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Status of the ITER Project

accompanying the

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT AND THE COUNCIL

ITER status and possible way forward

{COM(2010) 226 final}

STATUS OF THE ITER PROJECT

1 INTRODUCTION

ITER[1] is a global project to build and operate an experimental reactor with the aim of demonstrating the scientific and technological feasibility of fusion energy for peaceful purposes. Its successful accomplishment would establish whether fusion can become a major sustainable energy source contributing to the EU's strategy for the long term security in the supply of energy. Nuclear fusion, the process that powers the sun, offers the prospect of producing an essentially limitless source of safe and clean energy with no CO_2 emission, contributing to tackling climate change. The ITER project should be followed by a demonstration reactor, expected around 2050, on the path towards the commercial exploitation of fusion power. Its implementation will concur to the achievement of the "Smart Growth" priority of the European strategy for smart, sustainable and inclusive growth (Europe 2020 strategy) as it will strengthen knowledge and innovation as drivers of the EU future growth.

ITER is a magnetic fusion energy experiment, building on the achievements of several European precursors and especially on the Joint European Torus[2] (JET), currently the world's highest performance fusion device. Indeed, it is recognized by scientists that the most advanced fusion experiments to date have all been based on “magnetic confinement”[3]. ITER is a uniquely global cooperation - a pioneering initiative seeking to demonstrate shared technological solutions to global problems.

With strong backing of the Council, the Commission successfully negotiated with international partners on behalf of the Community and succeeded to fix the site for building ITER in Europe at Cadarache, France. Being host of and the largest stakeholder in the project, gives Europe a leading role in ITER's construction and underpins its pre-eminent position in fusion. This position will afford Europe a unique opportunity to benefit from emerging fusion technologies and possible spin–offs. It also endows the Euratom with special responsibility for and commitments to the project.

ITER is conducted under the terms of an International Agreement[4] between the European Atomic Energy Community (Euratom) and 6 other Parties - China, India, Japan, Korea, Russia, and the USA, which was signed in Paris in November 2006 and which entered into force in October 2007. The agreement established the ITER Organization (IO) with full international legal personality, to be responsible for the joint implementation of the ITER project. The Members of the ITER Organization are the Parties to the Agreement and they jointly direct and supervise its conduct through their representation in the ITER Council which is the principal organ of the ITER Organization.

The Agreement has an initial duration of 35 years in order to construct, operate, and de-activate the ITER facilities, broken down as follows:

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1 Originally denoted "International Thermonuclear Experimental Reactor".

2 JET is situated at the Culham Science Centre in the United Kingdom.

3 An alternative approach uses so-called "inertial confinement", which is in a considerably less advanced state of development towards practical exploitation.

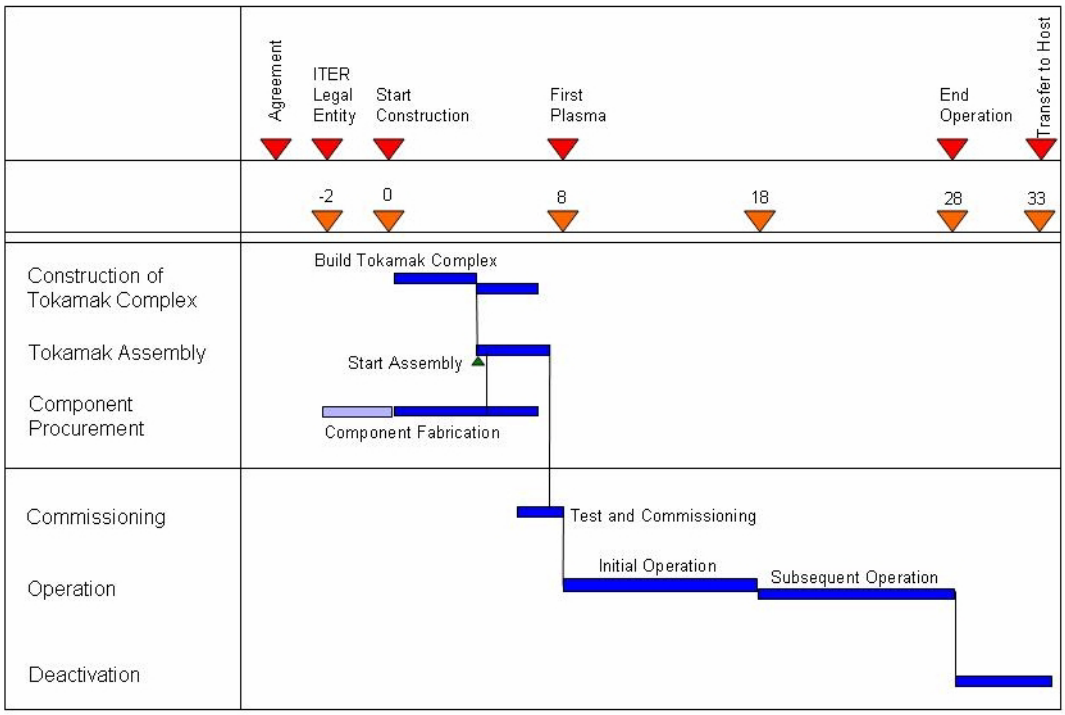
4 OJ L 358, 16.12.2006, p. 62–80.

– The construction period, the most intense in terms of resource needs, was initially scheduled for 10 years and would culminate in the so-called "First Plasma", the physics process materialising the start of the operation.

– This will be followed by an operation phase of about 20 years during which ITER will be progressively brought to its full performance capabilities.

– After the end of operations, there will be a 5 years phase of deactivation, whereupon the host country, France, will take over responsibility for the facilities and their decommissioning using a fund set aside during the operation for this purpose.

Figure 1: overall planning of the ITER project[5].



Under the ITER Agreement each Member has its own "Domestic Agency" responsible for managing its contribution, and especially for procuring the various components needed to build ITER and to be provided to ITER Organization as contributions in kind .

The Euratom contribution for ITER is entirely managed through the European Joint Undertaking for ITER – "Fusion For Energy" (F4E), established as the European Domestic Agency by the Council in March 2007[6] and based in Barcelona, to discharge the international commitments of Euratom under the ITER Agreement. The Members of F4E, Euratom, the 27 Member States plus Switzerland, are all represented in its governance. The EU contribution to

[5] This planning is included in the "Final Report of the ITER Engineering Design Activities" Documentation Series No. 21, IAEA, 2001, referred in the article 3 of the ITER Agreement and included in the attachment "Final Report of Negotiations on ITER Joint Implementation, 1 April 2006 Attachment 2_D".

[6] OJ L 90, 30.3.2007, p.58.

ITER construction mainly consists of major systems and components for ITER procured by F4E and provided "in kind" to the ITER Organization as well as cash provided to IO.

The Commission represents Euratom, as one of the 7 Members of the ITER Organization, in the ITER Council and its subsidiary bodies. It also represents Euratom in the F4E Governing Board and provides more than 80% of the F4E resources.

The construction of ITER is technically extremely challenging in its scale and complexity. It will represent a major engineering undertaking on the scale of the construction of a very large commercial power plant with large-scale industrial contributions in civil, mechanical, electrical and nuclear engineering combined in unprecedented conditions. It is foreseen that about three quarters of the overall EU contribution to ITER will result in contracts with the European high-tech industry. The timely fulfilment of these contracts will involve the transfer to European industry of major fusion specific technologies and know-how built up over 50 years in the European fusion programme. As experience has shown, large scale application of leading-edge technologies in scientific infrastructures stimulates innovation and increases competitiveness of European high-tech industries throughout the construction period well before the project starts yielding its scientific results. This project should also contribute to encouraging talented young scientists and engineers to develop their careers in Europe.

The launch of the ITER project marked an important milestone in the development of world-wide big science collaboration. For Europe the project is emblematic of the EU's capacity to take a leading role at the global level in science and technology. The ITER Organization presents a possible model for future large scale international collaborative infrastructure projects.

2 THE CURRENT CONTEXT

The Member States have been following work on ITER through their representation in the Governing Board of F4E. The EU Council was informed in late 2008[7] that the estimated costs for ITER construction would be much higher than the initial estimates of 2001, on the basis of which the international ITER agreement of November 2006 had been negotiated. The most important factors responsible for the increases of the cost estimates were summarized as follows:

- the need for additional and more complex technical components to increase assurance of ITER success [not foreseen in 2001 with the level of knowledge at that stage];
- escalation of the materials and construction costs much faster than average inflation rates;
- increased complexity of project integration in managing interfaces across 7 Parties [rather than the 3 Parties foreseen in 2001];
- the effort needed to ensure sufficient design specifications of the ITER components to initiate tender action for industry [In 2001 the design was generic; and not detailed enough for tenders];
- 2001 cost estimates that are now seen to have been rough and tight.

[7] Note from the Commission on ITER status for the Competitiveness Council of 1-2 December 2008. 16451/08 – RECH 394 – ATO 119.

- higher resources than foreseen for inspection and testing to comply with the Quality Assurance requirements for a nuclear installation and the millions of parts to be assembled;
- the start-up costs of establishing autonomous organisations from scratch.

Since the end of 2008, the Commission has kept the Council of the EU closely informed on any development in this respect. The European Parliament has also expressed its interest in the project on various occasions.

On 29 May 2009, the Commission presented to the Council a summary of the status of the ITER project, the challenges faced and the actions taken. The Commission also set out a number of **boundary conditions** that it considers pre-requisite to be met in order to ensure the success of the project at acceptable cost and reasonable risks. These conditions include credible cost assessment and cost containment policies, realistic timetable and sound management of the project at all levels.

At its meeting of 16 November 2009[8], the Council confirmed its unanimous support to the ITER project, understanding that the construction cost of ITER would be substantially higher than initially planned, and "provided that the boundary conditions elaborated by the Commission in the end can be met".

The Council also concluded that the "**Baseline**", which refers to the inter-related elements of scope (specifications of the machine to build), schedule (time table for construction) and cost for ITER, must build upon a scenario providing the optimal conditions for the project by integrating the above-mentioned boundary conditions. It called for action to be taken on necessary management changes, and a strong policy to be applied on cost reduction and cost containment. In addition, the Council invited the Commission to explore possibilities for providing the increased funding needed.

Today, for our international partners in ITER, the critical step for the project is to agree on the Baseline which is an item to be decided upon at the next meeting of the ITER Council currently scheduled for mid June in China. The adoption of the Baseline by the ITER Council would enable the ITER Organization, its Members and their Domestic Agencies, to develop a coherent and credible basis for the construction of ITER.

The adoption of the Baseline had been targeted for the fifth ITER Council meeting in November 2009 but it was not achieved. The Commission delegation, following the political direction of the EU Council, made clear that the boundary conditions were not respected and so declined to adopt the proposed schedule. Euratom, the main contributor to the project, was isolated in taking this position. In the run up to the currently schedule June 2010 ITER Council when the final agreement is expected on the Baseline, Euratom has already delayed this decision.

[8] Documents 15815/09 RECH 401 ATO 136 + ADD 1 RESTREINT UE.

3 ITER COST

3.1 Framework of the ITER Agreement

Through the international ITER Agreement, Euratom has taken the major responsibility for the construction phase of the project. During this phase Euratom contributes 5/11 (around 45%) of the total, of which 80% is funded from Euratom and 20% from France, the rest being equally divided among the other 6 ITER Parties (1/11 or around ~9% each)[9].

During the operation and deactivation phases, Euratom will contribute to 34% of the total costs.

Table 1: ITER project cost breakdown and sharing[10]:

ITER Agreement Total Value of the ITER Project and EU Share for the various Phases of the Project

		Total Values	Cost Sharing		EU share	
		MEuros [2001 value]	EU	other Parties each	MEuros [2001 value]	MEuros [2008 value]
Construction (10 Years)	In-kind	3,282	45.46%	9.09%	1,492	1,735
	Cash	1,790	45.46%	9.09%	814	945
	Total	**5,073**	**45.46%**	**9.09%**	**2,306**	**2,680**
Operation (20 Years)	Operation costs	**4,847**	**34.00%**	**13.00%**	**1,648**	**1,915**
	Fund for decommisioning	**530**	**34.00%**	**13.00%**	**180**	**209**
De-Activation (5 Years)	**Total**	**281**	**34.00%**	**13.00%**	**96**	**111**
TOTAL		**10,730**			**4,230**	**4,916**

In 2001 the ITER Parties (then EU, Japan and Russia) provided cost estimates of the project on the basis of technical specifications prepared by the ITER design team at that time. These estimates provided the basis for the ITER Parties to make their decisions on the scope of their involvement in implementing ITER[11] and serve as a basis for the conclusion of the ITER Agreement in November 2006.

3.2 Initial estimates for the Euratom contribution to ITER construction (based on 2001 estimates)

Due to the specific nature of the Agreement, Euratom, as every other Party, committed to provide the agreed **contributions in kind independently of the final cost** of procuring and delivering those components. The final cost of each ITER component to be delivered in kind

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9 Cost Sharing for all Phases of the ITER Project. Attachment 2(b) to the Final Report on Negotiations on the ITER Joint Implementation, 1 April 2006

10 This table derives from the attachments to the ITER Agreement: "Final Report of Negotiations on ITER Joint Implementation, 1 April 2006 Attachment 2_A", and "Final Report of Negotiations on ITER Joint Implementation, 1 April 2006 Attachment 2_B".

11 Common Understanding on Procurement Allocation, Attachment 2(c) to the Final Report of Negotiations on ITER Joint Implementation, 1 April 2006.

will be known only when the procurement process is completed and the components accepted by the ITER Organization.

According to the 2001 estimates, the Euratom contribution, amounted to **EUR 2680 million** (in 2008 value), corresponding to EUR 1 735 million for the components/systems to be provided "in kind" , and EUR 945 million to be provided "in cash" to the ITER Organization. These 2001 estimates for the Euratom contribution exclude F4E other activities[12] and its running costs, as F4E was established late 2007.

3.3 Revision of the estimates for the Euratom contribution

The original estimates for Euratom contributions have evolved since the original calculations in 2001 to take account of the latest updated estimates from 2008 and 2009:

- of the revised actual costs to Euratom of meeting its obligations for contributions in kind, which were assessed during 2008 by an Ad-Hoc Group to the F4E Governing Board chaired by R. Toschi[13].On average, more than half of the differences between the 2001 estimate and the 2008 one could be attributed to so-called internal factors (specific to the project) mainly linked to evolution of the project e.g. (i) design changes; (ii) assessment of technologies; (iii) Quality Assurance. The rest of the difference is due to external factors that would affect any similar construction project such as increases of the real cost of raw materials and labour. For one of the major components, the ITER buildings, an independent assessment was carried out by a group of experts nominated by the Member States and by the Commission. The outcome of this assessment is fully in line with the costing exercise made by the Toschi group and a civil engineering consultancy contracted by the ITER Organization[14].
- of the IO revised costs related to the design and the management resources needed, which were assessed by an international experts panel set up by the ITER Council and chaired by F. Briscoe[15].

and to include the costs of operation and other activities of F4E following its establishment in 2007 which were not foreseen in the 2001 cost estimates.

3.4 Current estimates of Euratom contributions during the ITER construction period

The initial period estimated for the construction of ITER was of 10 years. The schedule currently used as a working basis aims at starting the operation phase with a First Plasma in November 2019. Because the first operation will take place without all the equipments installed in ITER, the operation phase will then overlap with the completion of the construction phase. For the purpose of budget planning, the ITER construction could be considered to extend to 2020, as all the major investments are expected to be completed by that time.

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12 "Other activities", according to the tasks of the Joint Undertaking as per ref.**Error! Bookmark not defined.**, refer to the ITER Test Blanket Programme, the implementation of the Broader Approach agreement with Japan and to the activities in preparation for the construction of a demonstration fusion reactor.

13 Report from the Ad Hoc Group on the Cost of the EU In-kind Contributions to ITER. ref F4E(08)-GB08-07. 8th meeting of the F4E Governing Board of 4th December 2008.

14 Report on the independent assessment of ITER buildings cost estimates dated 17.December.2009 and transmitted to the Member States on 20 January 2010.

15 Assessment of resource estimates for ITER construction, 5th meeting of the ITER Council 18-19 November 2009. Record of decisions, attachment 8 appendix C.

The current cost estimates updated by F4E according to the proposed schedule and presented to the F4E Governing Board in March 2010[16] amount to EUR 7 253 million (in 2008 value), subject to possible modification upon adoption of the Baseline (scope, schedule, cost). These current estimates comprise: EUR 6.6 billion (6603 million in 2008 value that would require EUR 5 282 million of funding from Euratom and EUR 1 321 million from France) for the contribution to ITER construction and EUR 650 million for the F4E running costs and other activities. The resulting overall contribution required from Euratom would be of EUR 5.9 billion (EUR 5 892 million)[17]. A comparative evolution of the cost estimates is presented in Table 2 and related Figure 2 here after.

16 F4E(10)-GB15-08-RESTRICTED -F4E Governing Board meeting of 30-31 March 2010.

17 To this contribution about EUR 40 million should be added, which come from the F4E members (EURATOM, 27 Member States and Switzerland) other than EURATOM and France.

Table 2: Evolution of estimates of ITER related costs from 2001 estimates to updated estimates

	EU contribution to ITER construction (in M€ 2008 value *)	
	As agreed in 2006 on the basis of 2001 cost estimate	2010 update
Euratom	*2145*	*5282*
France	*536*	*1321*
total	2680	6603

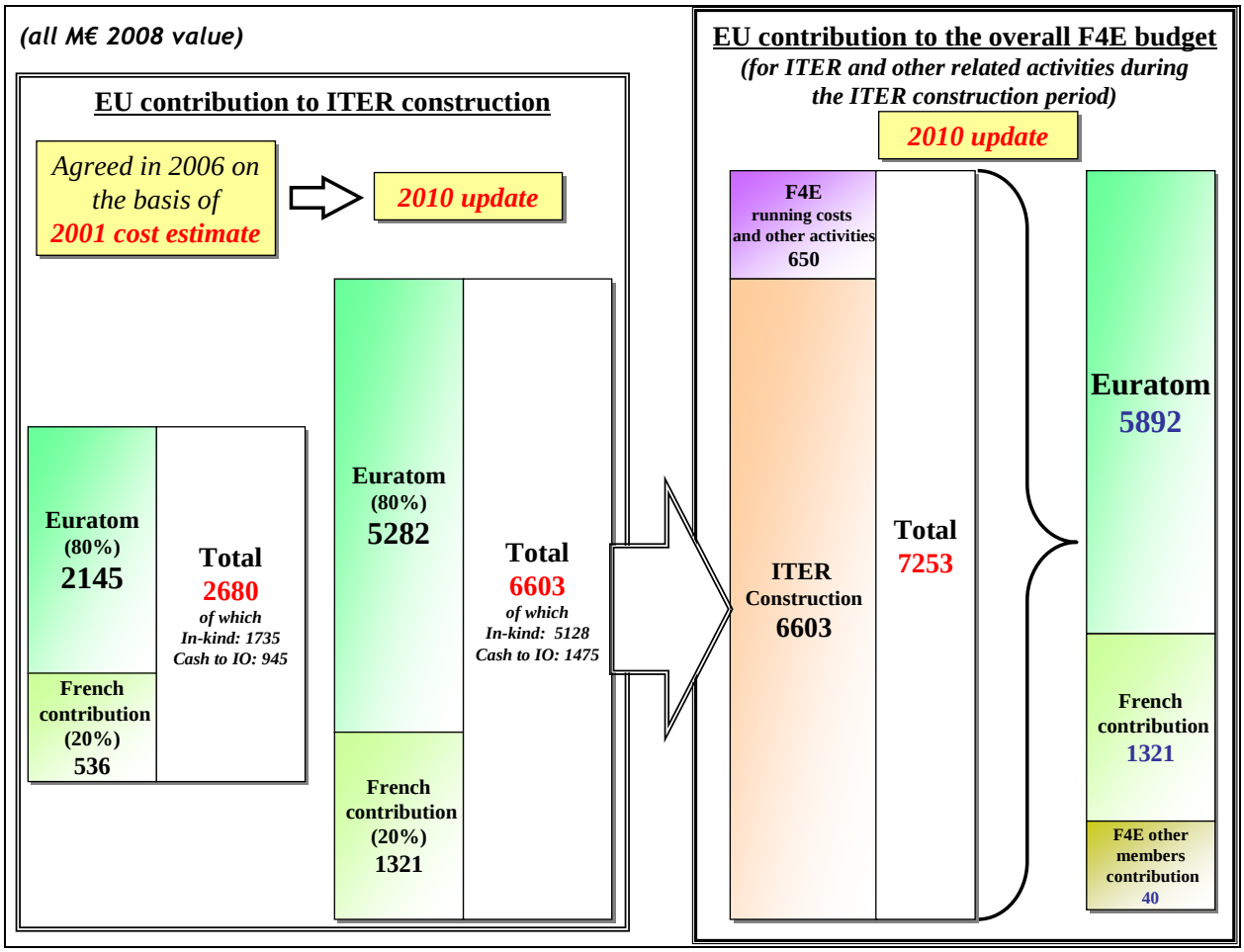
Overall F4E budget during the ITER construction period 2010 update (in M€ 2008 value*)	
F4E running costs and other activities	650
ITER	6603
Total	7253

Breakdown contributions to the overall F4E budget during the ITER construction period 2010 update (in M€ 2008 value*)	
Euratom	*5892*
France	*1321*
F4E other members**	40
Total	7253

* These estimates do not include inflation from 2008 onwards.

** The F4E members (Euratom, 27 Member States and Switzerland) other than Euratom and France make contributions not exceeding 10% of the annual resources required for the administration of the Joint Undertaking (a total of about EUR 40 million for the ITER construction period, 2007-2020)

Figure 2: Graphical representation of the Table 2



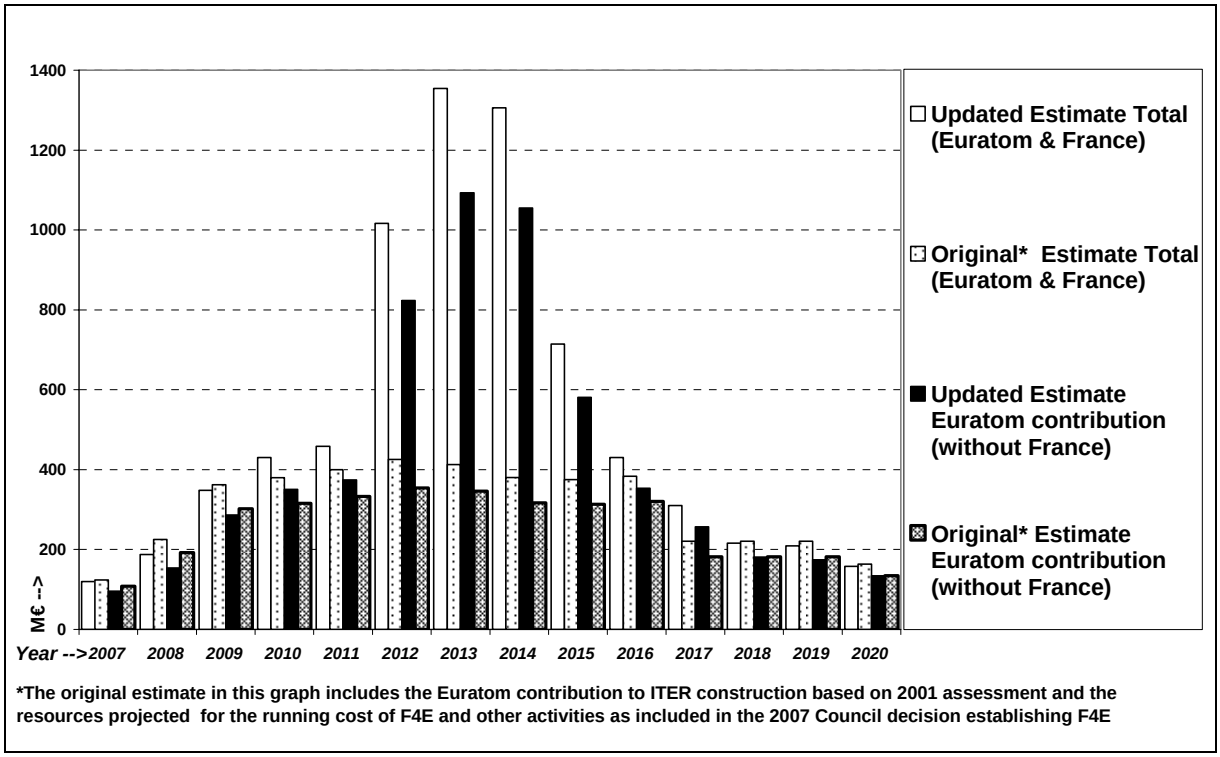
Indicative profiles for cost estimates and Euratom's contribution during the ITER construction period

The estimate of Euratom's share of the F4E resources (including F4E running costs but excluding the contribution from France) throughout the whole construction period (2007-2020) of about **EUR 5.9 billion** (in 2008 value) is broken down as follows:

- For 2007-2011 (5 years) the estimated financial needs are about EUR 1.3 billion;
- For 2012-2013 (2 years) the estimated financial needs are about EUR 2 billion;
- For 2014-2020 (7 years) the estimated financial needs are about EUR 2.6 billion.

A profile of the original and updated estimates of Fusion for Energy needs and the Euratom's share total contribution to ITER (including F4E running costs and other activities but excluding the French contribution to ITER construction) is presented in Figure 2 here under:

Figure 3: F4E total indicative resource estimate (2008 value) during the ITER construction period.



The peak in the resources needed in the years from 2012 to 2015 is linked to the start in 2012 of the major construction activities on site and the launch of the series production of many components that will follow the fabrication of prototypes.

3.5 The gap between the initial and the updated cost estimates

The initial cost estimate of the Euratom contribution for the ITER construction (to be provided by Euratom and France), based on the 2001 assessment, was of EUR **2.7** billion (in 2008 value and excluding F4E running costs and other activities).

As the updated total F4E cost estimates including the contribution to the ITER construction and the F4E running costs and other activities are of about EUR **7.2** billion (in 2008 value) for the period of ITER construction (2007-2020), more than a doubling of the Euratom contribution to ITER construction is required compared to the initial estimates (see Table 2).

Thus, there is a substantial gap between the initial and the current updated overall estimates that needs to be considered in order to take decisions about the future of the project.

The cost estimates of the project are continually being improved and refined as is the case for large-scale and long-term infrastructures/research projects. Uncertainties around the current cost estimates for the early period of the construction phase have been significantly reduced mainly due to the advancement on the designs and the assessments made by industry.

However, beyond that early period of construction, it cannot be excluded that further cost increases will emerge in the future through the later parts of the construction and the operation phases of the project (e.g. during the process of assembling the many thousands of components, coming from the 7 different parts of the world).

A strong policy for cost containments already initiated both at the level of the ITER Organization and of F4E will have to be vigorously pursued in order to control and mitigate as much as possible further escalation of costs.

The gap between the programmed expenditure for 2012 and 2013 and the estimated needs

The current instrument for funding of ITER is the Seventh Framework Programme (FP7) of the European Atomic Energy Community (Euratom) for nuclear research and training activities (2007 to 2011)[18]. The provisions in the Multiannual Financial Framework (2007-2013), covering the Euratom FP7 and programmed expenditure for 2012 and 2013, were made taking into account the initial cost estimate, and the need for establishing the Domestic Agency, F4E.

Some EUR 2.1 billion (in current value)[19] of commitment appropriations from the Euratom Budget would be needed for the years 2012-2013 in order to commit the procurements needed early in the construction process. Considering the programmed appropriations available for this purpose in the current Multiannual Financial Framework (EUR 346 million for 2012 and EUR 344 million for 2013 in current value), Euratom is facing an estimated deficit on commitment appropriations of about **EUR 1.4 billion** (in current value) **for the years 2012-2013** (EUR 550 million in 2012 and EUR 850 million in 2013) in addition to the contribution from France, in order to honour the Euratom obligations under the ITER Agreement.

[18] OJ L 460, 30.12.2006.

[19] While cost estimates for ITER construction have been done in EUR 2008 value, to allow immediate comparison with existing ceilings in the budget instruments, the need for 2012-2013 are presented in EUR current value.

Table 3: gap in the resources needed

*in million Euro (current value**Error! Bookmark not defined.**)*	**2012**	**2013**	**TOTAL**
A- F4E projection on commitment appropriations from Euratom FP7 budget	ca. 900	ca. 1200	ca. 2100
B- Indicative amount available for the new Euratom FP7 budget contribution to ITER (row A in table 1)	ca. 350	ca. 350	ca. 700
Additional commitment appropriations required for Euratom (A – B)	**ca. 550**	**ca. 850**	**ca. 1400**

4 MEETING THE BOUNDARY CONDITIONS, STATE OF PLAY.

Good progress is being made in meeting the boundary conditions that the Commission believes necessary to ensure the success of the project at acceptable cost and reasonable risks.

4.1 Cost estimates

In view of the scale of variations indicated, as well as the uncertainty of the revised estimates for the IO and for F4E, each of these bodies has been subjected to independent expert assessment (see footnotes 14 and 15). Significant progress has been achieved on the assessment of the cost estimates for ITER construction, which are the best estimates attainable. This is mainly due to the increase in the level of maturity of the design of the machine which allows decreasing the ranges of uncertainty and to the development and implementation by IO of more rigorous and transparent costing methodologies.

Those estimates are not foreseen to undergo material variations in the short term. Given the scale and nature of an undertaking such as ITER at the edge of global scientific and technical knowledge, cost estimates and the management of cost evolution will be subject to an agreed range of cost containment measures to minimise the risk of unforeseen cost overruns.

4.2 Cost containment policies

As from 2008, when IO and F4E entered into the implementation phase of the ITER construction, and in face of the high technical pressure giving rise to increasing costs, cost containment policies and measures have been pursued with the highest priority by the IO and F4E and feature as regular items on the agendas of their governing bodies.

Focusing mainly on the design of the ITER machine and its integration, the ITER Organization has been directed to pursue measures to optimize cost, reduce risk and simplify interfaces. A range of measures are being pursued in this sense, including:

- value engineering studies for the overall design[20,]

[20] Value engineering is a systematic method to improve the "value" of goods or products and services by using an examination of function.

- rationalising the allocation of procurement obligations,
- agreeing standards and
- exploiting economies of scale.

The ITER Council has encouraged further activities along the lines presented and charged the ITER management to make quantified assessments of their effects to be monitored. In this regard, the European Commission would encourage an active and transparent monitoring of an agreed list of cost containment measures to be approved by the ITER Council and to be reported on annually or as soon as significant cost escalations arise.

At EU level, the F4E Governing Board on 30-31 March 2010 discussed the efforts made on cost containment for the EU in-kind contribution and found that F4E is engaged on several fronts in a wide range of technical, contractual and industrial measures that aim to reduce risks and contain costs. These measures include:

- procurement strategies
- value engineering for the procurements
- contractual and industrial measures including active promotion of competition and adapting the provisions of F4E contracts.

These measures will be complemented by analyses of the recently awarded tenders which should allow F4E to identify trends and to further refine its strategy.

Euratom and other Members of the F4E Governing Board shall receive a report setting out progress on these measures annually or in real time when there is a risk of significant cost escalation.

4.3 Realistic timetable for the ITER construction

The schedule of construction leading to an operational phase by the end of 2018, as proposed by IO in September 2009, was found to be too risky and costly, in particular for Europe which has the responsibility for providing major components early in the construction. On these grounds and in accordance with the conclusions of the EU Council, Europe opposed the adoption of this schedule at the last ITER Council of November 2009. This triggered criticism from the other ITER Members.

Since November 2009, the IO and the Domestic Agencies of the Parties have been working on a revised and more realistic schedule, seeking, where possible, to accelerate schedules to meet demanding delivery dates and to mitigate risks. After intense work of F4E in consultation with IO, industry and other Domestic Agencies, it appears that the current proposed schedule, under which the operational phase would be attained in early November 2019, appears to be technically credible and achievable, and in line with delivery dates that the Parties assess to be realistically achievable, provided that the risk mitigation approaches are successful.

4.4 Sound management of the project at all levels

- Management of the European contribution to ITER

A management assessment of F4E, conducted in the second half of 2009, concluded that radical changes were needed to the organisation and culture of the agency to put it in a position to fulfil Europe's obligation to ITER. Early January 2010, the Director of F4E resigned and a new Director has been appointed *ad interim*. He is restructuring F4E in light of the management assessment report. All efforts will also be made to review the functioning of F4E

governance in ensuring cost containment and most efficient use of resources and the monitoring of F4E activities by the Commission will be reinforced.

- Management of IO

The ITER Council of June 2009 established a Management Assessment of IO. The report, delivered to the last ITER Council (November 2009), stated that changes were needed of both the top management and the organizational structure.

The ITER Parties reached in February 2010 a common understanding concerning changing the top management of IO. The agreed steps are now being taken with the view to formalising top management change at the ITER Council in June 2010.