmap, in particular the construction of the fusion electricity demonstration facility (DEMO), crucial long-lead time research such as the development of new materials needed for DEMO must start immediately. This will need the construction of suitable facilities, such as the planned facility to irradiate and test materials needed for DEMO (DONES - DEMO-Oriented Neutron Source).

Given the delay in achieving First Plasma the fusion research community has an opportunity to improve coordination and scientific exploitation of existing tokamaks¹⁵ around the world, such as JET (EU), K-STAR (Korea), EAST (China), and DIII-D (United States), in order to better prepare for ITER operation. This is particularly the case for the JT-60SA Tokamak (Japan) being constructed on budget by Euratom and Japan as part of the Broader Approach activities and which will become operational by 2020¹⁶.

¹³ 'In kind contribution' refers to the delivery by the ITER Members (through their Domestic Agencies) of all the components necessary to build ITER, including the buildings.

¹⁴ 'Fusion electricity, a roadmap to the realisation of fusion energy', 2012.

¹⁵ From the Russian 'tokamak', is a device that uses a powerful magnetic field to confine plasma in the shape of a torus.

¹⁶ Five Members of Fusion for Energy are currently voluntary contributing to the Broader Approach activities: Spain, France, Germany, Italy and Belgium.

At present Switzerland is the only non-Euratom country associated to the Euratom activities for ITER through Fusion for Energy. Switzerland is associated to fusion activities since 1978, allowing Switzerland to benefit from contracts and grants with Fusion for Energy and the ITER Organization and to be associated to the Euratom fusion research programme.

As the project evolves towards its operation phase new opportunities could be open to countries not currently involved in ITER, through cooperation agreements (e.g. Australia) or association to ITER activities through Euratom as in the case of Switzerland. Following the signature of the Joint Comprehensive Plan of Action in July 2015 the ITER Organization is exploring the possibility to cooperate with Iran on fusion research.

III. DELIVERING A CONFIDENT PATH TOWARDS ITER CONSTRUCTION

Soon after the adoption of the 2010 baseline the ITER Members came to realise that, in addition to the immaturity of the design and the manufacturing challenges, management deficiencies and a lack of cooperation between the Domestic Agencies and the ITER Organization were hindering the implementation of the project. Both the 2010 schedule and cost estimate were thus perceived to be unreliable.

The 2013 independent management assessment of the ITER Organization recommended changes in the project management and the development of a more realistic schedule and resource plan. In March 2015 decisions were adopted by the ITER Council to restructure the management and on an Action Plan under the leadership of a new Director-General. This Plan envisaged a complete re-organisation of the ITER Organization, close cooperation with the Domestic Agencies¹⁷, freezing designs to allow the construction of buildings and other components and the establishment of a Reserve Fund. This Fund was created to cover the additional cost to the Domestic Agencies caused by changes initiated by the ITER Organization to the design of components. The provisions for its use were adopted by the ITER Council in 2015 and its implementation is under the direct responsibility of the Director-General of the ITER Organization. It is funded from the cash contribution of the ITER Members according to their share in the construction phase (45% for Euratom). Euratom has ensured that its contribution to the Reserve Fund is within its capped budget for ITER up to 2020. From 2021 onwards the ITER Organization has estimated a total contribution to the Reserve Fund which Euratom takes into account in its estimate for the in-cash contribution (see the Commission Staff Working Document accompanying this Communication for details). The Fund introduces an incentive for the ITER Organization to minimize changes as much as possible, and therefore acts as a risk mitigation measure.

The Action Plan is also focussed on cost control and the establishment of a new reliable schedule and associated cost estimates that should lead to a new baseline. In about one year and a half the ITER Organization has already completed about 60% of this action plan and is making good progress in the remainder.

¹⁷ In particular, 'Joint ITER Organization - Domestic Agencies project teams' were set up in key project areas, supervised by a joint project management body (Executive Project Board), allowing early identification of problems and their resolution.

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 and cost containment measures. To date 80% of the actions have been implemented and good progress is being made in the implementation of the remainder.

III.1 Long term schedule of the project following a staged approach

Following a positive review by the independent ITER Council Review Group¹⁸, the ITER Organization presented to the ITER Council in June 2016 a new schedule and associated cost estimates for the completion of the construction of the fusion machine until First Plasma. The earliest technically achievable First Plasma date is currently estimated to be in December 2025, but this does not include contingencies and therefore depends upon all major risks being mitigated by the ITER Organization and the Domestic Agencies. The detailed schedule for the period from First Plasma in December 2025 to a full performance operation (so called Deuterium-Tritium phase) estimated in 2035 was presented by the ITER Organization and agreed by the ITER Council in November 2016 as the basis of the revised ITER baseline.

The new schedule follows a so-called *staged approach* which focuses first on the construction of the components which are essential to achieving First Plasma in 2025, followed by successive series of installation and testing phases before starting the full performance phase (Deuterium-Tritium operation) in 2035. First Plasma construction activities therefore are to be followed by limited additional Final Installation activities (also covered by the construction budget) in the operation phase from January 2026 until the start of Deuterium-Tritium Operation in 2035. This schedule offers the possibility to better manage the project risks by tackling progressively the technical challenges and ensuring that the ITER Organization and Domestic Agencies focus on what is most important to reach First Plasma. It also provides flexibility to accommodate the placement of contracts and allows for a longer research programme between First Plasma (end of 2025) and the Deuterium Tritium phase (2035).

III.2 Resources to sustain the path to ensure the full implementation of ITER

The revision of the project cost for each ITER Member, including Euratom (resources from the EU budget and France and Fusion for Energy Members) has essentially two components: (a) the revision of each Member's cash contributions to the ITER Organization for the latter's share of construction, assembly and operations and (b) the revision of the resources needed for the procurement of the respective in-kind contributions that each Member is committed to deliver to the project as well as the administrative costs for each Domestic Agency. In addition to the EUR 6.6 billion (in 2008 values) budgeted for the construction up to 2020 under the previous baseline, the resources needed by Euratom to enable the successful completion of the facility and the start of the performance operation phase have been estimated in this section on the basis of: (1) the cash request presented by the ITER

¹⁸ ITER Council Working Group on Independent Review of the Updated Long-Term Schedule and Human Resources (or in brief ITER Council Review Group).

Organization to the ITER Council of November 2016¹⁹ and (2) Fusion for Energy's estimates presented at its Governing Board of December 2016²⁰ (all quoted values are in 2008 unless explicitly stated otherwise; while the enclosed tables report the estimates in both 2008 and current values) as well as (3) assumed full compliance with the legal commitments under the ITER Agreement by which the Euratom contribution is not directly affected by Brexit (see also page 3). It is also assumed that France as a host country will continue to provide 20% of the Euratom contribution.

Euratom in-cash contributions under the new schedule

The additional²¹ amount of in-cash contributions to the ITER Organization by Euratom (through the budget of Fusion for Energy) for the construction phase up to First Plasma is now foreseen at about EUR 1.1 billion for the period 2021-2025 and ca. EUR 0.6 billion to cover Final Installation activities during the period 2026-2035 (also from the construction budget).

Euratom in-kind contributions under the new schedule

Furthermore, based on cost estimates established by Fusion for Energy on the basis of the staged approach, an additional²¹ EUR 2.1 billion will be required during the period 2021-2025 to cover the cost of Euratom's in-kind contributions necessary to achieve First Plasma, including components on the critical path, such as the vacuum vessel and buildings and the cost of the initial stages of design and construction activities for components under Euratom responsibility required for the subsequent assembly phases.

It is important to underline that under the *staged approach* construction activities to achieve First Plasma in December 2025 will be followed by further development and construction of components for the ITER machine during the subsequent Final Installation activities. The additional²¹ resources required to complete the remaining Euratom in-kind components after 2025 and until 2035 (start date of full performance operation) will be of the order of EUR 0.9 billion, without taking into account the possible revenue from the Reserve Fund of the ITER Organization.

Combined cost of Euratom contribution to the ITER project

While the object of this Communication is primarily to give detailed information on the resources estimates for the construction phase of the project until First Plasma in 2025, Tables 1 and 2 below show the total estimated Euratom contribution to the revised baseline of the project based on the *staged approach* (billion EUR in 2008 and current value, respectively).

¹⁹ Proposal for the Updated Project Plan and Resource Estimates (PPRE), ITER_D_U29DBA v1.1.

²⁰ Implications of the ITER updated Schedule and Resources Estimates on Fusion for Energy, F4E(16)-GB36-12.1.

²¹ In addition to the costs foreseen for construction under the previous baseline.

Euratom contribution 2008 value	Up to the end of the current MFF period		To FP	From FP to DT		
	2007-2013	2014-2020	2021-2025	2026-2027	2028-2035	Total²² after 2020
F4E total cash to IO	3.2	0.9	1.1	0.5	1.1	2.7
Construction budget		0.9	1.1	0.3	0.3	1.7
Operations budget		0.0	0.0	0.2	0.8	1.0
F4E in kind contribution		1.9	2.1	0.5	0.4	3.0
F4E administration		0.3	0.3	0.1	0.4	0.8
F4E other activities		0.1	0.4	0.1	0.04	0.5
EC project administr.		0.06	0.04	0.02	0.07	0.13
Totals²²	3.2	3.3	3.9	1.2	2.0	7.1

Table 1. Summary table of Euratom contribution in 2008 value. All numbers are expressed in billion EUR, the First Plasma (FP) date is 2025 and the start of the performance operation (DT) is in 2035.

Total cash to IO is split as follows:

Construction budget (45.46% of share) includes the cost of Final Installation activities after First Plasma

Operations budget (34 % of share) includes: running costs of the machine, provision for operational upgrades and spares, decommissioning and deactivation costs

F4E in-kind include the costs of all contracts to provide Euratom's in-kind contribution and takes into account an estimated return revenue from the Reserve Fund.

F4E admin provides an upper limit to F4E administrative costs.

Other activities include: TBM, DEMO, DONES, JT60-SA operation, cash to Japan and other minor horizontal activities.

EC project administr. is the average Commission administration costs of the project. Figures after 2020 are based on the average budget for the period 2014-2020 (EUR 0.67 million current value).

Combining the total estimated cash and in-kind contribution to the ITER Organization, the total additional Euratom contribution (through the Fusion for Energy budget) from 2021 till the end of 2035 is now estimated at about EUR 5.7 billion (EUR 8.4 billion in current values). Adding the operational cost of Fusion for Energy's administration (up to EUR 0.8 billion), Fusion for Energy's other activities such as Test Blanket Module and Broader Approach (EUR 0.5 billion) and the European Commission average administration costs of the project (EUR 0.13 billion), the total Euratom resources for the same period are estimated at EUR 7.1 billion (EUR 10.4 billion in current values). To be noted that the ITER Council of November 2016 requested the ITER Organization to make further cost savings.

The figures given above represent the overall Euratom contribution to ITER construction²³. A complete overview of the estimated distribution of the European resources needed for the

²² Amounts rounded off to one decimal

²³ If the United Kingdom seeks association to the Euratom ITER activities through Fusion for Energy, as mentioned under point II.2, the discussions between Euratom and the United Kingdom would need to cover the level and modalities of the contribution of the United Kingdom and the terms and conditions upon which funding would be made available to United Kingdom based undertakings.

ITER project is given in table 4 of the Staff Working Document. This table also shows the estimate of the European Commission average administration costs of the project, Fusion for Energy's administrative costs and the costs of ITER-related activities of Fusion for Energy.

Euratom contribution current value	Up to the end of the current MFF period		To FP	From FP to DT		
	2007-2013	2014-2020		2026-2027	2028-2035	
			2021-2025			Total²² after 2020
F4E total cash to IO	3.5	1.1	1.5	0.7	1.6	3.8
<i>construction</i>		1.1	1.4	0.4	0.4	2.2
<i>operations</i>		0.0	0.1	0.3	1.2	1.6
F4E in kind contribution		2.5	3.1	0.8	0.7	4.6
F4E administration		0.4	0.3	0.1	0.6	1.0
F4E other activities		0.1	0.5	0.2	0.1	0.8
EC project administr.		0.07	0.05	0.02	0.08	0.15
Totals²²	3.5	4.2	5.5	1.8	3.1	10.4

Table 2. As Table 1, but in current values.

The estimated needs for Fusion for Energy for the construction phase of the project from 2021 until First Plasma in 2025 will therefore be about EUR 3.9 billion (2008 value).

III.3 Solid basis to succeed in constructing ITER, supported by independent reviews and continued commitment of the ITER Members

Important recent developments provide a good basis for the ITER project to move forward towards success, although risks still exists. The final design for components needed for First Plasma has reached 89% while that for non-First Plasma components stands at 71%, according to information provided by the ITER Organization. The maturity of the design gives more reliability to the new schedule and associated resource estimates which have been prepared in close collaboration between the Domestic Agencies and the ITER Organization and take into account therefore the technical capacities and financial constraints of the ITER Members and Domestic Agencies. A new level of cooperation between the ITER Organization and the Domestic Agencies is supported by newly introduced tools²⁴ designed to better cope with design changes that could otherwise lead to delays or extra expenditure.

A positive appreciation of the progress made both by the new ITER management and the project itself has been confirmed by the ITER Council Review Group that concluded in its report that the revision of the schedule was beneficial to the project and was conducted in a

²⁴ In particular the Reserve Fund to address cost of changes initiated by the ITER Organization to the design of a component; and also the creation of joint ITER Organization-Domestic Agencies project teams in key areas of the project, supervised by a joint project management body (Executive Project Board), to identify problems and propose effective solutions.

professional and robust manner. In addition the 2015 Management Assessment of the ITER Organization also acknowledged effective efforts to make the project advance recognising management improvements, including in the decision making processes, as well as improved cooperation and integration of activities between the ITER Organization and the Domestic Agencies. Overall the assessment affirmed that these changes were leading to an acceleration in the progress of the project.

In parallel changes at European level have intensified in early 2016 with the appointment of a new Director in Fusion for Energy with industrial expertise that has aligned the objectives of the Joint Undertaking with those of the ITER Organization, giving rigorous attention to risk management and cost containment measures. Further changes are underway to better deliver the Euratom contribution to ITER on schedule and on budget and to identify potential risks and mitigation measures. Changes introduced to the operation and practices of Fusion for Energy are in line with the recommendations from the European Court of Auditors (ECA) as well as the Commission's own Internal Audit Service (IAS). To date Fusion for Energy has dealt with 83% of the recommendations of the ECA and the IAS, which is now Fusion for Energy's internal auditor in compliance with a recommendation of the ECA. The consolidation and improvement of the financial performance of Fusion for Energy has been confirmed in annual discharge procedures by the European Parliament, based on annual review of the accounts by the ECA that has consistently confirmed the regularity and conformity of Fusion for Energy's accounts.

In June 2016 the Governing Board of Fusion for Energy launched a high-level assessment exercise on the planning for the delivery of the components under Euratom responsibility and the associated resources. The results of this review, presented in December 2016, confirmed the capacity of Fusion for Energy to deliver the Euratom contribution to the new ITER schedule on time and coherent with the *staged approach*. This review also underlined the capacity of the Joint Undertaking to deliver the components required within the current available budget until 2020 and the cost projections made thereafter. Nevertheless design and manufacturing challenges, affecting in particular the critical path, continue to exist and could have further impact on the revised schedule.

As regards the ITER Members, following the completion of the new schedule and associated resource estimates, they are currently engaged in securing the necessary resources for the project. Domestic procedures have been launched in China, Korea, Japan and Russia. The underlying assumption in the political decision-making process of all ITER Members is that Europe will maintain its leadership and support for the ITER project.

The United States Department of Energy in May 2016 published a report on ITER for Congress underlining the positive achievements in the project while advocating to continue the reforms underway. The report acknowledged December 2025 as the earliest technically achievable date for First Plasma ('early finish date'), while noting that further risk of schedule slippages could still materialise. A subsequent detailed review of the project to First Plasma carried out by the United States Department of Energy in January 2017 further confirmed that the project schedule to First Plasma should have a contingency of 24 months. The United

States nevertheless agreed to continued participation in the project, with a further review in 2019.

The reorientation of the project has been crucial in sustaining the support and commitment of all ITER Members to the project.

IV. MONITORING AND TACKLING THE INHERENT RISKS OF ITER

ITER as a first of a kind large-scale international project at the technological frontier of knowledge is exposed to inherent risks as regards long term schedule and cost predictability, but also in terms of stability of management and governance.

The new schedule and associated cost estimates, together with the changes brought to management and governance, now give more confidence on the successful completion of ITER construction. Important challenges remain, in particular the completion of the buildings and vacuum vessel, both Euratom contributions which are on the critical path of the project. Strong risk management is therefore key for the project and notably for the success of the new baseline in particular to address remaining risks in terms both of schedule and resources. In particular, independent reviewers of both the ITER Organization and Fusion for Energy indicate that the completion of First Plasma by December 2025 is the earliest technically achievable date and includes no contingency. To ensure schedule reliability, a reasonable contingency should be included. In particular, the budget estimate of Fusion for Energy until First Plasma was considered reasonable, with a possible uncertainty of 10% due to overall project delays.

IV.1 Measures to address risks at overall project level

The new management of the ITER Organization has embraced risk management principles which are applied to other large engineering projects, in particular to meet the First Plasma date in 2025. A quantitative approach to risk management is now been taken regarding the probability of risk occurrence, its impact (in months and Euros) and defining mitigation actions. All main risk classes as well as potential new risks are addressed. A Project Risk and Opportunity Management Committee is in place and the Project Risk Register is being further improved and is now accessible to all staff of the ITER Organization and Domestic Agencies. Further progress is however needed to freeze the interfaces of components as this has a critical role in reducing risks of schedule slippage and cost increase.

An important element of this system is the set of milestones, introduced for the first time by the ITER Council in November 2015 and further developed in June 2016, against which the progress of the project and its adherence to the schedule can be better monitored. This will allow deviations in the execution of project to be identified and addressed earlier. The ITER Council has also decided to carry out regular six-monthly in depth risk reviews focused on critical areas of the project, starting with risk management in 2017. These reviews are another way to identify possible risks and to address them before they have a negative impact.

At the same time further improvements need to be made in the governance of the ITER Organization for effective oversight of the project. In this respect, in November 2016 the ITER Council agreed to reduce the number of sub-committees, rationalise their function and

eliminate overlaps. In 2017 it will analyse other simplification opportunities to focus governance on delivery and strategic issues.

IV.2 Measures to address risks in the European participation

In parallel to a comprehensive strategy to make the ITER project a success Euratom, its Member States and Switzerland, as members of Fusion for Energy, have to continue with substantial efforts to improve the performance of the Joint Undertaking.

A culture change is underway in Fusion for Energy. It focuses on accountability for cost, the introduction of reporting systems to better address potential risks and the introduction of milestones against which the execution of the Euratom contribution is better monitored. Regarding cost risks, in spring 2015 Fusion for Energy initiated a major exercise for the revision of its own cost estimate at completion based on information from individual contracts and packages of work. Following this exercise a cost risk register has been adopted. The new management of Fusion for Energy is focused on stemming cost increases and schedule delays in the two most critical areas of the Euratom contribution (buildings and vacuum vessel) and is reinforcing project control and updating cost estimated for completion of major systems on a monthly basis. The Commission will require Fusion for Energy to seek further cost containment measures, including a comprehensive strategy for dealing with cost claims from contractors.

Based on the lessons already learned and the results of the 2017 mid-term review of Fusion for Energy the Commission will continue to reinforce its oversight of the Joint Undertaking, which will be reflected through a new Administrative Agreement to anchor not only the changes stemming from the new Financial Regulation that entered into force in 2016 but also effective reporting and monitoring.

V. ITER: THE WAY FORWARD

Euratom has shown strong leadership to address the challenges of the ITER project and to put it back on track. The radical measures adopted in particular since 2015 are now yielding encouraging results. Progress is visible on the ITER site, with the construction of many buildings advancing well, mainly under European responsibility.

This progress, corroborated by independent experts and recognised by the ITER Members themselves, confirms that the actions taken were necessary to reorient the project.

Following the 2016 ITER Councils the ITER Organization is set to follow the *staged approach* with the aim to minimise the cash contributions needed from the ITER Members. It has an updated baseline for the project covering the new schedule, estimated cost and the staff resources for the period up to December 2025 (earliest achievable date for First Plasma) and an indicative schedule and cost baseline for the period from 2026 to Deuterium Tritium operation in 2035. While both Euratom and Fusion for Energy remain fully committed to adhering to the revised schedule and thus achieving the First Plasma Date of December 2025, experience from the construction of similar large scale one-of-a-kind facilities shows that achieving First Plasma should be subject to a contingency. Based on the input of independent

reviews made in 2016, and 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 budget would be appropriate.

It is now time for the ITER Members to launch their internal procedures for the approval of the budgetary requirements. Several ITER Members have already indicated the availability of funding for their contributions but are not likely to make formal commitments before Euratom's position is clarified. For Europe the new schedule and its associated costs, backed up by the improvements in the project, provide the necessary grounds for the Commission to request the support of the European Parliament and a mandate from the Council of the EU to approve the new ITER Baseline *ad referendum* on behalf of Euratom, most likely at a Ministerial level ITER Council meeting in 2017. The Euratom approval needs to be *ad referendum* since the final Euratom contribution from the EU budget to the ITER project and the other costs related to the activities of Fusion for Energy and to the management of the ITER project will be subject to the Commission's proposals and outcome of negotiations on Brexit and the next Multiannual Financial Framework post 2020.

This mandate will not only ensure the Euratom support to the new schedule but will in addition demonstrate the continued commitment of Europe to ITER and reinforce European leadership in the project. Our international partners in ITER expect that Europe, as ITER host, continues to be the driving-force in keeping the project on track.