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THE EUROPEAN CONTRIBUTION TO ITER: ACHIEVEMENTS AND CHALLENGES

Final report

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THE EUROPEAN CONTRIBUTION TO ITER: ACHIEVEMENTS AND CHALLENGES

Final report

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The contribution from further interviewees is greatly appreciated.

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List of abbreviations

BAUA	BA unit of account[1]
CAS	Credit Allocation profile
DA	Domestic Agency
DG	Director General
DT	Deuterium-Tritium
EFLO	European Fusion Laboratory Liaison Officers
F4E	Fusion for Energy
FP	First Plasma
GB	F4E Governing Board
IC	ITER Council
ILO	Industrial Liaison Officers
IO	ITER Organisation
ITER	International Thermonuclear Experimental Reactor
IUA	ITER unit of account[2]
PA	Procurement arrangement
SME	Small and medium-sized enterprise

[1] One BAUA equals EUR 678 (value 5 May 2005)
[2] In 2008, the IUA exchange rate approved by the ITER Council corresponded to EUR 1 498.16

Executive summary (English)

Scope of the study and methodology

The present document is the final report of the study "The European contribution to ITER: Achievements and challenges".

It serves three purposes. It discharges the reporting obligation entailed in Article 5b of Council Decision 2013/791/Euratom of 13 December 2013 for the Commission to submit to the European Parliament and to the Council a progress report on the implementation of the Decision. It aims to support the Commission in preparing a mid-term evaluation of the execution of European participation in the ITER project in line with the Better Regulation Guidelines. Finally, it serves as an input for the post-2020 Multi-Annual Financial Framework discussion by contributing to the preparation of the Commission's ex-ante evaluation of the EU contribution to the ITER project and the Broader Approach activities under the next Multi-Annual Financial Framework.

The unit of analysis of the study is the European contribution to ITER and as such entails the work scope of the "European Joint Undertaking for the Development of Fusion Energy" (Fusion for Energy, or F4E) which was set up by a Council Decision[3] on 27 March 2007 with the mandate to manage the EU's contribution to the ITER project on behalf of Euratom.

F4E's tasks are defined in Article 1(2) of F4E's Statutes. They are threefold:

1. To provide the contribution of the European Atomic Energy Community (Euratom) to the ITER Organisation (IO) for the ITER project, under the terms of the International ITER Agreement;
2. To provide the contribution of Euratom to Broader Approach (BA) activities[4] with Japan for the rapid realisation of fusion energy, entailing at present three collaborative projects located in Japan;
3. To prepare and coordinate a programme of activities in preparation for the construction of a demonstration fusion reactor (referred to as DEMO) and related facilities including the International Fusion Materials Irradiation Facility (IFMIF).

The temporal scope of the study is the period 2014-2017. The start of the current Multi-Annual Financial Framework (i.e. 2014) is used as the reference point with the end of 2017 as a cut-off point. This means the evaluation is to take into account the important turnaround of the ITER project from mid-2015 and of the management and execution of EU's participation from 2016.

Three main sources of data have been used for this report: literature (including data provided by F4E), semi-structured interviews with three different groups of stakeholders (F4E staff, IO staff and other external stakeholders), and a survey among all members of the F4E Governing Board (GB) and the Industrial Liaison Officers (ILO)[5].In the analysis, the data sources have been triangulated to generate findings.

Desk research is a central method to collect information on the progress of the European contribution to the ITER project. A large share of the consulted literature has been produced by F4E; F4E also provided additional data sources and explanations. The data is considered to be reliable given the strong scrutiny under which F4E works, including regular audits by the European Court of Auditors. Given the timeframe of this project data for 2017 has not always been conclusive, the desk research is partly based on draft documents (most notably the Draft Annual and Multiannual Programme Years 2019-2023).

A total of 34 semi-structured interviews (during field visits at F4E and IO as well as by phone) were conducted with different types of stakeholders, each lasting for about an hour.

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[3] Referred to hereafter as F4E's Statutes – Council Decision 2007/198/Euratom amended by Council Decision 2013/791/Euratom of 13 December 2013 and Council Decision (Euratom) 2015/224 of 10 February 2015

[4] See below

[5] Industrial Liaison Officers (ILOs) are a network of representatives from different European countries that together with F4E raise awareness regarding funding schemes and ways to get involved in the ITER project.

The response rate to the online survey was 45% for the Governing Board (GB) members and 36% for the for Industrial Liaison Officers (ILO), which is not very high considering their small populations (60 and 22, respectively) and the high commitment that could be expected from them. The results of the survey can therefore not be statistically generalised to the GB and ILO populations[6]. Although this limitation should be kept in mind when interpreting the survey results, they nevertheless still give an indication of the opinion of GB members and ILOs on the European contribution to ITER.

Summary of the progress report on the implementation of Council Decision 2013/791/Euratom

Introduction

Progress is presented for three stages:

- Revenues of F4E;
- Resource use; and
- Results achieved.

In accordance with the Council Decision, the analysis covers the progress under the current MFF (for the period 2014 till 2017). Due to the timing of the report, final data for 2017 is not always available and the analysis has to rely partly on forecasts as specified in the respective figures in the following sections. Progress is presented in relation to the first two objectives (ITER and BA).

With regards to the unit of measure of progress three different units are used:

- Budget;
- Milestones; and
- Credits.

Budget

The amount of EUR 6.6 billion (in 2008 value) adopted by the Council of the EU in 2010[7] serves as a ceiling for F4E's spending up to 2020.

The estimated Euratom contribution after 2020 is presented in the table below.

Table 1 Summary table of Euratom contribution in commitment appropriations (2008 value in EUR billion)

	To FP	From FP to DT		Total after 2020
	2021-2025	2026-2027	2028-2035	
F4E total cash to IO	1.1	0.5	1.1	2.7
Construction budget	1.1	0.3	0.3	1.7
Operations budget	0	0.2	0.8	1.0
F4E in kind contribution	2.1	0.5	0.4	3.0
F4E administration	0.3	0.1	0.4	0.8
F4E other activities	0.4	0.1	0.04	0.5
EC project administr.	0.04	0.02	0.07	0.13
Totals	**3.9**	**1.2**	**2.0**	**7.1**

Source: COM(2017) 319 final Communication from the Commission to the European Parliament and the Council – EU contribution to a reformed ITER Project

Budget is presented in commitment[8] appropriations and payment[9] appropriations. They usually differ because projects are committed in the year they are decided and are paid over the years as the implementation of the programme and project progresses.

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[6] Louis M. Rea and Richard A. Parker, *Designing and Conducting Survey Research: A Comprehensive Guide*, Fourth edition (San Francisco, CA: Jossey-Bass, a Wiley brand, 2014), 198.
[7] Council conclusions on ITER status of 7 July 2010 (Ref. 11902/10)
[8] Legal pledges to provide finance, provided that certain conditions are fulfilled
[9] Cash or bank transfers to the beneficiaries

Milestones

Milestones are predefined achievements up to 2025 used by IO (called ITER Council or *IC milestones*) and F4E (Governing Board or *GB milestones*) to measure progress of the ITER project.

The milestone list is updated each year with a rolling wave approach, i.e. updated in waves and in more detail as the project continues. F4E uses the milestones to measure progress of its technical objectives by the achievement on time. To increase the degree of detail of the objectives in the short term, F4E has selected some additional milestones (Governing Board or GB milestones) leading to the IC ones.

Credits

"Credits" are a unit used for both, the ITER project (objective 1 of F4E) as well as the BA (objective 2 of F4E). In the ITER project, the in-kind contributions to IO are organised through Procurement Arrangements (PAs) which represent specific work to be performed and delivered to IO. When a PA is developed by IO, milestones are agreed to mark the progress in the execution of the work, some of which have a credit associated to them which is released by IO to F4E whenever the milestone is achieved. Credits do not correspond to the actual costs in EUR borne by F4E for the procurement of that component but to the values of each PA as agreed between IO and its members. Contributions are also formalised under PAs between F4E and the Japanese Implementing Agency for the BA. As for ITER, the accounting between the involved parties in the BA is done in credits, with the unit "BA unit of account" (BAUA).

Revenues

The operating revenues of F4E include mainly:

- The Euratom contribution;
- The ITER Host state (France) contribution; and
- The Membership contributions.

The contribution from Euratom constitutes the main source of revenue for F4E. The ceiling for the Euratom contribution from the general EU budget to the ITER project is set in Article 16 of the Council Regulation (EU/EURATOM) No 1311/2013[10] of 2 December 2013 for the years 2014-2020 at EUR 2 707 million (in 2011 value). The contribution is detailed in the Council decision 2013/791/Euratom[11], at EUR 2 915 million (in current value). During the MFF 2014-2020, as of 31 December 2017, F4E has received a total of EUR 1 741.6 million in commitment appropriations and EUR 2 090.9 million in payment appropriations[12] (both in current values) from Euratom contributions.

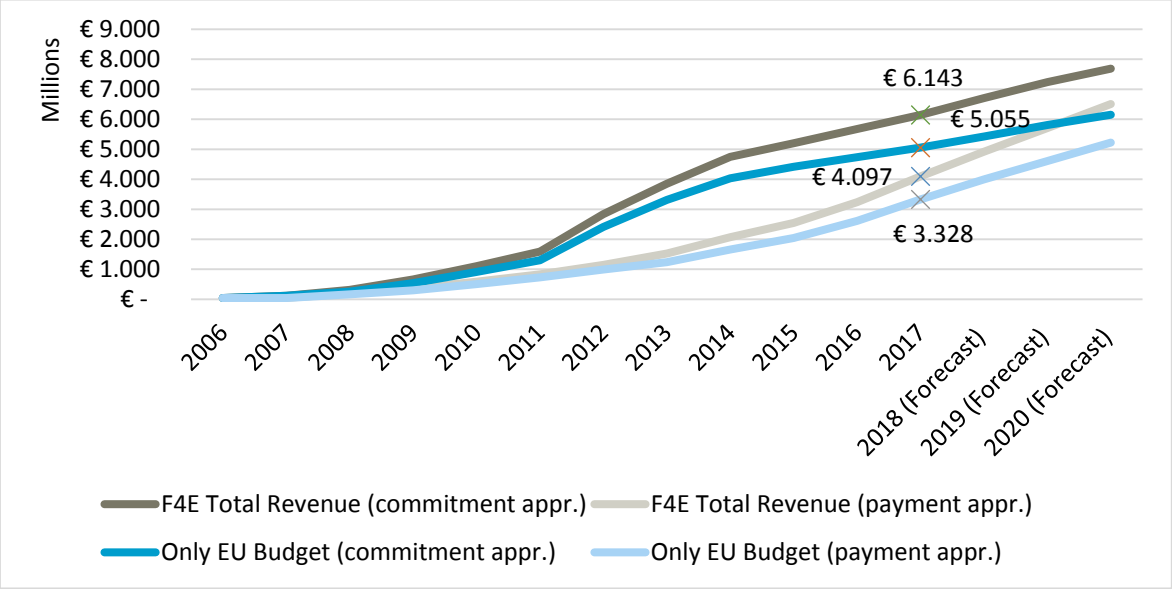
The contribution from the ITER Host State (France) covers 9.09% of the total costs of the ITER construction phase, equivalent to 20% of the F4E budget for ITER construction. As of 31 December 2017, the contributions amounted to a total of EUR 1 026.7 million in commitment appropriations and EUR 708.3 million; during the MFF 2014-2020, as of 31 December 2017 the amounts are EUR 509 million and EUR 445 million, respectively.

The Membership Contributions are established and adopted annually within the budget. They correspond to 10% of the administrative budget. By end of 2017 the total revenue from Membership Contributions was EUR 39.3 million in commitment appropriations and EUR 39.7 million in payment appropriations. Only looking at 2014-2017, the two figures both amount to EUR 18.3 million.

A chart with a running total of commitment and payment appropriations only from all revenue streams as well as separately from the EU budget are presented in the figure below.

[10] Council regulation (EU, Euratom no 1311/2013) laying down the multiannual financial framework for the years 2014-2020 (2 December 2013)
[11] Council decision (2013/791/Euratom) amending Decision 2007/198/Euratom establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it (13 December 2013)
[12] It should be noted that payments in the 2014-2017 period also cover the commitments made before 2014.

Figure 1 Cumulative sums of commitment appropriations and payment appropriations (current value in EUR million)



Source: F4E Draft Annual and Multiannual Programme Years 2019-2023

Resource use

Contribution to ITER

The final sum of the Euratom in-cash and in-kind contribution to ITER project is a fixed amount corresponding to the 45.46% of the total project costs during the construction phase. F4E pays its share in yearly contributions.

To ensure a fair cost sharing of ITER by "value", 90% of the project is based on in-kind contributions. From 2014 until end of May 2017[13] contracts with a total value of EUR 1.06 billion and until 1 January 2017[14] grants with a value of EUR 12.36 million have been awarded.[15] From the beginning of the project until the respective data cut-off points the values amount to EUR 3.71 billion and EUR 99.51 million, respectively.

According to the ITER Agreement, there is a transfer of 10% of procurement responsibility from Euratom to Japan under the supervision of the IO. This is financed through a cash contribution from EU to Japan paid by F4E which amounted to approx. EUR 226.12 million in payment appropriations between 2014 and 2017.

In accordance with the ITER Agreement, the share of the contributions made to IO is 10% in cash. Between 2014 and 2017 a total of EUR 447.46 million in payment appropriations have been transferred to IO.

Contribution to BA

The direct contribution of F4E through its own budget is limited in general to a supporting, qualifying or integration role. To a large extent the EU activities to be undertaken in the framework of the BA agreement are provided in-kind by so-called Voluntary Contributors with some direct procurement from F4E. The direct procurement expenditure amounted to EUR 42.95 million until end 2017 of which between 2014 and 2017 EUR 21.36 million (both in

[13] Latest available data
[14] Latest available data
[15] The great difference stems from the different nature of the expenditures. Grants are awarded for scientific character and cover mostly human costs and prototypes, while value of contracts is directly connected to investments.

commitment appropriations). Payment appropriations until end of 2017 and between 2014 and 2017 amounted to EUR 36.19 million and EUR 22.41 million, respectively.

Administrative expenditure

Administrative expenditure consists of two main categories:

- Staff expenditure: This expenditure is recurrent and mainly based on the establishment plan (salaries).
- Operation expenditure: This expenditure is based on the needs for the execution of the ITER and BA projects (objectives 1 and 2 of F4E) as described in the "Final Report of Negotiations on ITER Implementation", 1 April 2006 and in the Broader Approach Agreement.

Between 2014 and 2017 overall administrative expenditure amounted to EUR 373 million of which staff expenditure accounted for 87% and operation expenditure to 13%.

Human resources

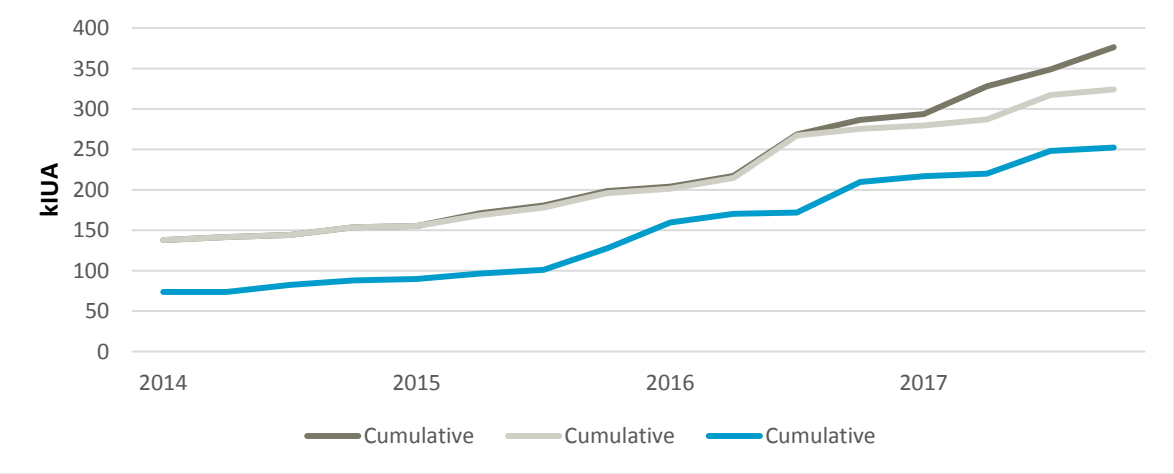
In 2014 temporary reinforcements were agreed and granted in 2015 and 2016 in form of additional short-term positions for 24 Contract Agents and 21 Temporary Agents, respectively, on condition that they are phased out by the end of 2019. This sets the authorised staff level since 2016 at 467.

Results achieved

Contribution to ITER

As of November 2017, F4E has signed contracts corresponding to 87% of all ITER credits to be obtained from EU sources.[16] The achieved and released ITER credits compared to the baseline from 2014 – 2017 are presented in the figure below[17].

Figure 2 ITER credits 2014 – 2017 in kIUA



Source: Data from F4E. The baseline used for this chart is the F4E Current baseline; this is the schedule at the end of September 2016 plus approved baseline changes. The actuals and forecast are those in the latest Detailed Working Schedule from the 2nd Amendment of the 2017 Work Programme.

[16] Draft Annual and Multiannual Programme Years 2019-2023

[17] The difference between the achieved and the released credits is explained by the fact that once F4E achieves a credit milestone, all necessary data, reports and other information has to be collected and provided to IO. This information is linked to the delivery by the supplier of all the necessary documents and to the F4E approval of these deliverables. Furthermore, IO has to revise and validate the whole set of documents provided in order to confirm such achievement. For this reason, the process can take up to a few months.

Contribution to BA

As of November 2017, the share of remaining credits to be obtained for the three BA projects are as follows:

- Satellite Tokamak Programme – 27%
- IFMIF/EVEDA Project – 18%
- IFERC Project – 3%

Findings of the mid-term evaluation

The section below presents a summary of the findings of the mid-term evaluation based on the findings from the 21 evaluation questions that have been presented in the terms of reference of this study. While each evaluation question covers a specific aspect, this summary provides a broader picture for the main topics that have been identified during the evaluation process.

Status F4Es three objectives

Contribution to ITER

Overall, F4E delivers its yearly targets for its contribution to ITER according to the baseline. F4E has been focusing its effort and resources predominantly on achieving its first objective (contribution to ITER) and in particular the achievement of the First Plasma in 2025 in line with the 2016 baseline. In terms of ITER credits achieved, a 10-month delay can be observed vis-à-vis the 2016 baseline, which is attributed to delays on the tokamak building, which was announced shortly after the new baseline. In the current planning (as of November 2017) the delay is scheduled to be compensated in the coming years and to be fully back on track in 2024.

However, overall, F4E delivers its yearly targets according to the baseline over the evaluation period. The data is in line with the findings from the stakeholder consultation in which stakeholders from F4E, IO and other stakeholders confirmed a regained confidence in F4E's ability to achieve its objective of delivering Euratom's contribution to ITER.

Contribution to the Broader Approach

Overall progress on the Broader Approach projects is satisfactory, as indicated by the ratio of credit awarded under the Broader Approach to credit planned, which was above 88% on average in 2016. Progress in achieving yearly targets is shown in Figure 34 below.

The Broader Approach is seen as a success story by most stakeholders since it performs very well and within normal deviations for long-term R&D projects.

Contribution to DEMO

Progress on DEMO activities is currently limited to those included in the framework of the IFERC project under the BA Agreement. EUROfusion is carrying forward preparatory work for DEMO, financed from the Euratom programme, and F4E has a limited support function.

Procurement performance (in-kind contributions)

Procurement procedures are subject to EU regulation which hinder better performance of procurements. When performing public procurement and grant procedures, F4E is obliged to follow the Euratom Financial Regulation[18] and Rules of Application,[19] subject to some limited derogations provided in the F4E Financial Regulation and Implementing Rules. It was indicated in interviews and a survey carried out for this evaluation that, while some relevant derogations have been obtained, the regulations are still very similar to those of EU institutions such as the European Commission, and not designed for an international

[18] Regulation (EU, Euratom) no. 966/2012 of the European Parliament and of the Council of 25 October 2012, on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002; as amended by Regulations no. 547/2014, 1142/2014 and 2015/1929

[19] Commission Delegated Regulation (EU) No. 1268/2012 of 29 October 2012 on the rules of application of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council on the financial rules applicable to the general budget of the Union; as amended by Commission Delegated Regulation (EU) 2015/2462

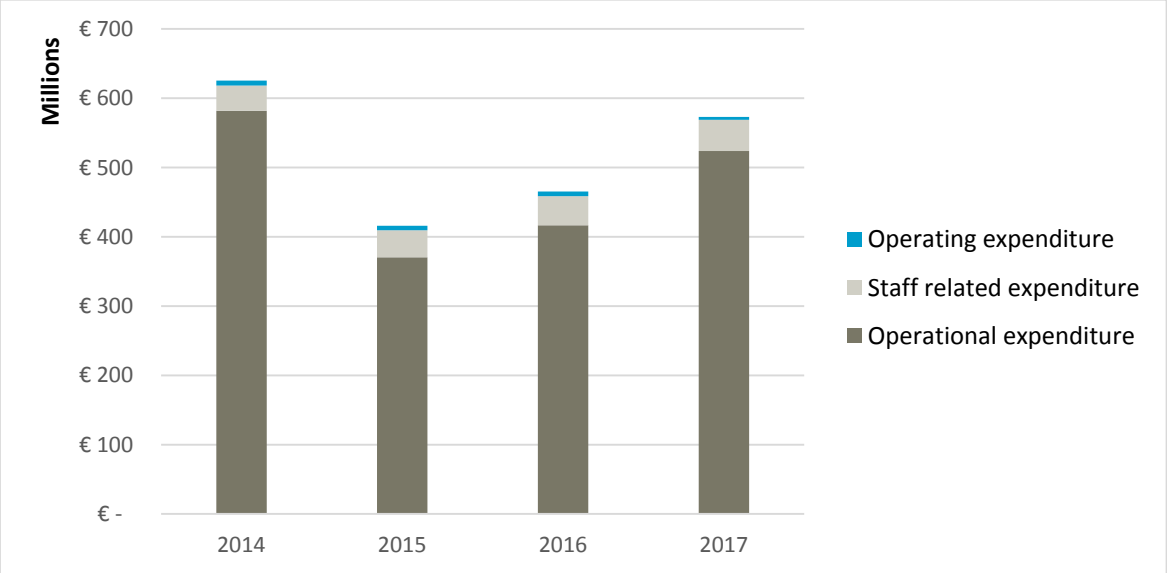
experimental science project. This leads to more complex and inflexible procedures than in "traditional" industrial projects, and it was perceived as advantageous to consider further adaptations to the rules, to provide F4E with further agility and better reflect the needs of a one-of-a-kind project such as ITER.

F4E's approach to procurement has evolved over the organisation's lifetime and brought it closer to the realities that F4E operates in. Within the given boundaries, F4E has evolved its procurement procedures constantly over its lifetime and partly in cooperation with the ILO network. Overall, this brought the procurement procedures closer to the realities of the market that F4E operates in which consists of a limited number of companies able to supply the high-tech components required.

The cost of the European contribution to ITER

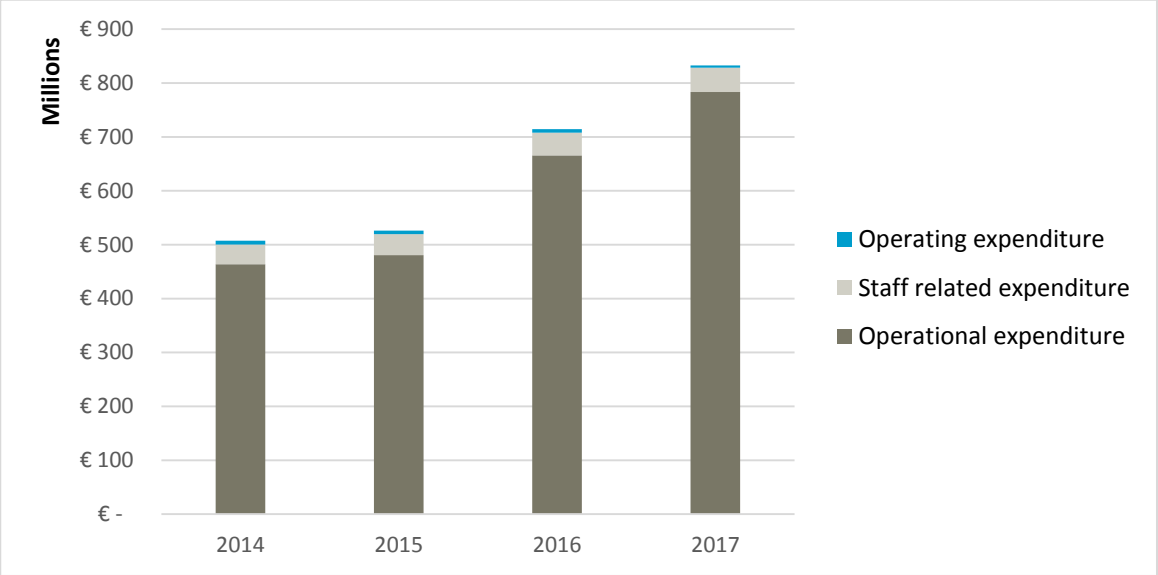
The development of expenditures over the evaluation period is presented below in commitment appropriations and payment appropriations[20]. The ITER project over the years 2014-2017 has been progressing and has now reached the execution phase of construction and the undertaking of larger contracts, which require more monitoring personnel. The administrative and operating costs have increased in line with this development.

Figure 3 Total expenditure 2014 – 2017 (commitment appropriations current value in EUR million)



[20] It should be noted that payments in the 2014-2017 period also cover the commitments made before 2014.

Figure 4 Total expenditure 2014 – 2017 (payment appropriations current value in EUR million)



Source: F4E Annual and Multiannual Programme Years 2019-2023

Administrative expenditure

The administrative expenditure has increased through the evaluation period but can be considered cost-effective. The total administrative expenditures over the years 2014-2017 represent in average 9% (at the level of commitment appropriations) and 7% (at the level of payment appropriations) of the total expenditure. There is an increasing trend in the administrative costs over the 2014-2017 period due to a number of reasons. Overall the split between administrative and operational costs is in line with similar large infrastructure projects of this size and international co-operation. Interviewees from IO and other stakeholders also generally had the perception that the administrative cost of F4E is appropriate compared to the budget that the organisation administers.

Operational expenditure

F4E fulfils its obligations for in-cash contributions to IO. The F4E processes for handling in-cash contributions are limited to follow-up on planning and executing the payments, including checking that the requested cash transfers are within the total limits for the European contribution before payments are executed. The IO has the full decision competence as to how these contributions are spent, and F4E is not mandated to perform any form of follow-up on how these contributions are spent by the IO. Within this framework, the F4E management of in-cash contributions is efficiently carried out, but whether the funds are spent efficiently depends on the IO, and F4E does not have direct influence into this.

Cost-effectiveness of the in-kind contributions is inherently linked to the adequateness of the procurement procedures; however, impacts only manifest slowly. Any approach of procurement can have both positive and negative impacts, and this includes F4E's approach, which has evolved over time. Quantitatively those impacts can only become evident in the future due to the generally long timeline for large procurements and due to their individual timelines.

Cost-effectiveness of the kind-contributions is also subject to other influences and attributability of impacts is challenging. The nature of ITER requiring first-of-a-kind procurements imposes uncertainties and potentially influences the progress and costs. Other potential influences include developments in market and technological developments. The attributability of potential changes in cost-effectiveness of in-kind contributions in the future remains a challenge due to this.

Impact of the EU legal framework

Besides the financial regulation, the cost-effectiveness of Europe's contribution to ITER is also challenged by other restrictions from the legal framework. The EU legal

framework that is imposed on F4E is not adapted to a large first-of-a kind project like ITER. In addition to the financial regulation, other legal obligations such as the staff regulation for the EC staff have been identified as being potentially hindering the cost-effectiveness of F4E. Impacts include high administrative burden, a lack of flexibility for procurement and project management and high dependence on legal processes. Although some relevant derogations of the legal framework have been obtained already, the regulations applying to F4E could be adapted even further to the needs of a project such as ITER – enabling F4E to act more like an international science organisation and less like an EU institution.

The benefits of the European contribution to ITER

Contracts and grants awarded

From the establishment of F4E in 2007 until end of May 2017[21] contracts with a total value of EUR 3.7 billion have been awarded. From the founding of F4E until 1 January 2017[22] grants with a total value of EUR 99.51 million have been awarded. 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.

For the majority of contracted parties, implementing F4E contracts is seen as part of their core business. Additionally, for small share of the contracted parties, a F4E contract is regarded as a stepping stone towards realising longer term spin-offs and benefits[23].

Participating companies and research institutions benefit from taking part in cutting-edge technology projects and networks, which give them an advantage in terms of innovation and competitiveness. Firms judge that working on ITER bolsters their reputation as a leading high-tech company and many also have a positive appraisal of the indirect benefits outside of fusion and big science and more than a third of firms have developed new cutting-edge technologies as a result of their work on ITER. Finally, around a quarter of firms reported that the work on ITER has helped them to access new business opportunities both inside and outside fusion.[24]

Contribution of the F4E Industry Policy

There have been significant efforts made by F4E to address the objectives of the F4E Industrial Policy[25] with focus on assessing the outcomes of the F4E's procurement activities in terms of the tender process and award of contracts in Europe, the extent to which they lead to collaboration, innovation and competition and the scope of participation of SMEs in the procurement procedures, and overall the evaluation concludes that the objectives of the F4E´s industrial policy are met.

Procurement rules ensure efficient allocation of contracts, despite barriers to matching the capacity and technology requirements. A procurement strategy, consisting of unbundling large procurement packages and assessing the market capacity, is in place to ensure participation of as many economic operators as possible, including SMEs.

F4E engages actively with the industry and research communities to promote participation in calls for tenders and calls for proposals. This includes cooperation with the network of Industrial Liaison Officers (ILOs) and the European Fusion Laboratory Liaison Officers (EFLO) Network. This also includes communication and information initiatives to raise awareness and capability. In this respect, the Industry Portal is pivotal.

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[21] Latest available data
[22] Latest available data
[23] This paragraph is based on preliminary findings from the Value for Money study (2018).
[24] This paragraph is based on preliminary findings from the Value for Money study (2018).
[25] Objective 1. Deliver the European contributions to ITER and the Broader Approach within the agreed budget and schedule making best use of the industrial and research potential and capabilities of all F4E members, in line with competition rules. Objective 2. Broaden the European industrial base for fusion technology for the long-term development of fusion as a future energy source and to ensure a strong and competitive European industrial participation in the future fusion market. Objective 3. Foster European innovation and competitiveness in key emerging technologies to further the development of the Innovation Union and its impact at the international level

In spite of this, it is recognised that the participation to ITER activities by the industry and SMEs remains a challenge. The high complexity of the technologies, due to the "first-of-a-kind" nature of ITER, constitutes a barrier for the participation of companies. Also, the process covering procurements and contracts and leading to the outcomes is experienced by interviewees as rather long and complex.

Economic impact

A recent Impact Assessment study found that spending on ITER by F4E is having significant positive economic impacts, with 34 000 job years created to date, including 7 400 in 2017 alone; and almost EUR 4.8 billion in Gross Value Added to date, with more than EUR 1.1 billion in Gross Value Added estimated in 2017. Under the current baseline for the period between 2020 and 2030 this trend is expected to continue by creating 14 500 new jobs, contributing EUR 3 668 million (in 2015 values) Gross Value Added and by leading to the creation of more than 6 963 SMEs.

In the host region of the ITER facilities the project is considered to have contributed to the creation of work for local people working on-site, increasing industry capacity, especially in the region. Also, different side effects have been mentioned such as creation of new schools in the region, economic development by renting houses, establishing agencies as a result of this logistic and infrastructure.

There is an imbalance in the geographical spread of contracts and grants. This results largely from F4E's value-for-money based procurement procedures. F4E does not make any positive discrimination to favour geographical spread, as the EU public procurement rules apply. Consequently, there is an imbalance in the geographical spread of contracts and grants. Other reasons include that the five major beneficiaries represent the largest economies in Europe; that France is the host nation for ITER, where most of the deliveries must be made and geographical proximity to the delivery site tends to increase the interest and competitiveness for contractors, particularly for construction contracts and other contracts requiring significant on-site presence (a similar effect may apply to a smaller extent to Spain, the host nation of F4E); relevant expertise for specialised contracts – e.g. fusion expertise or related nuclear expertise - may be unevenly distributed over the Euratom members.

F4E tries to create a favourable environment for SMEs; however, barriers remain. According to F4E interviews, SMEs constitute about 48% of F4E's number contracts and 15% of the contract value. The new strategy of un-bundling may increase the potential for SMEs tendering for contracts, although only to a limited extent, since the individual contracts still tend to be fairly large. Subcontracting may also present relevant opportunities to SMEs. It was noted that large projects such as the construction of buildings are coming to an end, while small scale projects are in their startup phase; this could increase SME participation in future years. In the survey,[26] a majority of respondents indicated disagreement with the statement that the "procurement practices of F4E benefit SMEs to the extent possible". All ILO respondents disagreed with this statement, whereas 37% of GB respondents disagreed. In telephone interviews with ILOs, it was also indicated that there was still scope for reducing the barriers for SME participation in tenders.

Impact of the project turnaround and reorganisation

***The 2015 ITER and F4E Action Plans, and the associated reorganisations at ITER and F4E*, appear to have had a positive impact on the performance of the ITER project and the European contribution to ITER**,[27] and have contributed to the reestablishment of trust in the capacity to carry out the ITER project to the demonstration stage and prove the feasibility of fusion as a source of energy. As mentioned earlier, F4E delivers its yearly targets according to the new baseline over the evaluation period which has not been the case before 2014 where the project experienced heavy delays and cost overruns due to, among other reasons, weaknesses in its management and governance. The data is in line with the findings from the stakeholder consultation in which stakeholders from F4E, IO and other stakeholders confirmed a regained confidence in F4E's ability to achieve its objective of delivering Euratom's contribution to ITER.

[26] Ramboll on the basis of European contribution to ITER survey results 2018; responses to questions 3, 5c, 8 and 10c

[27] 6th Annual Assessment of F4E - Report to the Governing Board

However, it is too early to determine whether the positive impact can be sustained in the long term, and there is still potential for further improvements.

Specific improvements achieved within F4E include:[28]

- Implementing a new organisational structure in October 2016, which includes a separate Project Management Department (already established in 2015) and an integrated CFO/Commercial Department[29],
- Improvement of project management, both in terms of capabilities and tools, e.g. for monitoring and contract management
- The introduction of milestones for monitoring the status of the execution of the European contribution,
- Substantial strengthening of risk management and risk mitigation[30] including the establishment of a cost risk register[31] and a "risk appetite" policy[32],
- Structured follow-up on audit recommendations, leading to the closing of several open issues, and achieving all pending actions on previous internal audit recommendations in June 2016[33], and
- An improvement in the cooperation between the IO and F4E, an increased joint team spirit, and an increased F4E on-site presence in Cadarache.

Most stakeholders perceive that the changes had a positive impact on Europe's contribution to ITER. Interviews with staff of F4E and ITER IO supported the view that these improvements have had a positive impact on the performance, a view that was also shared by F4E Governing Board members in the survey carried out for the purposes of this evaluation. However, ILOs have a less positive opinion. The results should be seen against the background of the interfaces of the two groups with the F4E and IO. The GB group is closely involved in the development of F4E and has direct contacts with IO. The ILOs, on the other hand, are predominantly receivers of information about upcoming procurements[34].

The 2016 project baseline has had a strong positive impact on the European contribution to ITER. While the new baseline foresees a significantly longer construction phase and increased costs for all ITER members, this made the baseline more realistic, which was a key factor for re-establishing trust in the ITER project from its funding parties, staff and other stakeholders.[35] Also, the new baseline provides a sounder foundation for planning, execution and monitoring of the European contribution to ITER. An independent assessment of the capacity of F4E to deliver the European contribution to the new ITER baseline[36] confirmed the capacity of F4E to deliver the Euratom contribution to the new ITER schedule on time and coherently with the staged approach and within the current available budget until 2020.

The *'Straight Road to First Plasma'* strategy has mostly positive aspects but also potentially carries risks. The introduction of the strategy by F4E to all of ITER[37], focusing resources on the activities and scope needed for ITER's First Plasma at the end 2025 has had a positive result in cost-control, project culture and a stronger project oriented mindset in the organisation. However, the deferral of post-First Plasma activities entails a de-prioritisation of units and tasks in F4E that are not directly linked to the 2025 First Plasma goal, and some interviewees in F4E considered this to be a potential source of risks for the long-term performance of the Joint Undertaking.

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[28] In addition to the referenced documents, interviews with F4E and ITER IO staff have been used as sources for this section
[29] F4E Annual Activity Report 2016, pp. 76-77
[30] Fusion for Energy (F4E) Assessment and Review – The F4E Review Group (RG), 31 October 2016
[31] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[32] "Risk Appetite" Policy, 2016 (F4E(16)-GB36-10)
[33] F4E Annual Activity Report 2016
[34] In addition, they also work with F4E on the improvement of procurement procedures.
[35] U.S. Department of Energy – U.S. Participation in the ITER Project, May 2016; European Parliament resolution of 27 April 2017 with observations forming an integral part of the decision on discharge in respect of the implementation of the budget for the European Joint Undertaking for ITER and the Development of Fusion Energy (Fusion for Energy) for the financial year 2015 (2016/2194(DEC))
[36] Fusion for Energy (F4E) Assessment and Review – The F4E Review Group (RG), 31 October 2016
[37] F4E Consolidated Annual Activity Report 2016

Analysis of the performance framework

The Integrated Management System is mostly fit for its purpose. The Integrated Management System currently consists of KPIs that work on different levels: corporate level SPI (schedule performance index) and CPI (cost performance index), then on sub-level for each service, and finally on working level. Performance indicators are automatically extracted and calculated in Prima Vera system based on input data. Over time, the system has been continuously improved, implemented at F4E, and made available for different services. After the adoption of the F4E Action Plan in 2015, further actions were taken to improve the planning and monitoring activities.

The process for reporting and monitoring is largely supported by interactive IT systems available for most F4E staff. These systems are intimate elements of an Integrated Reporting System (IRS). The IRS, together with policies and strategies of monitoring and reporting, provides a reliable and familiar environment for on-time reporting activities. The IRS also allows availability of reports when needed since the system is on-line. Interviewees from F4E confirmed that usage of interactive systems in combination with F4E units' specific services enables them to meet deadlines and make reports available and the administrative burden was reported in interviews to be reasonable.

The data quality from the automated reporting systems is considered to be not sufficient. Interviews stated that the quality of monitoring data could be improved. One reason that was mentioned is not fully corresponding IT systems for monitoring and reporting. There are different reporting platforms in use by different departments that are integrated in IRS, but they are not fully compatible. Another aspect that has been highlighted is that input data might not always be entered correctly because of lack of competence of the person carrying out this activity.

Technology and scientific adaptation

F4E has limited possibilities to adapt within the ITER project governance framework. Fusion research started in the second half of the 20th century and the first tokamak began operation in 1958. Today, technological evolution in the field of fusion research is linear and is not moving at a critical speed. However, ITER is a long-term project with a design and construction phase of almost 20 years that has started in 2007 and technological and scientific advances are to be expected during this timeframe. Those can only be incorporated to a very limited extent since the core of the project cannot be changed. This is for two reasons: The governance structure of ITER as agreed on in the IA does not allow for major changes since allocation of machineries and costs have been agreed on in this agreement. Additionally, the nature of the project with the interface-based in-kind contributions from different actors requires a steady design.

F4E is open to adapting to the extent possible but does not actively foster innovation from SMEs. Interviews confirmed that F4E shows interest in new developments and uses this limited space adequately by adapting procurements to technological and scientific advances. On the other hand, concerns have been raised that the procurement processes might rely too heavily on selection criteria such as references, numbers of years of experience and financial strength for innovative SMEs to be able to join the procedures.

Contribution to the EU strategic agenda

Desk research indicates that the objectives of F4E – (a) to provide Europe's contribution to ITER, (b) to support the BA, and (c) to contribute to DEMO[38] – and ITER – to demonstrate the scientific and technological feasibility of fusion energy[39] - are relevant to the present European Union's needs and policies.

The research nature of the European contribution to ITER makes it highly relevant for the EU strategic agenda. The objectives of F4E and ITER fit within the wider Strategic Energy

[38] As defined in Article 1(2) of F4E's Statutes

[39] https://www.iter.org/doc/www/content/com/Lists/WebText_2014/Attachments/245/ITERAgreement.pdf

Technology (SET) Plan[40] (which highlights Europe as a key player in nuclear fusion), the main aim of which is to accelerate the development and deployment of low-carbon technologies in accordance with the European Union's 2050 Energy Strategy[41]. The effort devoted by F4E to ITER research and development in nuclear fusion is also in line with the European Commission's Energy Security Strategy[42], which aims to ensure a stable and abundant supply of energy for European citizens and the economy. The ITER project can also be seen to support other EU needs and policies, in context of two key features of the Energy Roadmap 2050[43]. First, as a key contributor to European growth and jobs, boosting European technological development. Second, as a lead project in the shift towards a 'Global-EU' research and innovation policy[44], according to its international outlook and broad scope.

Insights from desk research also suggest that the European contribution to ITER is coherent with other European Commission's initiatives and the wider EU policy regarding energy, climate and environment. The ITER project is supported by several European initiatives (e.g. Roadmap to Fusion Electricity[45], EUROfusion and the Joint European Torus[46], Euratom Research and Training Programme[47]), and vice versa, ITER is in line with the first objective of the Commission's political agenda, that is, 'boosting jobs, growth and investment in future high potential technologies'[48].

Most importantly, the ITER project fits in the Framework Strategy for the Energy Union. The Energy Union outlines the three objectives of EU energy policy – security of supply, sustainability and competitiveness[49]. These goals are of concern to the ITER project, yet with a long-term, research-oriented approach. For this reason, nuclear fusion cannot be the sole driver of the transition towards a low-carbon economy, as technological advancements in other energy sources, such as those from renewables, continue to be supported by the EU[50].

Finally, the European contribution to ITER is coherent with EU international obligations under the Paris Agreement and the Sustainable Development Goals. The European Contribution to ITER does not directly support the Paris Agreement goal of limiting global warming to below 2°C above pre-industrial levels by the end of this century due to the late expected realisation of commercially viable fusion power. The European Contribution to ITER can be seen as compatible with the Sustainable Development Goals.

EU added value

Insights from the available data strongly suggest that an intervention at Euratom level is crucial in terms of resource availability as well as for project complexity. The funds required for the participation in ITER would present a considerable share of the public R&D funds of even the biggest EU Member States and thus it is very likely that, in the absence of a coordinating role of the EU, two or more EU Member States would need to join the IA to assume the contribution of Euratom which is per IA the host party of the ITER project and as such has not the right to withdraw from the agreement. This would have led or would lead to even higher complexity of the ITER project accompanied by problems that a higher complexity entails.

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[40] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[41] The EU has set itself a long-term goal of reducing greenhouse gas emissions by 80-95%, when compared to 1990 levels, by 2050. https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2050-energy-strategy
[42] Communication from the commission to the European Parliament and the Council. European Energy Security Strategy {SWD(2014) 330 final}
[43] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Energy Roadmap 2050 {COM(2011) 885 final}
[44] European Commission (Ed.). (2012). Global Europe 2050. Luxembourg: Publ. Off. of the Europ. Union.
[45] EFDA (2012) Fusion Electricity. A roadmap to the realization of fusion energy.
[46] European Parliament Research Service (EPRS) (2017) Briefing How the EU budget is spent.
[47] European Commission Decision C(2017)7123 of 27 October 2017. Euratom Work Programme (2018
[48] COM(2017) 319 final Communication from the Commission to the European Parliament and the Council – EU contribution to a reformed ITER Project
[49] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[50] In the EU, these renewable energies shall account for about 20% of the gross final energy consumption by 2020 and 60% by 2050 (see Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A policy framework for climate and energy in the period from 2020 to 2030. {COM(2014) 15 final})

Economies of scale can be expected from bundling European resources[51]**.** This factor is assumed in general for EU agencies such as F4E[52]. Also based on statements from interviewees and the survey results there is a high agreement that the intervention at EU level provides efficiency gains (e.g. lower administrative and operating costs) compared to what could have been achieved at national level. However, no data is available to underline these assumptions due to the unique form of the ITER and the system of in-kind contributions which is not easily comparable to other projects.

An important aspect of EU added value in this mega project are influence and political stability. It can be assumed that the participation at EU level, which will be allowed to take on the largest share in the project in terms of resources, increased the influence of Europe on important aspects of the project such as the site of the construction. Political stability is a crucial factor for such a long-term project and having the EU as a host, which is as a union of several nations gives more stability.

Another important added value factor coming from the intervention at EU level is increased coherence. As stated in Annex I of the IA, each member and the IO shall ensure access for the IO and the other members to inventions and other intellectual property generated or incorporated in the execution of the contracts, provided that inventors' rights are respected. Consequently, all EU Member States and Switzerland, being members of Euratom, have access to the results of fusion-related R&D from the ITER project.

The nature of F4E as an EU body is not necessarily conducive to optimal functioning. As highlighted earlier F4E, being an EU agency, is subject to a set of regulations which is seen to be potentially detrimental to the performance of F4E. The recent Impact Assessment study (2018) assessed options of using other legal instruments of delivery mechanisms including as a public-private partnership, joint undertaking (the current legal form), EU agency, intergovernmental organisation, private company and as a European Research Infrastructure Consortium with the results of the impacts, though the different legal documents are still pending at the time of writing.

With regard to resource need, as mentioned above. the project continues to require considerable funding and also after the current Multiannual Financial Framework. It is estimated that a total of EUR 7.1 billion[53] is needed until 2035 (i.e. until the beginning of high fusion power operation). This amount is unlikely to be covered by one EU Member State and would probably require the involvement of two or more states which entails the abovementioned complications.

Finally, the member of F4E's Governing Board and Industry Liaison Officers unanimously agreed, or strongly agreed, that the objectives addressed by Euratom's participation in ITER continues to require resources and action at EU level.

Acceptability

The findings suggest that the awareness of both ITER and Euratom's participation in it is high among their direct stakeholders, i.e. the industry and the fusion community.

There seems to be little awareness by the general public. One proxy for the interest of the general public is press coverage. Since 2009, IO systematically tracks press attention around the world concerning the ITER project. A significant peak happened in December 2017 following a press release by IO after about 50 % completion of the ITER project[54]. Otherwise, the media coverage has been relatively constant, and no growing trend can be seen. On social media platforms, compared to other DAs, F4E has a good outreach. However, the comparison with another major nuclear research project, CERN, shows that interest on social media platforms of F4E and ITER is comparably low. Likewise, several interviewees in F4E stated that they feel that F4E is not well known by the general public and that this should be improved.

F4E's communication efforts may appear to place too much focus on F4E and not on the overall project, also in comparison with the communication efforts of other DAs.

[51] See MEMO/11/938 Brussels (European Commission) European Commission proposes Supplementary Research Programme for ITER. 21st December 2011
[52] See https://euagencies.eu/sites/default/files/eu_agencies_brochure_2017.pdf
[53] In 2008 values
[54] ITER Organisation (2017). World's most complex machine is 50 percent completed. Press release. https://www.iter.org/doc/www/content/com/Lists/list_items/Attachments/759/2017_12_Fifty_Percent.pdf

However, it was also acknowledged that since the DAs are not only about ITER (e.g. F4E also works on the BA), they should be able to market themselves beyond ITER too while focusing on the message that ITER is a group project. IO stakeholders also stated the perception that the communication of F4E seems to be too much focused on engineering and procurement progress instead of the unique nature of the ITER project.

With regard to reputation of the ITER project among the general public there is a perception that recent management organisations have restored faith and brought the project back on track as suggested by a non-systematic assessment of the press following a press announcement at about the half-way stage towards completion of ITER at the end of 2017.

Conclusions

All three objectives are in line with current planning. The credits received for contributions to ITER show a slight delay at the end of the evaluation period; however, delays are not comparable to the situation before 2014 where the project experienced heavy delays and cost overruns. The BA is predominantly on track. No clear timeline exists for DEMO yet, but preparatory work is currently pursued.

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. Overall, they led to a project culture and a stronger project oriented mindset in the organisation.

As for indirect effects, the abovementioned achievement of ITER credits mostly in line with the current baseline is a clear positive change compared to earlier periods. Indirect positive changes are also perceived by F4E staff (internal view) as well as by direct stakeholders such as IO and other interviewees who state an increased motivation and enthusiasm in the work of F4E. Other indirect effects related to changed procurement practices that might have an influence on the cost-effectiveness of the in-kind contributions are subject to long timelines and cannot yet be measured.

Another major change is the new baseline in operation since 2016. External evaluators consider the baseline to be realistic and promising in terms of ITER's technological achievement. The new baseline also entails additional costs for the European contribution to ITER after 2020, until which the financial contribution from Euratom is capped. Looking at the current planning until 2020 this cap will be respected as the baseline was specifically adapted to satisfy its requirements.

While acknowledging methodological difficulties in assessing this, the data suggests that the European contribution to ITER is cost-effective, both for its administrative spending as well as for its operational spending. However, the Euratom contribution still suffers from the fact that it is provided under EU framework which sometimes is not fully consistent with what would be considered as best practice for effective and efficient delivery.

Contracts for the major share of Europe's contribution have 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.

Europe's participation in ITER is considered fully in line with research as well as long-term energy and carbon objectives; the characteristics of fusion energy which make it 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.

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 ITERs construction period, is crucial in terms of resource availability as well as to reduce project complexity.

Résumé exécutif (Français)

Portée de l'étude et méthodologie

Le présent document constitue le rapport définitif de l'étude intitulée « Contribution européenne au projet ITER: Réalisations et défis ».

Il a trois objectifs. Il libère la Commission de l'obligation de présenter un rapport d'activités prévue à l'Article 5b de la Décision du Conseil 2013/791/Euratom du 13 décembre 2013 au Parlement européen et au Conseil sur la mise en œuvre de la Décision. Il vise à appuyer la Commission dans la préparation d'une évaluation à mi-parcours de la participation européenne au projet ITER conformément aux lignes directrices pour une meilleure réglementation . Enfin, il sert de source d'informations aux discussions du cadre financier pluriannuel post 2020 en contribuant à la préparation de l'évaluation ex-ante de la Commission de la contribution de l'UE au projet ITER et aux activités de l'Approche élargie du prochain cadre pluriannuel financier.

L'unité d'analyse de l'étude est la contribution européenne au projet ITER et à ce titre comprend le champ des activités de l'« Entreprise commune européenne pour le Développement de l'énergie de fusion » (Fusion for Energy ou F4E) qui a été établie par une Décision du Conseil[55] le 27 mars 2007 avec pour mandat la gestion de la contribution de l'UE au projet ITER pour le compte d'Euratom.

Les missions de F4E sont définies à l'Article 1(2) des Statuts de F4E. Elles sont triples :

1. Apporter la contribution de la Communauté européenne de l'énergie atomique (Euratom) à l'organisation ITER (OI) pour le projet ITER, dans le cadre l'Accord international ITER;
2. Apporter la contribution d'Euratom aux activités de l'Approche élargie (AE)[56] avec le Japon pour la réalisation rapide de l'énergie de fusion, qui comprend actuellement trois projets de collaboration implantés au Japon;
3. Préparer et coordonner un programme d'activités en préparation de la construction d'un réacteur de fusion de démonstration (désigné DEMO) et d'installations connexes, notamment le Centre international d'irradiation de matériau de fusion (IFMIF).

La durée de l'étude est la période 2014-2017. Le début de l'actuel cadre pluriannuel financier (c'est-à-dire 2014) est utilisé comme le point de base de référence dont la fin est prévue pour 2017. Autrement dit, l'évaluation doit tenir compte de l'important changement dans la conduite du projet ITER à partir de la mi-2015 et dans la gestion et la mise en œuvre de la participation de l'UE à partir de 2016.

Trois principales sources de données ont été utilisées pour le présent rapport: la littérature (notamment les données fournies par F4E), les entretiens semi-dirigés avec trois groupes différents de parties prenantes (le personnel de F4E, le personnel de l'organisation ITER (OI) et d'autres parties prenantes externes) et tous les membres du Conseil de direction (CD) et les officiers de liaison industriels (OLI)[57]. Dans l'analyse, les sources de données ont été triangulées afin de générer les résultats.

La recherche documentaire est une méthode centrale de collecte d'informations sur l'évolution de la contribution européenne au projet ITER. Une grande partie de la littérature consultée a été produite par F4E. F4E a aussi fourni des sources de données supplémentaires et des explications. Les données sont considérées fiables, étant donnée la sévère surveillance sous laquelle travaille F4E, notamment les audits réguliers de la Cour des comptes européenne. Etant donné le cadre temporel de ce projet les données pour 2017 n'ont pas toujours été concluantes, la recherche documentaire est en partie basée sur des projets de documents (plus particulièrement le Projet annuel et pluriannuel de programmation pour les années 2019-2023).

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[55] Ci-après désigné les Statuts de F4E – Décision du Conseil 2007/198/Euratom modifiée par la Décision du Conseil 2013/791/Euratom du 13 décembre 2013 et Décision du Conseil (Euratom) 2015/224 du 10 février 2015.

[56] Voir ci-dessous.

[57] Les officiers de liaison industriels (OLI) sont un réseau de représentants de différents pays européens qui ensemble avec la F4E sensibilisent aux plans de financement et aux moyens de s'impliquer dans le projet ITER.

Un total de 34 entretiens semi-dirigés (aussi bien lors des visites sur le terrain à F4E et à l'OI que par téléphone) ont été réalisés avec différents types de parties prenantes, chacun durant environ une heure.

Le taux de réponse à l'enquête en ligne a été de 45 % pour les membres du Conseil de direction et de 36 % pour les Officiers de liaison industriels (OLI), ce qui n'est pas un taux très élevé si l'on tient compte de leur faible nombre (60 et 22, respectivement) et du fort engagement que l'on pourrait attendre d'eux. Les résultats de l'enquête ne peuvent par conséquent être statistiquement généralisés à la totalité des membres du Conseil de direction et des Officiers de liaison industriels[58]. Bien qu'il faille avoir cet inconvénient à l'esprit lorsqu'on interprète les résultats de l'enquête, ceux-ci donnent toutefois une idée sur l'opinion des membres du Conseil de direction et des Officiers de liaison industriels sur la contribution européenne au projet ITER.

Résumé du rapport d'activités sur la mise en œuvre de la Décision du Conseil 2013/791/Euratom

Introduction

Les progrès sont présentés sur trois points :

- Ressources financières de F4E ;
- Utilisation des ressources; et
- Résultats accomplis.

Conformément à la Décision du Conseil, l'analyse couvre l'évolution dans l'actuel cadre pluriannuel financier (pour la période 2014 jusqu'à en 2017). En raison de l'échéance du rapport, les données définitives pour 2017 n'ont pas toujours été disponibles et l'analyse a dû reposer en partie sur les prévisions telles que spécifiées dans les chiffres respectifs des sections suivantes. Les progrès sont présentés par rapport aux deux premiers objectifs (ITER et AE).

En ce qui concerne l'unité de mesure du progrès, trois unités différentes sont utilisées :

- Budget;
- Étapes du projet; et
- Crédits.

Budget

Le montant de 6,6 milliards d'euros (en valeur 2008) adopté par Conseil de l'UE en 2010[59] sert de plafond pour les dépenses de F4E jusqu'en 2020.

L'estimation de la contribution d'Euratom après 2020 se trouve dans le tableau ci-dessous.

Tableau 2 Résumé du tableau de la contribution d'Euratom en crédits d'engagement (2008 valeur en milliards d'euros)

	Vers FP	De FP à DT		Total après 2020
	2021-2025	2026-2027	2028-2035	
F4E total espèces à OI	1,1	0,5	1,1	2,7
Budget de construction	1,1	0,3	0,3	1,7
Budget d'opérations	0	0,2	0,8	1,0
F4E contribution en nature	2,1	0,5	0,4	3,0
Administration F4E	0,3	0,1	0,4	0,8
Autres activités F4E	0,4	0,1	0,04	0,5
CE Administration du projet	0,04	0,02	0,07	0,13
Totaux	**3,9**	**1,2**	**2,0**	**7,1**

Source: COM(2017) 319 Communication définitive de la Commission au Parlement européen et au Conseil – Contribution de l'UE à un projet ITER réformé

[58] Louis M. Rea and Richard A. Parker, *Designing and Conducting Survey Research: A Comprehensive Guide*, Fourth edition (San Francisco, CA: Jossey-Bass, a Wiley brand, 2014), 198.
[59] Conclusions du Conseil sur le statut d'ITER du 7 juillet 2010 (Réf. 11902/10).

Le budget est présenté en crédits[60] d'engagements et crédits[61] de paiement. Ils diffèrent habituellement car les crédits pour les projets sont engagés au cours de l'année où ils ont été décidés et sont payés au fil des ans à mesure que la mise en œuvre du programme et du projet progresse.

Étapes du projet

Les étapes du projet sont des réalisations prédéfinies jusqu'en 2025 utilisées par l'OI (appelées Conseil ITER ou étapes du projet CI) et F4E (Conseil de direction ou étapes du projet CD) pour évaluer les progrès du projet ITER.

La liste des étapes du projet est mise à jour chaque année par une approche dite de « rolling wave », c'est-à-dire mise à jour par vagues et de manière plus détaillée à mesure que le projet progresse. F4E utilise les étapes du projet pour évaluer les progrès réalisés vers l'atteinte de ses objectifs techniques par la réalisation en temps voulu. Pour augmenter le degré de précision des objectifs à court terme, F4E a sélectionné quelques étapes supplémentaires du projet (Conseil de directionou étapes du projet du conseil de direction) qui mènent à celles du CI.

Crédits

Les « Crédits » sont une unité à la fois pour le projet ITER (objectif 1 de F4E) ainsi que l'AE (objectif 2 de F4E). Dans le projet ITER, les contributions en nature à l'OI sont organisées par des Passations de marchés (PM) qui représentent le travail spécifique à effectuer et à fournir à l'OI. Lorsqu'une PM est préparée par l'OI, il est convenu des étapes du projet qui marqueront les progrès enregistrés dans le travail, dont certains disposent d'un crédit qui leur est associé, lequel est fourni par l'OI à F4E chaque fois qu'une étape du projet est réalisée. Les Crédits ne correspondent pas aux coûts réels en euros supportés par F4E pour la fourniture de ce composant, mais aux valeurs de chaque PM tel que convenu entre l'OI et ses membres. Les contributions sont aussi formalisées dans le cadre des PM entre F4E et l'Agence japonaise d'exécution pour l'AE. Comme pour ITER, la comptabilité entre les parties impliquées dans l'AE est faite en crédits, avec l'unité « unité de compte AE » (UCAE).

Ressources financières

Les ressources opérationnelles de F4E comprennent essentiellement :

- La contribution Euratom
- La contribution de l'Etat hôte d'ITER (la France); et
- Les contributions des membres.

La contribution d'Euratom constitue la principale source financière de F4E. Le plafond de la contribution Euratom du budget général de l'UE au projet ITER est indiquée à l'Article 16 du Règlement du Conseil (EU/EURATOM) No 1311/2013[62] du 2 décembre 2013 pour les années 2014-2020 à 2 707 millions d'euros (en valeur de 2011). La contribution est détaillée dans la Décision du Conseil 2013/791/Euratom[63], à 2 915 millions (en valeur actuelle). Pendant le cadre financier pluriannuel 2014-2020, au 31 décembre 2017, F4E a reçu un total de 1 741,6 million d'euros en crédits d'engagement et 2 090,9 millions d'euros en paiement[64] (en valeurs courantes) des contributions d'Euratom.

La contribution de l'État hôte ITER (la France) couvre 9,09 % du total des coûts de la phase de construction d'ITER, soit l'équivalent de 20 % du budget de F4E pour la construction d'ITER. Au 31 décembre 2017, les contributions s'élevaient à un total de 1 026,7 d'euros en crédits d'engagement et à 708,3 millions d'euros. Pendant le cadre financier pluriannuel 2014-2020, au

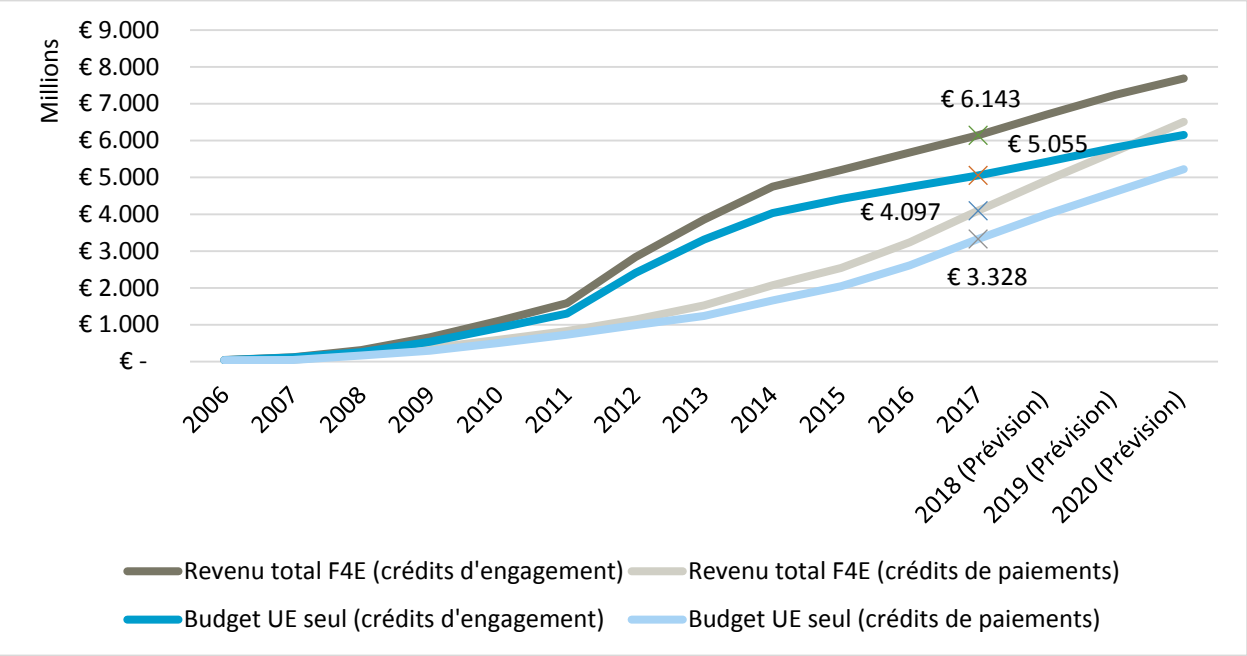
[60] Gages de sécurité juridiques à fournir des financements, à condition que certaines conditions soient remplies.
[61] Espèces ou virements bancaires aux bénéficiaires.
[62] Règlement du Conseil (EU, Euratom n0 1311/2013) exposant le cadre financier pluriannuel pour les années 2014-2020 (2 décembre 2013).
[63] Décision du Conseil (2013/791/Euratom) modifiant la Décision 2007/198/Euratom portant création de l'Entreprise commune européenne pour ITER et du Développement de l'Énergie de fusion et lui conférant les avantages (le 13 décembre 2013).
[64] Il convient de noter que les paiements de la période 2014-2017 couvrent aussi les engagements pris avant 2014.

31 décembre 2017 les montants sont respectivement de 509 millions d'euros et 445 millions d'euros.

Les contributions des membres sont déterminées et adoptées annuellement dans le cadre du budget. Elles correspondent à 10 % du budget administratif. Autour de la fin 2017, le revenu total des contributions des membres s'élevait à 39,3 millions d'euros en crédits d'engagement et à 39,7 millions d'euros en crédit de paiement. Rien que pour la période 2014-2017, les deux chiffres s'élèvent à 18,3 millions d'euros.

Un graphique représentant le total cumulé des crédits d'engagement et de paiement uniquement de toutes les sources de revenus de même que séparément du budget de l'UE se trouve dans la figure ci-dessous.

Figure 5 Total des sommes des crédits engagement et de paiements (valeur actuelle en millions d'euros)



Source: Programme de projet annuel et pluriannuel de F4E Années 2019-2023

Utilisation des ressources

Contribution au projet ITER

La somme définitive de la contribution d'Euratom en espèces et en nature au projet ITER est un montant fixe correspondant à 45,46 % du total des coûts du projet pendant la phase de construction. F4E paie sa part en contributions annuelles.

Pour garantir un juste partage des coûts d'ITER par « valeur », 90 % du projet se fait en contributions en nature. De 2014 jusqu'à la fin mai 2017[65], des marchés d'une valeur totale de 1,06 milliard d'euros et jusqu'au 1er janvier 2017[66] des subventions d'une valeur de 12,36 millions ont été accordés.[67] Du début du projet jusqu'aux termes des données respectives, les valeurs s'élèvent à 3,71 milliards d'euros et à 99,51 millions d'euros respectivement.

[65] Toutes dernières données disponibles.
[66] Toutes dernières données disponibles.
[67] Le grand écart découle de la nature différente des dépenses. Les subventions sont accordées pour le caractère scientifique et couvrent essentiellement les coûts humains et les prototypes, tandis que la valeur des marchés est directement liée aux investissements.

Selon l'Accord ITER, il existe un transfert de 10 % de la responsabilité d'approvisionnement d'Euratom vers le Japon sous la supervision de l'OI. Ce transfert est financé par une contribution de l'UE en espèces versées au Japon et payées par F4E. Le transfert s'élevait à environ 226,12 millions en crédits de paiement entre 2014 et 2017.

Conformément à l'Accord ITER, la part des contributions faites à l'OI est de 10 % en espèces. Entre 2014 et 2017, un total de 447,46 millions d'euros en crédits de paiement ont été transférés à l'OI.

Contribution à l'AE

La contribution directe de F4E par son propre budget est limitée en général à un rôle d'appui, de qualification ou d'intégration. Dans une large mesure, les activités de l'UE qui doivent être effectuées dans le cadre de l'accord AE sont financées en nature par les soi-disant Contributeurs volontaires avec un approvisionnement direct de F4E. Les dépenses directes afférentes à l'approvisionnement s'élevaient à 42,95 millions jusqu'à la fin 2017 dont 21,36 millions d'euros entre 2014 et 2017 (les deux en crédits d'engagement). Les crédits de paiement jusqu'à la fin de 2017 et entre 2014 et 2017 s'élevaient à 36,19 millions d'euros et 22,41 millions d'euros respectivement.

Dépenses administratives

Les dépenses administratives consistent en deux catégories principales :

- Dépenses en personnel: Ces dépenses sont récurrentes et reposent essentiellement sur le tableau des effectifs (salaires).
- Dépenses de fonctionnement: Ces dépenses reposent sur les besoins de mise en œuvre d'ITER et les projets AE (objectifs 1 et 2 de F4E) tel que décrits dans le « Rapport définitif des négociations sur la mise en œuvre d'ITER », le 1er avril 2006 et dans l'Accord sur l'Approche élargie.

Entre 2014 et 2017, les dépenses administratives globales s'élevaient à 373 millions d'euros dont les dépenses en personnel représentaient 87 % et les dépenses de fonctionnement 13 %.

Ressources humaines

En 2014, il a été convenu des renforcements temporaires et recrutés en 2015 et 2016 sous la forme de postes supplémentaires à court terme 24 Agents contractuels et 21 Agents temporaires, respectivement à la condition qu'ils seraient remerciés d'ici la fin 2019. Cette situation établit le niveau de personnel autorisé depuis 2016 à 467.

Résultats accomplis

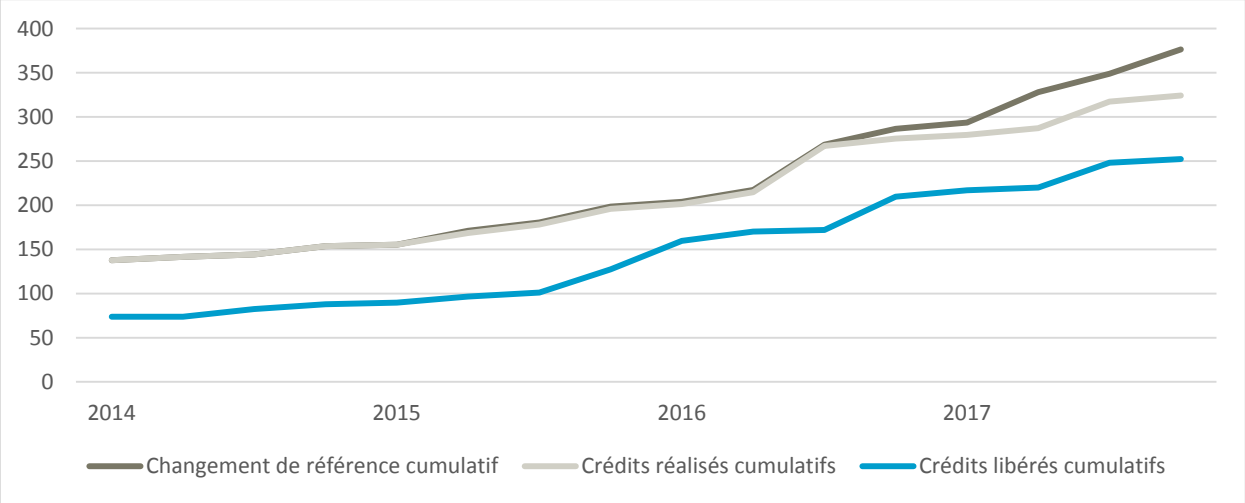
Contribution au projet ITER

Au mois de novembre 2017, F4E a signé des contrats correspondant à 87 % de tous les crédits ITER attendus des sources de l'UE.[68] Les crédits ITER réalisés et libérés par rapport à la base de référence de 2014 - 2017 sont présentés dans la figure ci-dessous[69].

[68] Projet du programme annuel et pluriannuel des années 2019-2023.

[69] La différence entre les crédits réalisés et libérés s'explique par le fait qu'une fois que la F4E réalise un étape du projet de crédit, toutes les données nécessaires, les rapports et autres informations doivent être recueillies et transmis à l'OI. Ces informations sont liées à la livraison par le fournisseur de tous les documents nécessaires et à l'approbation par la F4E de ces instruments. En outre, l'OI doit réviser et valider l'ensemble des documents fournis afin de confirmer cette réalisation. Pour cette raison, le processus peut durer quelques mois.

Figure 6 crédits ITER 2014 – 2017 en milliers d'unités de compte I



Source: Données provenant de F4E. La base de référence utilisée pour cette figure est la base de référence actuelle de F4E. Il s'agit du calendrier à la fin de septembre 2016 auquel sont ajoutés les changements approuvés par rapport à la référence. Les chiffres réels et les prévisions sont ceux du dernier Calendrier de travail détaillé à partir de la 2e modification du programme de travail.

Contribution à l'AE

Au mois de novembre 2017, la part des crédits restants à obtenir pour les trois projets de l'AE se décline ainsi que suit :

- Programme Satellite Tokamak – 27 %
- Centre international d'irradiation de matériaux de fusion/Project EVEDA – 18 %
- Projet IFERC (centre international de recherche sur l'énergie de fusion) – 3%

Résultats de l'évaluation à mi-parcours

La section ci-dessous présente un résumé des résultats de l'évaluation à mi-parcours sur la base des résultats des 21 questions d'évaluation qui ont été présentées dans les termes de base de référence de la présente étude. Alors que chaque évaluation couvre un aspect spécifique, ce résumé donne une perspective plus grande des principaux sujets identifiés lors du processus d'évaluation.

Trois objectifs des statuts de F4E

Contribution au projet ITER

Globalement, F4E présente ses objectifs annuels pour sa contribution au projet ITER selon la référence. F4E concentre ses efforts et ses ressources essentiellement sur l'atteinte de son premier objectif (contribution au projet ITER) et en particulier la réalisation du « premier plasma » en 2025 conformément à la base de référence de 2016. En termes des crédits ITER réalisés, on observe un retard de 10 mois par rapport à la base de référence de 2016, lequel est imputé aux retards accusés dans la construction du tokamak, qui ont été annoncés immédiatement après la nouvelle référence. Selon la planification actuelle (au mois de novembre 2017), il est prévu que le retard sera rattrapé dans les années à venir et que tout sera de nouveau en bonne voie en 2024.

Toutefois, de manière générale, F4E présente ses objectifs annuels selon la base de référence tout au long de la période d'évaluation. Les données sont conformes aux résultats de la consultation des parties prenantes lors de laquelle les parties prenantes de F4E, l'OI et d'autres parties prenantes ont confirmé un regain de confiance dans la capacité de F4E à réaliser son objectif de livraison de la contribution d'Euratom au projet ITER.

Contribution à l'Approche élargie

Dans l'ensemble, les progrès enregistrés dans les projets relatifs à l'AE sont satisfaisants, comme l'indique le ratio de crédit accordé dans le cadre l'Approche élargie au

crédit prévu, qui a été supérieur à 88 % en moyenne en 2016. Les progrès enregistrés dans l'atteinte des objectifs annuels sont indiqués dans la figure 34 ci-dessous.

L'Approche élargie est perçue comme une réussite par la majorité des parties prenantes étant donné qu'elle produit de bons résultats et ce dans les limites des écarts normaux pour les projets à long terme relatifs à la RD.

Contribution à DEMO

Les progrès relatifs aux activités DEMO (démonstration de la production d'électricité à partir de la fusion) sont actuellement limités à ceux compris dans le cadre du projet IFERC de l'Accord AE. EUROfusion poursuit le travail préparatoire pour DEMO, financé par le programme Euratom, et F4E a une fonction de soutien limitée.

Performance d'approvisionnement (contributions en nature)

Les procédures d'approvisionnement sont soumises à la réglementation de l'UE qui empêchent une meilleure performance des approvisionnements. Lors de la réalisation de l'approvisionnement public et des procédures d'octroi de subventions, F4E est tenu de suivre le Règlement Financier Euratom[70] et les Règles d'Application,[71] sous réserve de quelques dérogations prévues dans la Réglementation financière de F4E et des Règles de mise en œuvre. Il est ressorti des entretiens et d'une enquête menée pour les besoins de cette évaluation que, tandis que certaines dérogations pertinentes ont été obtenues, les règlements restent très semblables à ceux des institutions de l'UE telle que la Commission européenne et ne sont pas conçus pour un projet international de science expérimentale. Cette situation aboutit à des procédures plus complexes et rigides que celles des projets industriels « traditionnels » et il a été estimé avantageux d'envisager des adaptations supplémentaires aux règles pour donner à F4E davantage de souplesse et mieux refléter les besoins d'un projet unique en son genre comme ITER.

L'approche de F4E en ce qui concerne l'approvisionnement a évolué tout au long de la vie de l'organisation et l'a rapproché des réalités dans lesquelles évolue F4E. Dans des limites données, F4E a vu constamment évoluer ses procédures d'approvisionnement tout au long de son existence et en partie en coopération avec le réseau des OLI. Dans l'ensemble, cet état des choses a rapproché les procédures d'approvisionnement des réalités du marché dans lequel évolue F4E, lequel comprend un nombre limité de sociétés capables de fournir les composantes de haute technologie nécessaires.

Le coût de la contribution européenne au projet ITER

L'augmentation des dépenses pendant la période d'évaluation est présentée ci-dessous dans les crédits d'engagement et crédits de paiement[72]. Le projet ITER de 2014-2017 a évolué et a maintenant atteint la phase d'exécution de la construction et l'entreprise de marchés plus grands, ce qui nécessite davantage de personnels de surveillance. Les coûts administratifs et de fonctionnement ont augmenté en accord avec cette augmentation.

[70] Règlement (EU, Euratom) n0 966/2012 du Parlement européen et du Conseil du 25 octobre 2012, sur les règles financières applicables au budget général de l'Union et abrogeant le Règlement du Conseil (EC, Euratom) n0 1605/2002 ; tel que modifié par les Règlements n0 547/2014, 1142/2014 et 2015/1929.

[71] Règlement délégué de la Commission (UE) n0 1268/2012 du 29 octobre 2012 sur les règles de l'application du Règlement (UE, Euratom) n0 966/2012 du Parlement européen et du Conseil sur les règles financières applicables au budget général de l'Union ; tel que modifié par le Règlement délégué de la Commission (UE) 2015/2462.

[72] Il convient de noter que les paiements de la période 2014-2017 couvrent aussi les engagements pris avant 2014.

Figure 7 Total des dépenses 2014 – 2017 (crédits d'engagement valeur actuelle en millions d'euros)

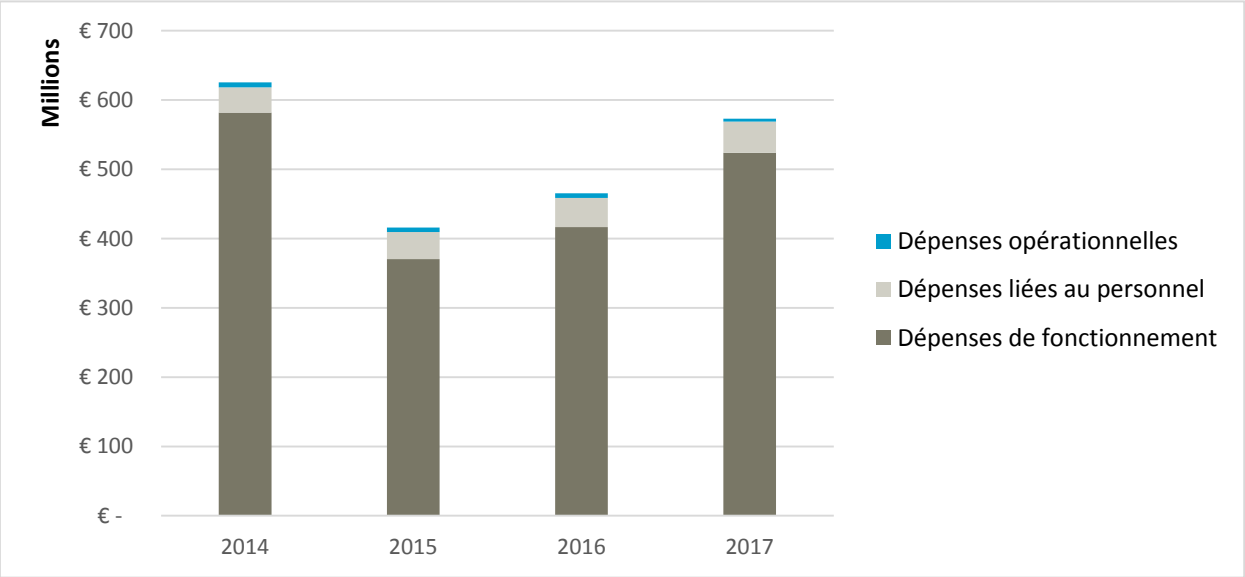
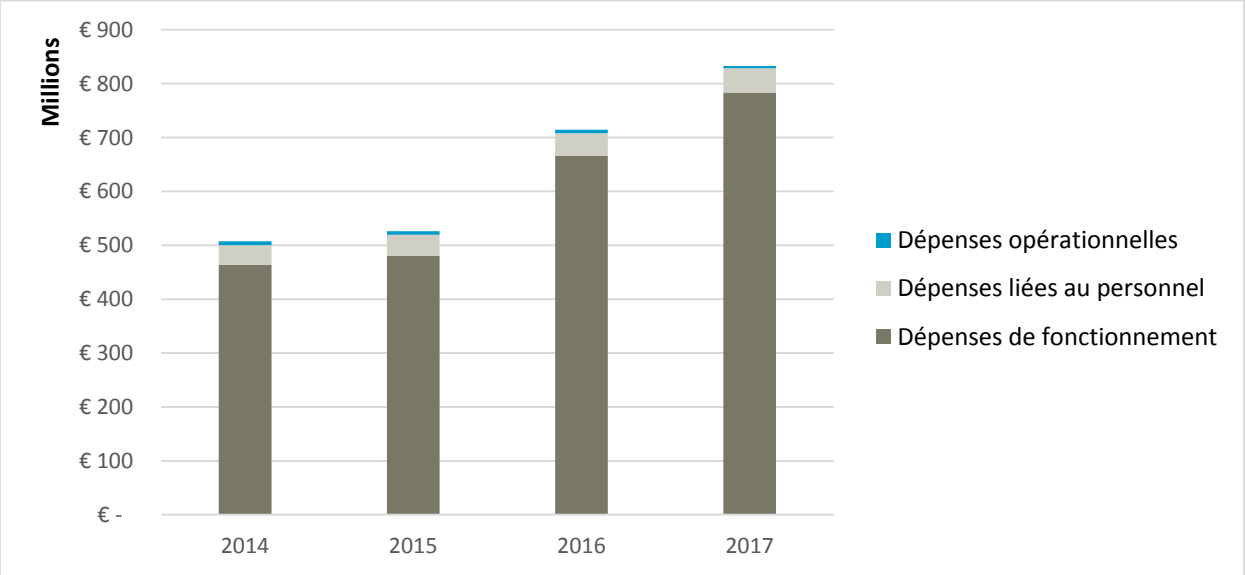


Figure 8 Total des dépenses 2014 – 2017 (crédit de paiement valeur actuelle en millions d'euros)



Source: Projet du programme annuel et pluriannuel de F4E années 2019-2023

Dépenses administratives

Les dépenses administratives ont augmenté pendant la période d'évaluation, cependant elles peuvent être considérées rentables. La totalité des dépenses administratives au cours des années 2014-2017 représente en moyenne 9 % (au niveau des crédits d'engagement) et 7 % (au niveau des crédits de paiement) du total des dépenses. On observe une tendance croissante des coûts administratifs sur la période 2014-2017 du fait d'un certain nombre de raisons. Dans l'ensemble, la fracture entre coûts administratifs et coûts de fonctionnement est conforme à celle de grands projets d'infrastructure de cette envergure et de coopération internationale. Les personnes interrogées chez l'OI et les autres parties prenantes estimaient aussi généralement que les coûts administratifs de F4E sont corrects par rapport au budget géré par l'organisation.

Dépenses de fonctionnement

F4E remplit ses obligations en ce qui concerne les contributions en espèces à l'OI. Les processus de gestion par F4E des contributions en espèces sont limités au suivi de la planification et à l'exécution des paiements, y compris la vérification que les transferts d'espèces demandés s'inscrivent dans les limites totales de la contribution européenne avant l'exécution des paiements. L'OI a la décision pleine et entière de la manière dont ces contributions sont utilisées, et F4E n'est pas mandatée pour effectuer un suivi d'aucune sorte sur la manière dont l'OI utilise ces contributions. Dans ce contexte, la gestion par F4E des contributions en espèces est faite de manière efficiente, mais l'utilisation efficiente des fonds dépend de l'OI et F4E n'exerce aucune influence directe sur cette question.

La viabilité des contributions en nature est fondamentalement liée au respect des procédures d'approvisionnement. Toutefois son impact ne se fait sentir que lentement. Toute approche en matière d'approvisionnement peut avoir des impacts positifs et négatifs, y compris l'approche de F4E qui a évolué au fil du temps. Quantitativement ces impacts ne peuvent être visibles qu'à l'avenir du fait des délais généralement longs nécessaires pour de grands approvisionnements et du fait de leurs délais individuels.

La viabilité des contributions en nature est aussi soumise à d'autres influences et il est difficile d'en connaître les causes exactes. La nature d'ITER nécessitant les approvisionnements uniques en leur genre entraîne quelques incertitudes et influence potentiellement les progrès et les coûts. Les autres influences potentielles sont entre autres les évolutions qui interviennent sur le marché et la technologie. La possibilité d'imputer des changements potentiels à la rentabilité des contributions en nature à l'avenir demeure un défi à cause de cette question.

Impact du cadre juridique de l'UE

Outre la réglementation financière, la rentabilité de la contribution de l'Europe au projet ITER connaît aussi des défis du fait d'autres restrictions du cadre juridique. Le cadre juridique de l'UE qui s'impose à F4E n'est pas adapté à un grand projet constituant une première comme ITER. En plus de la réglementation financière, d'autres obligations juridiques comme le règlement relatif au personnel pour le personnel de la CE ont été signalés comme étant potentiellement néfastes pour la rentabilité de F4E. Ces effets négatifs sont en autres le lourd fardeau administratif, un manque de flexibilité pour l'approvisionnement et la gestion de projet, et une forte dépendance aux processus juridiques. Bien que certaines dérogations pertinentes au cadre juridique aient déjà été obtenues, les règlements qui s'appliquent à F4E pourraient être davantage adaptés aux besoins d'un projet tel que ITER, ce qui permettrait à F4E d'agir plus comme une organisation internationale à caractère scientifique et moins comme une institution de l'UE.

Les avantages de la contribution européenne au projet ITER

Marchés et subventions accordés

Depuis la création de F4E en 2007 jusqu'à la fin mai 2017[73] des marchés d'une valeur totale de 3,7 milliards d'euros ont été accordés. Depuis la création de F4E jusqu'au 1er janvier 2017[74] des subventions d'une valeur totale de 99,51 millions d'euros ont été octroyées. Le nombre et la valeur des marchés et des subventions accordés par F4E, ainsi que leur répartition géographique, indiquent clairement que la Contribution européenne au projet ITER a considérablement profité à l'économie européenne. Du point de vue quantitatif, des montants de marchés et de subventions considérables ont débouché sur la création d'emplois et une augmentation de la rotation des effectifs.

Pour la majorité des parties contractantes, les marchés de mise en œuvre de F4E sont considérés comme faisant partie de leur activité principale. En outre, pour un petit nombre de parties contractantes, un marché de F4E est considéré comme tremplin vers la réalisation d'avantages et de profits à plus long terme[75].

[73] Toutes dernières données disponibles.
[74] Toutes dernières données disponibles.
[75] Le Présent paragraphe est basé sur les résultats préliminaires de l'étude Valeur pour l'argent (2018).

Les entreprises et les institutions de recherche participantes profitent de leur participation à des projets et à des réseaux de technologie de pointe, ce qui leur donne un avantage en termes d'innovation et de compétitivité. Les entreprises estiment que prendre part au projet ITER améliore leur réputation d'entreprise à l'avant-garde de la haute technologie, et nombreuses sont celles qui jouissent aussi des retombées positives des avantages indirects en dehors de la fusion et de la 'big science' et plus du tiers des entreprises ont développé des nouvelles technologies de pointe à la suite de leur collaboration au projet ITER. Enfin, environ un quart des entreprises ont rapporté que leur participation au projet ITER leur a permis d'accéder à de nouvelles opportunités d'affaires à la fois dans et en dehors de la fusion.[76]

Contribution à la politique industrielle de F4E

Les efforts effectués par F4E pour répondre aux objectifs de sa politique industrielle ont été considérables[77] avec un accent sur l'évaluation des résultats des activités d'approvisionnement de F4E en termes de processus de soumission d'offres et d'attribution de marchés en Europe; la mesure dans laquelle ils mènent à une collaboration, à une innovation et à la concurrence; et la portée de la participation des PME aux procédures d'approvisionnement. Dans l'ensemble, l'évaluation conclut que les objectifs de la politique industrielle de F4E sont atteints.

Les règles d'approvisionnement assurent une attribution efficiente des marchés malgré les difficultés à trouver l'équilibre entre la capacité et les exigences technologiques. Une stratégie d'approvisionnement qui consiste à séparer les grands ensembles d'approvisionnement et à évaluer la capacité du marché est en place pour assurer la participation d'autant d'opérateurs économiques que possible, notamment les PME.

F4E s'engage activement avec l'industrie et les communautés de recherche pour promouvoir la participation aux appels d'offres et les appels à propositions. Cette stratégie comprend la coopération avec le réseau d'Officiers de liaison industriels (OLI) et le Réseau européen des officiers de liaison de laboratoires de fusion. Elle intègre aussi la communication et les initiatives d'information pour sensibiliser et augmenter les capacités. A ce titre, le portail de l'industrie est capital.

Malgré cela, il est évident que la participation de l'industrie et des PME aux activités d'ITER demeurent un défi. La forte complexité des technologies, en raison de la nature « première du genre » d'ITER constitue un obstacle pour la participation des sociétés. En outre, le processus des approvisionnements et des marchés et menant aux résultats est décrit par les personnes interrogées comme plutôt long et complexe.

Impact économique

Une récente étude d'analyse d'impact a révélé que les dépenses de F4E pour le projet ITER ont des impacts économiques positifs considérables, avec la création de 34 000 emplois chaque année, dont 7 400 en 2017 seulement, et pratiquement 4,8 milliards d'euros de valeur ajoutée brute à ce jour, avec une estimation de plus d'1,1 milliard d'euros en valeur ajoutée brute en 2017. Dans le cadre de la base de référence actuelle pour la période 2020-2030, cette tendance devrait se poursuivre par la création de 14 500 nouveaux emplois, contribuant 3 668 millions d'euros (en valeurs 2015) en valeur ajoutée brute et en entraînant la création de plus 6 963 PME.

Dans la région hôte des installations du projet ITER, on considère que le projet a contribué à la création d'emploi pour la population locale travaillant sur site, en augmentant la capacité industrielle, notamment dans la région. En outre, différents effets induits ont été mentionnés tels que la création de nouvelles écoles dans la région, le

[76] Le Présent paragraphe est basé sur les résultats préliminaires de l'étude Valeur pour l'argent (2018).

[77] Objectif 1. Verser les contributions européennes au projet ITER et à l'Approche élargie dans les limites du budget et du calendrier convenus et fait bon usage du potentiel industriel et de recherche ainsi que des capacités de tous les membres de la F4E, conformément aux règles de la concurrence. Objectif 2. Elargir la base industrielle européenne pour la technologie de fusion en vue du développement à long terme de la fusion comme une source d'énergie à l'avenir et assurer une participation européenne forte et compétitive à l'avenir sur le marché de la fusion. Objectif 3. Encourager l'innovation et la compétitivité européennes dans les principales technologies émergentes pour faire évoluer le développement de l'Union de l'innovation et son impact au niveau international.

développement économique par la location de maisons, la création d'agences à la suite de cette logistique et de ces infrastructures.

Il existe un déséquilibre dans la répartition géographique des marchés et des subventions. Ceci résulte essentiellement des procédures d'approvisionnement basées sur le rapport coût/valeur de F4E. F4E ne fait aucune discrimination positive pour favoriser la répartition géographique étant donné que s'appliquent les règles d'approvisionnement public de l'UE. Par conséquent, il existe un déséquilibre dans la répartition géographique des marchés et des subventions. Comme autres raisons, les cinq principaux bénéficiaires représentent les plus grandes économies européennes; de plus, la France est le pays hôte d'ITER, où la plupart des livraisons doivent être faites et la proximité géographique du site de livraison tend à augmenter l'intérêt et la compétitivité pour les entrepreneurs, notamment pour les marchés de construction et d'autres marchés nécessitants une présence sur site (un effet similaire peut s'appliquer dans une moindre mesure à l'Espagne, le pays hôte de F4E). Enfin, l'expertise pertinente pour les marchés spécialisés, par exemple l'expertise sur la fusion ou l'expertise liée au nucléaire, peut être inéquitablement répartie entre les membres d'Euratom.

F4E essaie de créer un environnement favorable pour les PME. Toutefois, il demeure des obstacles. Selon les entretiens réalisés avec F4E, les PME représentent environ 48 % du nombre de marchés de F4E et 15 % de la valeur des marchés. La nouvelle stratégie de dégroupage peut augmenter le potentiel des PME soumettant des offres pour des marchés, même si c'est seulement dans une moindre mesure, étant donné que les marchés individuels ont tendance à être encore assez grands. La sous-traitance peut aussi présenter des opportunités intéressantes pour les PME. Il a été relevé que les grands projets tels que la construction de bâtiments arrivent à leur fin, tandis que des projets de petite envergure sont en train de prendre leur essor; cette nouvelle donne pourrait accroître la participation des PME à l'avenir. Dans l'étude,[78] une majorité de personnes interrogées ont exprimé leur désaccord avec l'opinion selon laquelle « les pratiques de F4E en matière d'approvisionnement profitent aux PME dans la mesure du possible. » Tous les Officiers de liaison industriels ont exprimé leur désaccord avec cette opinion, tandis que 37 % des membres du Conseil de direction n'étaient pas d'accord. Lors des entretiens téléphoniques avec les OLI, il a aussi été indiqué qu'il existait encore la possibilité de réduire les obstacles de la participation des PME aux appels d'offres.

L'impact de la rotation et de la réorganisation du projet

***Les Plans d'action ITER et F4E 2015 et les réorganisations associées au projet ITER et F4E* semblent avoir eu un impact positif sur la performance du projet ITER et la contribution européenne au projet ITER**,[79] et ont contribué à la restauration de la confiance dans la capacité de mener à bien le projet ITER au stade de la démonstration et de prouver la faisabilité de la fusion comme source d'énergie. Comme mentionné plus haut, F4E présente ses objectifs annuels selon la nouvelle base de référence durant la période d'évaluation, ce qui n'a pas été le cas depuis 2014 où le projet a connu d'importants retards et des dépassements de coûts en raison, entre autres, de la faiblesse de sa gestion et sa gouvernance. Les données sont conformes aux résultats de la consultation des parties prenantes selon laquelle les parties prenantes de F4E, l'OI et d'autres parties prenantes ont confirmé un regain de confiance dans la capacité de F4E à réaliser son objectif de versement de la contribution d'Euratom au projet ITER. Toutefois, il est trop tôt pour déterminer si l'impact positif peut être soutenu à long terme, et il existe encore la possibilité de réaliser d'autres améliorations.

Les améliorations spécifiques réalisées dans le cadre de F4E comprennent notamment:[80]

- L'installation d'une nouvelle structure organisationnelle en octobre 2016, qui comprend un Département de projet distinct (déjà créé en 2015) et un Département commercial intégré/CFO[81],
- Amélioration de la gestion du projet, à la fois en termes de capacités et d'outils, par exemple pour le suivi et la gestion des marchés.

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[78] Ramboll sur la base de la contribution européenne aux résultats de l'enquête ITER. Réponses aux questions 3, 5c, 8 et10c.
[79] 6e Evaluation annuelle de la F4E - Rapport au Conseil d'administration.
[80] En plus des documents de référence, les entretiens avec le personnel de la F4E et de l'OI ITER ont été utilisés pour cette section.
[81] Rapport d'activités annuelle de la F4E 2016, pp. 76-77.

- L'introduction des étapes de projet pour le suivi du statut du versement de la contribution européenne.
- Le renforcement substantiel de la gestion et de la réduction du risque[82], notamment la création d'un registre relatif aux risques de coûts[83] et une politique « goût du risque »[84],
- Suivi structuré selon les recommandations de l'audit, conduisant à la clôture de plusieurs questions ouvertes et à la réalisation de toutes les actions en instance suivant les recommandations des précédents audits internes en juin 2016[85], et
- Une amélioration de la coopération entre l'OI et F4E, un esprit d'équipe commun accru et une présence accrue de F4E sur le site de Cadarache.

La plupart des parties prenantes estiment que les changements ont eu un impact positif sur la contribution de l'Europe au projet ITER. Les entretiens avec le personnel de F4E et de ITER OI s'accordent pour dire que ces améliorations ont eu un impact positif sur la performance, un avis également partagé par les membres du Conseil de direction de F4E dans l'étude menée pour les besoins de la présente évaluation. Toutefois, les OLI ont une opinion moins positive. Les résultats doivent être examinés dans le contexte des interfaces des deux groupes que sont F4E et l'OI. Le groupe du Conseil de direction est profondément impliqué dans le développement de F4E et a des contacts directs avec l'OI. Les OLI, d'autre part, sont les principaux destinataires des informations relatives aux prochains approvisionnements[86].

La base de référence du projet de 2016 a eu un fort impact positif sur la contribution de l'Union européenne au projet ITER. Tandis que la nouvelle base de référence prévoit une phase de construction considérablement plus longue et des coûts accrus pour tous les membres ITER, cette nouvelle donne a rendu la base de référence plus réaliste, ce qui était un facteur clé pour la restauration de la confiance dans le projet ITER chez les parties qui le financent, le personnel et les autres parties prenantes.[87] En outre, la nouvelle base de référence fournit une solide fondation pour la planification, l'exécution et le suivi de la contribution européenne au projet ITER. Une évaluation indépendante de la capacité de F4E à verser la contribution européenne à la nouvelle base de référence d'ITER[88] a confirmé la capacité de F4E à verser la contribution d'Euratom au nouveau calendrier ITER à temps, dans le respect de l'approche prévue, et dans les limites du budget actuellement disponible jusqu'en 2020.

La stratégie de *« Ligne droite vers le premier plasma »* a pour l'essentiel des aspects positifs mais elle est aussi potentiellement porteuse de risques. L'introduction de la stratégie par F4E à l'ensemble d'ITER[89], concentrant les ressources sur les activités et la portée nécessaires pour le premier plasma ITER à la fin de 2025, a eu un résultat positif en termes de contrôle de coûts et de culture du projet et une dynamique projet plus déterminées au sein l'organisation. Toutefois, le report des activités post premier plasma suppose une révision des priorités dans les unités et les tâches de F4E qui ne sont pas directement liées à l'objectif Premier plasma 2025, et certaines personnes sondées à F4E ont estimé qu'il s'agissait d'une source potentielle de risques pour la performance à long terme de l'Entreprise commune.

Analyse du cadre de performance

Le système de gestion intégré est essentiellement adapté à l'usage prévu. Le système gestion intégré comprend actuellement des KPI qui fonctionnent à des niveaux différents: niveau de l'entreprise (indice du calendrier de performance) et CPI (indice de performance des coûts), ensuite à un niveau inférieur pour chaque service et finalement au niveau du travail. Les indicateurs de performance sont automatiquement tirés et calculés dans le système Prima Vera sur la base des données saisies. Au fil du temps, le système a été constamment amélioré, mis

[82] Evaluation et revue de la fusion de l'énergie (F4E) – Le Groupe de revue F4E (GR), 31 octobre 2016.
[83] Communication de la Commission COM(2017)319 au Parlement européen et au Conseil sur « la Contribution de l'UE à un Projet ITER réformé ».
[84] Politique « Appétit pour le risque », 2016 (F4E(16)-CA36-10).
[85] Rapport annuel de l'activité F4E 2016, pp. 76-77.
[86] En outre, ils travaillent aussi avec la F4E sur l'amélioration des procédures d'approvisionnement.
[87] La participation du ministère américain de l'Energie au projet ITER, mai 2016, la résolution du Parlement européen du 27 avril 2017 avec des observations formant partie intégrante de la décision sur la libération au titre de la réglementation du budget de l'Entreprise commune européenne pour ITER et le développement de l'Energie de fusion (Fusion pour l'Energie) pour l'exercice 2015 (2016/2194(DEC)).
[88] Evaluation et revue de la fusion de l'énergie (F4E) – Le Groupe de revue F4E (GR), 31 octobre 2016.
[89] Rapport annuel d'activité consolidé de la F4E 2016.

en œuvre à F4E, et mis à la disposition des différents services. Après l'adoption du plan d'action de F4E en 2015, des mesures supplémentaires ont été prises pour améliorer les activités de planification et de suivi.

Le processus de publication d'informations et de suivi est essentiellement appuyés par les systèmes informatiques interactifs disponibles pour la majorité du personnel de F4E. Ces systèmes sont des éléments clés d'un système intégré de rapport d'informations (SIRI). Le SIRI, avec les politiques et les stratégies de suivi et la publication de résultats, fournit un cadre fiable et familier conduisant au rapport d'informations dans les temps. Le SIRI permet aussi la disponibilité des rapports en temps opportun étant donné que le système est en ligne. Les personnes interrogées à F4E ont confirmé que l'usage des systèmes interactifs, en combinaison avec les services spécifiques des unités de F4E, leur permet de respecter les délais et de mettre les rapports à disposition. Il en est également ressorti que la charge administrative est raisonnable.

La qualité des données des systèmes de publication d'informations automatisés est considérée insuffisante. D'après les entretiens réalisés, la qualité des données de suivi pourrait être améliorée. L'une des raisons mentionnées ne correspond pas parfaitement aux systèmes informatiques pour le suivi et la publication d'informations. Il existe différentes plate-formes de publication d'informations utilisées par différents services qui sont intégrés au SIRI, mais ceux-ci ne sont pas totalement compatibles. Un autre aspect relevé est que les données peuvent ne pas toujours être correctement saisies du fait du manque de compétences de la personne chargée de ce travail.

Adaptation technologique et scientifique

F4E a des possibilités limitées pour s'intégrer au cadre de la gouvernance du projet ITER. La recherche sur la fusion a commencé durant la deuxième moitié du XXe siècle et le premier tokamak est entré en activité en 1958. Aujourd'hui, l'évolution technologique dans le domaine de la recherche sur la fusion est linéaire et n'avance pas rapidement. Toutefois, ITER est un projet à long terme dont la phase de conception et de construction est de presque 20 ans et dont le lancement a eu lieu en 2007. Les avancées technologiques et scientifiques qu'il doit entraîner sont attendues pendant cette période. Celles-ci ne peuvent être intégrées que dans une très moindre mesure étant donné que l'essentiel du projet ne peut être modifié. Cela tient à deux raisons: la structure de gouvernance d'ITER telle que convenue dans l'AI ne permet pas de changements majeurs puisque l'allocation des machines et des coûts ont été convenus dans cet accord. En outre, la nature du projet avec l'interface basé des contributions en nature des différents acteurs exige une conception robuste.

F4E est disposée à s'adapter dans la mesure du possible mais n'encourage pas activement l'innovation au sein des PME. Les entretiens ont confirmé que F4E affiche un intérêt pour l'innovation et utilise ce champ limité de manière adéquate en adaptant les approvisionnements aux avancées technologiques et scientifiques. D'autre part, des préoccupations ont été soulevées par rapport aux processus d'approvisionnement qui s'appuieraient trop sur les critères de sélection tels que les références, le nombre d'années d'expérience et la solidité financière pour que les PME innovantes puissent participer aux procédures.

Contribution à l'agenda stratégique de l'UE

La recherche documentaire indique que les objectifs de F4E – (a) livrer la contribution de l'Europe au projet ITER, (b) appuyer l'AE, et (c) contribuer à DEMO[90] – et au projet ITER – en vue de démontrer la faisabilité scientifique et technologique de l'énergie de fusion[91] – sont pertinents par rapport aux besoins et aux politiques actuelles de l'Union européenne.

La nature de ITER en tant que projet de recherche rend la contribution européenne au projet ITER très pertinente pour l'agenda stratégique de l'UE. Les objectifs de F4E et

[90] Comme définis à l'Article 1(2) des Statuts de la F4E.

[91] https://www.iter.org/doc/www/content/com/Lists/WebText_2014/Attachments/245/ITERAgreement.pdf

d'ITER s'intègrent plus largement au sein du Plan de Technologie d'énergie stratégique (SET)[92] (qui présente l'Europe comme un acteur majeur de la fusion nucléaire), dont le principal objectif est d'accélérer le développement et le déploiement des technologies à faibles émissions de carbone conformément à la stratégie énergie 2050 de l'Union européenne[93]. Les efforts consacrés par F4E à la recherche et au développement ITER dans le domaine de la fusion sont aussi conformes à la stratégie sécurité énergie de la Commission européenne[94], qui vise à assurer une provision stable et abondante d'énergie pour les citoyens et l'économie européenne. Le projet ITER peut aussi être perçu comme un appui à d'autres besoins et politiques de l'UE dans le cadre de deux principales caractéristiques de la Feuille de route énergie 2050[95]. Tout d'abord en tant que principal contributeur à la croissance européenne et à la création d'emplois par l'impulsion donnée au développement technologique européen. Deuxièmement, en tant que projet majeur dans le passage vers une politique de recherche et d'innovation « Global-EU »[96] selon ses perspectives internationales et sa vaste portée.

Des aperçus de la recherche documentaire font aussi penser que la contribution européenne au projet ITER est cohérente avec d'autres initiatives de la Commission européenne et la politique plus large sur l'énergie, le climat et l'environnement. Le projet ITER est soutenu par plusieurs initiatives européennes (e.g. Feuille de route vers l'électricité de fusion[97], EUROfusion et le Tore commun européen (Joint European Torus), le Programme de recherche et de formation Euratom[98]), et inversement, ITER est conforme au premier objectif de l'agenda politique de la Commission, qui est d'impulser la création d'emplois, la croissance et les investissements dans les secteurs d'avenir à fort potentiel technologique[99].

Encore plus important, le projet ITER s'intègre au cadre de la stratégie pour l'Union de l'énergie. Le projet Union de l'énergie définit trois objectifs de la politique énergétique de l'UE, à savoir la sécurité de l'approvisionnement, la pérennité et la compétitivité.[100] Ces objectifs sont importants pour le projet ITER, avec cependant une approche orientée sur la recherche à long terme. Pour cette raison, la fusion nucléaire ne peut être le seul stimulateur pour la transition vers une économie faible en émissions de carbone, étant donné que les avancées technologiques dans d'autres sources d'énergie, telles que les sources d'énergie renouvelables, sont toujours appuyées par l'UE[101].

Enfin, la contribution européenne au projet ITER est conforme aux obligations internationales de l'UE dans le cadre de l'Accord de Paris et des Objectifs de développement durable. La Contribution européenne au projet ITER n'appuie pas directement l'objectif de l'Accord de Paris de limitation du réchauffement climatique en dessous de 2°C au-dessus des niveaux préindustriels d'ici la fin de ce siècle en raison de la réalisation tardivement attendue d'une production d'énergie de fusion commercialement viable. La Contribution européenne au projet ITER peut être perçue comme compatible avec les Objectifs de développement durable.

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[92] MEMO/10/165 (Commission européenne) ITER & Recherche dans le domaine de la Fusion. 5 mai 2010.
[93] L'UE s'est fixé un objectif à long terme de réduction des émissions de gaz à effet de serre de 80-95 %, par rapport aux niveaux de 1990, d'ici 2050. https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2050-energy-strategy
[94] La communication de la commission au Parlement européen et au Conseil. Stratégie européenne sur la sécurité énergétique {SWD(2014) 330 final}.
[95] Communication de la Commission au Parlement européen, au Conseil, au Comité économique et social européen et au Comité des Régions. Feuille de route énergie 2050 {COM(2011) 885 final}.
[96] Commission européenne (Ed.). (2012). Global Europe 2050. Luxembourg : Bureau des publications de l'Union européenne.
[97] EFDA (2012) Electricité de fusion. Une feuille de route vers l'atteinte de l'objectif de l'énergie de fusion.
[98] Décision de la Commission européenne C(2017)7123 du 27 octobre 2017. Programme de travail Euratom (2018
[99] COM(2017) 319 Communication définitive de la Commission au Parlement européen et au Conseil – Contribution de l'UE à un projet ITER réformé.
[100] MEMO/10/165 (Commission européenne) ITER & Recherche dans le domaine de la Fusion. 5 mai 2010.
[101] Dans l'UE, ces énergies renouvelables représenteront environ 20 % de la consommation brute d'énergie définitive d'ici 2020 et 60 % d'ici 2050 (voir la Communication de la Commission au Parlement européen, au Conseil, au Comité économique et social européen et au Comité des Régions. Un cadre de politique pour le climat et l'énergie sur la période 2020-2030. {COM(2014) 15 final}).

Valeur ajoutée de l'UE

Les aperçus des données disponibles suggèrent fortement qu'une intervention au niveau d'Euratom est cruciale en termes de disponibilité de ressources ainsi que pour la complexité du projet. Les fonds nécessaires pour la participation au projet ITER pourraient représenter une part considérable des fonds publics de la R&D des Etats membres y compris les plus grands de l'UE. Ainsi il est très probable qu'en l'absence d'un rôle de coordination de l'UE, deux ou plusieurs Etats membres se verraient obligés d'intégrer l'AI pour assurer la contribution d'Euratom qui est, selon l'AI, la partie hôte du projet ITER et à ce titre n'a pas le droit de se retirer de l'accord. Ceci aurait conduit ou conduirait à davantage complexifier le projet ITER avec en prime les problèmes qu'entraînent une plus grande complexité.

Le regroupement des ressources européennes peut logiquement conduire à des économies d'échelle.[102] Ce facteur est généralement présumé pour les agences de l'UE telles que F4E[103]. Il ressort aussi des entretiens et des résultats de l'étude qu'il existe un fort consensus sur le fait que l'intervention au niveau de l'UE fournit des gains d'efficacité (par exemple des coûts administratifs et de fonctionnement moindres) par rapport à ce qui aurait pu être réalisé au niveau national. Toutefois, il n'existe pas de données disponibles pour conforter ces hypothèses en raison de la forme unique d'ITER et du système de contributions en nature qui n'est pas aisément comparables à d'autres projets.

L'influence et la stabilité politique constituent un important aspect de la valeur ajoutée de l'UE dans ce mégaprojet. On peut supposer que la participation au niveau de l'UE, qui sera autorisée à prendre la plus grosse partie du projet en termes de ressources, a augmenté l'influence de l'Europe sur les aspects importants du projet tel que le site de construction. La stabilité politique est un facteur crucial pour un tel projet à long terme et avoir l'UE comme hôte, laquelle est une union de plusieurs pays, procure plus de stabilité.

Un autre facteur important de valeur ajoutée émanant de l'intervention au niveau de l'UE est la cohérence accrue. Comme indiqué à l'Annexe I de l'AI, chaque membre et l'OI assurent l'accès à l'OI et aux autres membres aux inventions et à la propriété intellectuelle générée ou incorporée à l'exécution des marchés, à condition que les droits de l'inventeur soient respectés. Par conséquent, tous les Etats-membres de l'UE et la Suisse, en raison de leur appartenance à Euratom, ont accès aux résultats de la R&D liés à la fusion et ayant lieu au sein du projet ITER.

La nature de F4E comme organe de l'UE n'est pas nécessairement favorable à un fonctionnement optimal. Comme souligné précédemment, F4E en tant qu'agence de l'UE est soumise à un ensemble de règles potentiellement contre-productives pour sa performance. La récente étude d'analyse d'impact (2018) a évalué les options de recours à d'autres instruments juridiques de mécanismes de livraison, notamment un partenariat public-privé, une entreprise commune (la forme juridique actuelle), une agence de l'UE, une organisation intergouvernementale, une société privée, et un Consortium pour une infrastructure européenne de recherche avec les résultats des impacts, même si les différents documents juridiques sont encore en instance de préparation au moment de la rédaction de ce rapport.

Par rapport aux besoins en ressources, tel que mentionné ci-dessus, le projet continue de nécessiter un financement considérable même après le cadre financier pluriannuel actuel. Il estimé qu'un total de 7.1 milliards[104] d'euros est nécessaire jusqu'en 2035 (c'est à dire jusqu'au début de l'exploitation à pleine puissance. Ce montant ne peut probablement pas être couvert par un seul Etat-membre de l'UE et nécessiterait probablement la participation de deux ou trois Etats de plus, ce qui suppose les difficultés susmentionnées.

Enfin, les membres du Conseil de direction et les Officiers de liaison industriels de F4E sont unanimement d'accord ou sont fortement d'accord que les objectifs recherchés par la participation d'Euratom au projet ITER exigent toujours des ressources et des mesures au niveau de l'UE.

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[102] Voir MEMO/11/938 Bruxelles (Commission européenne) la Commission européenne propose un Programme de recherche supplémentaire pour ITER. 21 décembre 2011.
[103] Voir https://euagencies.eu/sites/default/files/eu_agencies_brochure_2017.pdf
[104] En valeurs de 2008.

Acceptabilité

Les résultats de l'étude donnent à penser que la conscience du projet ITER et de la contribution d'Euratom au projet est grande chez leurs parties prenantes directes, c'est-à-dire le secteur et la communauté de fusion.

Il semble que le grand public soit peu sensibilisé au projet. Un des indicateurs de l'intérêt du grand public est la couverture médiatique. Depuis 2009, l'OI observe systématiquement l'intérêt de la presse dans le monde par rapport au projet ITER. Un pic significatif a eu lieu en décembre 2017 suivant un communiqué de presse de l'OI après la réalisation d'environ 50 % du projet ITER[105]. Autrement, la couverture médiatique a été relativement constante, et aucune tendance à la hausse n'est perceptible. Sur les plateformes des réseaux sociaux par rapport à d'autres DA, F4E a une bonne audience. Toutefois, la comparaison avec un autre projet de recherche nucléaire de grande envergure, l'Organisation européenne pour la recherche nucléaire (CERN), indique que l'audience sur les plateformes de réseaux sociaux de F4E et d'ITER est comparativement faible. De même, plusieurs personnes interrogées ont déclaré avoir le sentiment F4E n'est pas bien connu du grand public et que cela doit s'amélioré.

Les efforts de communication de F4E peuvent sembler accorder beaucoup trop d'importance à F4E et non à l'ensemble du projet, également en comparaison avec les efforts de communication d'autres DA. Toutefois, il a aussi été reconnu que depuis que les DA ne portent pas seulement sur le projet ITER (par exemple F4E travaille aussi sur l'AE), ils doivent aussi pouvoir se mettre en valeur au-delà d'ITER tout en mettant l'accent sur le fait que le projet ITER est un projet de groupe. Les parties prenantes de l'OI ont également fait part du sentiment que la communication de F4E semble trop porter sur l'ingénierie et le progrès de l'approvisionnement plutôt que sur la nature unique du projet ITER.

Par rapport à la réputation du projet ITER chez le grand public, il existe la perception que les récentes organisations de gestion ont restauré la confiance et remis le projet sur la bonne voie tel que le donne à penser l'évaluation non systématique de la presse à la suite d'un communiqué de presse annonçant la réalisation de la moitié du projet ITER à la fin 2017.

Conclusions

Les trois objectifs sont conformes à la planification actuelle. Les crédits reçus pour les contributions au projet ITER indiquent un léger retard à la fin de la période d'évaluation. Toutefois, les retards ne sont pas comparables à la situation d'avant 2014 où le projet a connu de graves retards et des dépassements de coûts. L'AE est largement en bonne voie. Il n'existe pas encore d'échéancier pour DEMO, mais les travaux préparatoires sont actuellement en cours.

Pendant la période d'évaluation, la contribution européenne au projet ITER a été soumise à de grands changements en termes de sa structure de gestion. Les résultats directs des changements intervenus dans la gestion peuvent être considérés positifs et prometteurs. Dans l'ensemble, ils conduisent à une culture de projet et à une dynamique de projet plus déterminées dans l'organisation.

En ce qui concerne les effets indirects, la réalisation susmentionnée des crédits d'ITER et globalement conforme à la base de référence actuelle est un changement clairement positif par rapport aux périodes précédentes. Des changements indirects positifs sont également perçus aussi bien par le personnel de F4E que par les parties prenantes directes telles que l'OI et d'autres personnes interrogées qui font état d'une motivation accrue et de l'enthousiasme au travail de F4E. D'autres effets indirects liés au changement de pratiques en matière d'approvisionnement qui pourraient avoir une influence sur la rentabilité des contributions en nature sont soumis à des délais trop longs et ne peuvent pas encore être mesurés.

Un autre changement majeur est la nouvelle base de référence utilisée depuis 2016. Les évaluateurs externes considèrent la base de référence comme réaliste et prometteuse du point de vue de l'atteinte des objectifs technologiques d'ITER. La nouvelle base de référence comprend aussi les coûts supplémentaires pour la contribution européenne au projet ITER après 2020, date jusqu'à laquelle la contribution financière d'Euratom est plafonnée. Considérant la

[105] L'Organisation ITER (2017). La machine la plus complexe au monde est achevée à 50 pour cent. Communiqué de presse. https://www.iter.org/doc/www/content/com/Lists/list_items/Attachments/759/2017_12_Fifty_Percent.pdf

planification actuelle qui court jusqu'en 2020, ce plafond sera respecté étant donné que la base de référence était spécialement adaptée pour satisfaire ses exigences.

Tout en reconnaissant les difficultés méthodologiques de l'évaluation de cette question, les données font penser que la contribution européenne au projet ITER est économiquement viable, à la fois en termes de dépenses opérationnelles qu'en termes de dépenses de fonctionnement. Toutefois, la contribution d'Euratom souffre encore du fait qu'elle est versée dans le cadre de l'UE, ce qui n'est pas toujours totalement conforme à ce qui pourrait être considéré comme bonne pratique pour une livraison efficace et efficiente.

Les marchés pour la plus grosse part de la contribution européenne ont été attribués au secteur et aux institutions de recherche. Les nombres et la valeur des contrats et des subventions accordés par F4E, ainsi que leur répartition géographique, indiquent clairement que la Contribution européenne au projet ITER a considérablement profité à l'économie européenne. D'un point de vue quantitatif, des montants de contrats et de subventions considérables ont débouché sur la création d'emplois et une augmentation de la rotation des effectifs. En outre, la nature des marchés donnant lieu à des produits uniques en leur genre est considérée comme apportant un avantage aux sociétés européennes participantes en termes d'innovation et de compétitivité.

La participation de l'Europe au projet ITER est considérée comme étant parfaitement conforme à la recherche ainsi qu'aux objectifs énergie et carbone à long terme. Les caractéristiques de l'énergie de fusion qui la rendent unique conduisent à une forte complémentarité avec d'autres sources d'énergie zéro carbone telles que les énergies renouvelables ou l'hydrogène. Toutefois, étant donné la longueur des délais pour le début prévu de la production de l'énergie de fusion commerciale, le projet ne contribue pas directement à la satisfaction des besoins actuels et à moyen terme.

Des aperçus des données disponibles indiquent clairement qu'une intervention à Euratom par rapport au niveau des Etat-membres de l'UE, au moins jusqu'à la fin de la construction d'ITER, est cruciale en termes de disponibilité de ressources et de réduction de la complexité du projet.

1. Introduction

The present document is the final report of the study "The European contribution to ITER: Achievements and challenges".

The study has been managed by Unit D.4 "ITER" of DG ENER of the EC and conducted by Ramboll Management Consulting A/S, in partnership with Ramböll Sverige AB and Vivid Economics, between January 2018 and May 2018. The project is based on extensive and comprehensive desk research and targeted stakeholder consultations.

The present document is the final report of the study. It builds on the inception report and the interim report and presents the conclusive results of the project.

2. Methodology

2.1 Overall approach

2.1.1 Objectives of the study

The work is a support study for an evaluation of the European contribution to ITER. The purpose is threefold:

- The study is undertaken in line with the **reporting obligation** entailed in Article 5b of Council Decision 2013/791/Euratom of 13 December 2013 for the Commission to submit to the European Parliament and to the Council a progress report on the implementation of the Decision, specifically with regard to the results of the commitments and expenditure of the Euratom contribution during the current MFF. These results are presented in section 3.
- The study aims to support the Commission in preparing a mid-term evaluation of the execution of European participation in the ITER project in line with the **Better Regulation Guidelines**. The terms of reference of the study identifies evaluation criteria and evaluation questions that should be addressed in the study. The evolution of the European contribution to date and the quality and adequacy of the results/outputs from the perspective of EU policies, priorities and interests should be assessed. The efficiency or performance of F4E in meeting plans and schedules should also be analysed. To this purpose, the terms of reference identify minimum requirements in terms of methodology and stakeholder consultation.
- Finally, the study will serve as an input for the post-2020 Multi-Annual Financial Framework discussion. As such, it will contribute to the preparation of the Commission's **ex-ante evaluation** of the EU contribution to the ITER project and the Broader Approach (BA) activities under the next Multi-Annual Financial Framework.[106]

2.1.2 Scope of the study

The scope of the evaluation can be considered in its temporal and material extent.

The **material scope** is primarily the European contribution to ITER. Provided by the "European Joint Undertaking for the Development of Fusion Energy" (Fusion for Energy – F4E), the Euratom Domestic Agency that was set up by Council Decision 2007/198/Euratom, the European Contribution to ITER consists in Euratom's direct ("in-cash") financial contribution to the ITER Organisation (IO) costs and the "in-kind" contributions of components of the project. F4E's objectives besides the construction of ITER (i.e. the contribution to the preparation for the construction of a demonstration fusion reactor and related facilities, including the International Fusion Materials Irradiation Facility (IFMIF), and European activities under the Broader Approach Agreement) shall receive less attention compared to the ITER project.

The **temporal scope** of the evaluation is the period 2014-2017. The start of the current MFF (i.e. 2014) is to be used as the reference point with the end of 2017 as a cut-off point. This

[106] Subject to Request for services "Supporting Analysis for an Impact Assessment on the Future Funding of the EU Participation in ITER Project and Broader Approach (BA) Activities under the next Multi-Annual Financial Framework" (N° 2017-231)

means the evaluation is to take into account the important turnaround of the ITER project from mid-2015 and of the management and execution of EU's participation from 2016.

2.2 Data collection

This section gives an overview of the data collection tools used for the study.

Three main sources of data have been used for this report: literature (including data provided by F4E), semi-structured interviews with three different groups of stakeholders (F4E staff, IO staff and other external stakeholders), and a survey among all members of the F4E Governing Board (GB) and the Industrial Liaison Officers (ILO)[107].

In the analysis, the data sources have been triangulated to generate findings.

2.2.1 Desk research

Desk research is a central method to collect information on the progress of the European contribution to the ITER project. The desk research involved systematic assessment, and organisation, of information pre-existing to this study. A wide range of documents of different types has been consulted; a complete overview is presented in Annex 1.

2.2.2 Interviews

A total of 34 in-depth interviews were conducted with different types of stakeholders, as summarised in the table below. Each interview lasted for about one hour and was of a semi-structured nature. The interviews followed an interview guide, adapted for the type of stakeholder[108], yet allowed for exploration of topics outside the guide if considered relevant. The interview notes have been analysed, and the key results per evaluation question are presented in Annex 2.

Table 3 Number of interviewees per stakeholder group

Stakeholder group	Conducted interviews
IO	9
F4E	12
Other	13
Total	**34**

2.2.2.1 *Field visits at F4E and IO*

The evaluation team interviewed staff at Fusion for Energy (F4E) in Barcelona, Spain on 15 and 16 February 2018, and IO in Saint Paul-les-Durance, France on 06 March 2018 to increase understanding of the Euratom contribution to ITER, fill data gaps and gather feedback on latest developments and progress. A list of interviewees can be found in Annex 3.

2.2.2.2 *Interviews with external stakeholders*

Due to the small number of stakeholders having knowledge of the European contribution to ITER, and also in order to avoid overlap with other studies conducted in parallel, the stakeholder consultation focused on a restricted number of semi-structured phone interviews. A list of these interviewees can also be found in Annex 3.

2.2.3 Semi-structures survey among ILOs and GB members

A survey was conducted among member of the F4E Industrial Liaison Officer (ILO) network and the members of the F4E Governing Board. The survey results are presented in Annex 4.

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[107] Industrial Liaison Officers (ILOs) are a network of representatives from different European countries that together with F4E raise awareness regarding funding schemes and ways to get involved in the ITER project.
[108] That is, an adapted interview guide was created for representatives from: IO, F4E, ILO, GB, BA, Scientific Community, and the European Parliament.

2.3 Limitations

The methodology used in this evaluation follows best practice from the Better Regulation Toolbox and results can be considered pertinent. However, limitations related to methodology and data sources need to be considered and are listed below together with insights about how they were addressed.

Methodological limitations

Where possible information has been triangulated to confirm data. However, not in all cases different data sources were available and findings rely on a limited number of sources. The findings sections of each evaluation question in Annex 2 provide insights into which data sources each finding is based on.

The timeframe of the evaluation was rather short but sufficiently allowed for a thorough analysis.

The unique character and size of the ITER project exacerbates the comparison with other projects and thus a benchmark is often not appropriate or possible.

Data sources

Desk review

A large share of the consulted literature has been produced by F4E; F4E also provided additional data sources and explanations. The data is considered reliable given the strong scrutiny under which F4E works, including regular audits by the European Court of Auditors.

Given the timeframe of this project which has been conducted in early 2018, data for 2017 often is not fully conclusive. This is either because data covering all of 2017 was not available (e.g. for procurement procedures) or figures were not officially confirmed yet (e.g. the final accounts). Those respective limitations have been highlighted in the body of the text.

Interviews

The semi-structured nature of the interviews and the time-limit of one hour meant that the interviewer prioritised questions most relevant to the knowledge of the interviewee. As a result, the extent of the responses to the questions in the interview-guide varies between the interviewees.

The sample size of in-depth is considered to be sufficiently representative.

Relying on different groups of stakeholders allows institutional biases to be uncovered and the triangulation of the interview notes has been done in the analysis by comparing results from the different groups.

Survey

The response rate to the online survey was 45% for the Governing Board (GB) members and 36% for the for Industrial Liaison Officers (ILO), which is not very high considering their small populations (60 and 22, respectively) and the high commitment that could be expected from them. This implies that there may be self-selection biases in the sample. For example, it may be that more committed GB members and ILOs responded to the survey, and that these members are more likely to respond in a certain way.

The results of the survey cannot therefore be statistically generalised to the GB and ILO populations[109]. That is, the results do not lend themselves to the identification of their associated margin of error. Thus, as calculating the margin of error could be misleading, it was not calculated for the responses to the survey.

Notably, the biases outlined above do not impact on the value of the results of the survey. Although they should be kept in mind upon interpretation of the survey results, the results still give an indication of the opinion of GB members and ILOs on the European contribution to ITER.

[109] Louis M. Rea and Richard A. Parker, *Designing and Conducting Survey Research: A Comprehensive Guide*, Fourth edition (San Francisco, CA: Jossey-Bass, a Wiley brand, 2014), 198.

3. Progress report on the implementation of Council Decision 2013/791/Euratom

This section fulfils the reporting obligation entailed in **Article 5b of Council Decision 2013/791/Euratom**[110] of 13 December 2013 for the Commission to submit to the European Parliament and to the Council a progress report on the implementation of the Decision, specifically with regard to the results of the commitments and expenditure of the Euratom contribution during the current MFF[111].

3.1 Introduction

3.1.1 Introduction to ITER

ITER (Latin for "the way") is an international cooperation project to demonstrate fusion as a sustainable and economically viable energy source. Fusion is the process that powers the sun and other stars. Its emissions are safe and don't include carbon dioxide, and it is potentially a source of unlimited energy.

The ITER project consists of the construction and operation of the world's largest tokamak, a magnetic fusion device. The tokamak is an experimental machine designed to explore the potential of fusion as a source of energy. Inside the tokamak, energy from the fusion of atoms is absorbed by the vessel's walls as heat[112]. The ratio of the thermal fusion power produced to the thermal power required to achieve the fusion is called the gain factor, Q. In simple terms, it is the ratio of "power in" to "power out" (the plasma). If Q is greater than 1, the reactor is producing a net gain in energy. If Q is greater than 5, the energy from the fusion reactions is sufficient to self-heat the plasma.

The tokamak has been designed to pursue five technical objectives:

i. Achieve extended burn with a Q of at least 10;
ii. Demonstrate steady-state operation with a Q of at least 5[113];
iii. Demonstrate the integrated operation of technologies for a fusion reactor;
iv. Test components for a future reactor; and
v. Demonstrate the safety characteristics of a fusion device.

The ITER Agreement[114] was signed in Paris, France, on 21 November 2006 and entered fully into force on 24 October 2007 after ratification by all Members[115]. The depositary of the ITER Agreement is the Director-General of the International Atomic Energy Agency. The ITER Agreement set up the IO and led to the establishment of the ITER project. The IO has the overall responsibility for the construction, operation, exploitation and de-activation of the ITER facilities.

The Agreement requires that each Party to the Agreement sets up a Domestic Agency (DA) as an entity for coordinated interaction with IO and provision of contribution on behalf of the Party. Under the agreement, the "European Joint Undertaking for the Development of Fusion Energy"

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[110] Council Decision 2013/791/Euratom: Council Decision of 13 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

[111] Article 5b stipulates that "The Commission shall submit to the European Parliament and to the Council, by 31 December 2017, at the latest, a progress report on the implementation of this Decision on the basis of information provided by the Joint Undertaking. That report shall set out the results of the use of the Euratom contribution referred to in Article 4(3) as regards commitments and expenditure."

[112] Like a conventional power plant, a fusion power plant uses this heat to produce steam and then power through turbines and generators. However, ITER, being a research project, is not meant to produce actual electric energy.

[113] For a tokamak to be able to self-heat its own plasma, Q must be at least 5, as 1/5 of the power comes in the form of charged helium nuclei that stay in the plasma and give their energy to the plasma, while 4/5 comes in the form of neutrons that leave the plasma and deposit their energy in the walls

[114] Information Circular (IAEA) INFCIRC/702 Date: 25 April 2007 Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project

[115] China, India, Japan, Russia, South Korea, the United States, and Euratom

(Fusion for Energy, or F4E) was set up by a Council Decision[116] on 27 March 2007 with the mandate to manage the EU's contribution to the ITER project on behalf of Euratom. F4E was set up for a period of 35 years[117] and has its headquarters in Barcelona, Spain. The members of F4E are the Euratom Member States, Switzerland, and Euratom.

F4E's tasks are defined in Article 1(2) of F4E's Statutes. They are threefold:

1. To provide the contribution of the European Atomic Energy Community (Euratom) to the IO for the ITER project, under the terms of the International ITER Agreement;
2. To provide the contribution of Euratom to Broader Approach (BA) activities[118] with Japan for the rapid realisation of fusion energy, entailing at present three collaborative projects located in Japan;
3. To prepare and coordinate a programme of activities in preparation for the construction of a demonstration fusion reactor (referred to as DEMO) and related facilities including the International Fusion Materials Irradiation Facility (IFMIF).

In parallel to the ITER Agreement, Euratom entered into a separate bilateral agreement with Japan (the "Broader Approach" Agreement) in order to further facilitate and coordinate fusion-related developments. It was signed on 5 February 2007 in Tokyo and the activities started on 1 June 2007 after ratification of the Agreement by both Parties. F4E is also the Implementing Agency for the EU contribution to the three BA projects, as it was designated by the European Commission to discharge its obligations as defined in the BA Agreement.

The BA activities support the ITER Project and an early realisation of fusion energy on a time frame compatible with the ITER construction phase. The BA consists of three major projects:

- Satellite Tokamak Programme (STP): JT-60SA - - A project to upgrade an existing tokamak located in Naka, Japan. Europe is providing critical components such as the 18 large superconducting Toroidal Field coil magnets, and part of the power supply and the cryogenic system.
- International Fusion Materials Irradiation Facility - Engineering Validation and Engineering Design Activities (IFMIF/EVEDA) - - A facility for fusion materials testing. The key objectives of this project are testing and validating a Lithium Target for neutron beam production, commissioning of an Accelerator facility, the assembly of the RFQ module, and its ancillaries on site, and commissioning of the modules for accelerating the beam up to 5 MeV.
- International Fusion Energy Research Centre (IFERC) - – Carries out several projects including collaborative activities in testing and development of materials for future breeder blankets, joint work on pre-conceptual DEMO design, and the preparation of hardware and software for the Remote Experimentation Centre in Rokkasho, Japan Until May 2017, the Helios supercomputer performed large-scale simulation activities at IFERC, including ITER operation scenarios and contributions to DEMO design.

The Euratom resources for the implementation of the BA are largely (approx. 90 %) provided voluntarily by several participating European states (Belgium, France, Germany, Italy, Spain and, in the past, Switzerland).

The third task is currently mostly assumed by EUROfusion[119], which has a significant DEMO programme, and funded through the Euratom programme. Part of this programme is used by F4E to discharge its obligations under the BA agreement as defined in the BA IFERC project.

3.1.2 Turnaround

The construction of the ITER scientific installation in St-Paul-les-Durance, France, began in 2010 and was expected to last ten years.

However, the project experienced delays and cost overruns due to, among other reasons,

[116] Referred to hereafter as F4E's Statutes – Council Decision 2007/198/Euratom amended by Council Decision 2013/791/Euratom of 13 December 2013 and Council Decision (Euratom) 2015/224 of 10 February 2015

[117] Starting from 19 April 2007

[118] See below

[119] EUROfusion, the 'European Consortium for the Development of Fusion Energy', manages and funds European fusion research activities on behalf of Euratom

weaknesses in its management and governance[120]. In 2014 and 2015 a new Director General for the IO, Dr Bernard Bigot, was nominated and confirmed by the ITER council. Also in 2015, a new Director for F4E, Johannes Schwemmer, has been appointed.

In 2015, IO and F4E both presented action plans that had been preceded by critical assessments that identified managerial shortcomings in both organisations. In 2013, the "ITER Management Assessment" report[121] revealed several problems in the management and organisation of the ITER project and identified 11 recommendations for urgent action. In 2015 an action plan[122] was proposed by IO and since then implemented to correct the deficiencies identified by the Management Assessment. The plan proposed several measures to resolve the present difficulties, the most important ones being to build an integrated team of IO and the DAs and to present an updated and realistic project schedule. The previous schedule, dated from 2010, was considered to be unrealistic since it did not take in due consideration the technical challenges and the real capability of both the IO and the DAs to deliver their in-kind contributions. As a result, the expected delivery dates had been delayed for up to 45 months relative to their planned dates in the 2010 schedule. In addition, in order to deal with potential additional costs arising from future design changes a Reserve Fund was established under the responsibility of the Director General.[123]

Also in 2013, the European Parliament's Budgetary Control Committee published a report which revealed some shortcomings in the organisation of F4E. Following this, but mainly in support of the IO action plan F4E presented its own F4E action plan[124] that identified measures to address supplementary issues to those planned under the IO action plan.

In November 2015 the IO presented a proposal for the updated ITER long-term schedule to the ITER Council. The ITER Council rejected the proposal due to not taking into account the existing constraints from the members and the lack of sufficient risk mitigation actions to provide confidence in the proposed schedule. The proposal also required significant additional cash contributions from the ITER Members. The IO adjusted the schedule to allow a decrease of the required resources taking into account the resources available in F4E and the other ITER Domestic Agencies. The resources are to remain within the EUR 6.6 billion budget (in 2008 value).

The independent review of the ITER schedule and its associated resources in April 2016 concluded that the long-term schedule is feasible even though it also noted that the schedule as well as budget towards the December 2025 First Plasma milestone does not include any explicit contingency. The reviewers also recommended a 'Staged Approach' as a means of improving focus and optimising resources. This involved having up to four phases of ITER assembly and operation from First Plasma at the end of 2025 up to Deuterium-Tritium operations in 2035 so as to reduce technical risks. Following the positive outcome of the report, the new ITER Baseline was approved by the ITER Members at an ITER Council meeting in June 2017[125].

In January 2016 the F4E Director launched the project called 'Straight Road to First Plasma' (SR2FP) with the overall objective of concentrating resources (funding and staff) on the activities critical to the achievement of First Plasma at the end of 2025. This objective is fully consistent with the updated IO Overall Project Schedule, and is considered as an essential enabler to maximize the chance of project success. To that end, non-First Plasma projects were either suspended or slowed down until after 2020 in order to make resources available for the critical First Plasma projects and improve the likelihood of remaining within the EUR 6.6 billion budget (in 2008 values) and allowing for a reserve. This approach has now been fully integrated into F4E's planning and operations.

At the 18th ITER Council meeting in June 2016, the IO obtained approval *ad referendum* (i.e. subject to domestic processes of obtaining approval) of the schedule, resources and milestones until achievement of the First Plasma in 2025—commonly referred to as the 2016 baseline. [126]

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[120] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[121] Final report of the 2013 ITER Management Assessment, 18 October 2013
[122] 2015 ITER Action Plan – Foundations for a new phase of ITER
[123] Report of ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources (ICRG)
[124] F4E 2015 Action Plan
[125] http://fusionforenergy.europa.eu/mediacorner/newsview.aspx?content=1140
[126] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

3.2 Measuring progress

As mentioned above, the objective of this section is to report on the progress of the implementation of Council Decision 2013/791/Euratom on the basis of information provided by F4E.

Progress is presented for three stages:

- Revenues of F4E;
- Resource use; and
- Results.

In accordance with the Council Decision, the analysis covers the progress under the current MFF (for the period 2014 till 2017). Due to the timing of the report, final data for 2017 is not always available and the analysis has to partly rely on forecasts as specified in the respective figures in the following sections. Progress is presented in relation to the first two objectives (ITER and BA).

With regards to the unit of measure of progress three different units are used:

- Budget;
- Milestones; and
- Credits.

They are presented below and used in the assessment in the next sections as appropriate.

Budget

The EU Council conclusions adopted on 7 July 2010[127] approved EUR 6.6 billion (in 2008 values) for the F4E Joint Undertaking's contribution to the ITER construction phase of the project, with completion initially planned for 2020 under the 2010 baseline. Following the approval of the 2016 baseline, F4E set the new timetable and recalculated the related estimated cost at completion (EAC) of the F4E contribution to the project construction phase until the achievement of the First Plasma milestone in 2025. The results, which were presented to F4E's Governing Board in December 2016, indicated an expected funding requirement for the construction phase after 2020 of EUR 3.9 billion in 2008 values (contribution from EU budget/F4E Members and France) (59 % increase in relation to the approved EUR 6.6 billion budget). The amount of EUR 6.6 billion adopted by the Council of the EU in 2010 now serves as a ceiling for F4E's spending up to 2020.

The estimated Euratom contribution after 2020 is presented in Table 3 below.

Table 4 Summary table of Euratom contribution in commitment appropriations (2008 value in EUR billion)

	To FP	From FP to DT		Total after 2020
	2021-2025	2026-2027	2028-2035	
F4E total cash to IO	1.1	0.5	1.1	2.7
Construction budget	1.1	0.3	0.3	1.7
Operations budget	0	0.2	0.8	1.0
F4E in-kind contribution	2.1	0.5	0.4	3.0
F4E administration	0.3	0.1	0.4	0.8
F4E other activities	0.4	0.1	0.04	0.5
EC project administr.	0.04	0.02	0.07	0.13
Totals	**3.9**	**1.2**	**2.0**	**7.1**

Source: COM(2017) 319 final Communication from the Commission to the European Parliament and the Council – EU contribution to a reformed ITER Project

[127] Council of the European Union. Draft Council conclusions on ITER status and possible way forward. of 7 July 2010 (Ref. 11902/10).

Budget is presented in commitment[128] appropriations and payment[129] appropriations. They usually differ because projects are committed in the year they are decided and are paid over the years as the implementation of the programme and project progresses.

Milestones

Milestones are predefined achievements up to 2025 used by IO (called ITER Council or *IC milestones*) and F4E (Governing Board or *GB milestones*) to measure progress of the ITER project.

The IC milestones are critical path oriented and most of them are key to achieve FP, but some of them also relate to non-FP systems due to be delivered in other phases of the Staged Approach. The milestone list is updated each year with a rolling wave approach, i.e. updated in waves and in more detail as the project continues. F4E uses the milestones to measure progress of its technical objectives by the achievement on time. To increase the degree of detail of the objectives in the short term, F4E has selected some additional milestones (Governing Board or GB milestones) leading to the IC ones.

Credits

"Credits" are a unit used for both, the ITER project (objective 1 of F4E) as well as the BA (objective 2 of F4E).

In the ITER project, the in-kind contributions to IO are organised through Procurement Arrangements (PAs). Each of them represents specific work to be performed and delivered to IO. When a PA is developed by IO, milestones are agreed to mark the progress in the execution of the work. Some of these milestones have a credit associated to them which is released by IO to F4E whenever the milestone is achieved. Obtaining the full credit means that the DA has achieved all milestones and therefore fully discharged its obligation towards IO for that PA. Credits do not correspond to the actual costs in EUR borne by F4E for the procurement of that component but to the values of each PA as agreed between IO and its members. The unit used for ITER credits is "ITER unit of account" (IUA). In 2008, the IUA exchange rate approved by the ITER Council corresponded to EUR 1 498.16.

Contributions are also formalised under PAs between F4E and the Japanese Implementing Agency for the BA. As mentioned, most of the contributions to the BA from Euratom are provided by voluntary contributors. Direct contributions by F4E through its own budget are limited to providing support, quality assurance, transportation of components to Japan, integration, and limited procurement for EU contributions not covered by the voluntary contributors. As for ITER, the accounting between the involved parties in the BA is done in credits, with the unit "BA unit of account" (BAUA). One BAUA equals EUR 678 (value 5 May 2005).

Both credit systems cover only the progress of in-kind contributions under the respective agreements (ITER and BA); they do not reflect in-cash contributions and administrative costs of F4E.

3.3 Revenues of F4E

The operating revenues of F4E include mainly:

- The Euratom contribution;
- The ITER Host state (France) contribution; and
- The Membership contributions.

The contribution from Euratom constitutes the main source of revenue for F4E. The ceiling for the Euratom contribution from the general EU budget to the ITER project is set in Article 16 of the Council Regulation (EU/EURATOM) No 1311/2013[130] of 2 December 2013 for the years 2014-2020 at EUR 2 707 million (in 2011 value.) The contribution is detailed in the Council decision

[128]Legal pledges to provide finance, provided that certain conditions are fulfilled
[129]Cash or bank transfers to the beneficiaries
[130] Council Regulation (EU, EURATOM) (No 1311/2013 of 2 December 2013). Laying down the multiannual financial framework for the years 2014-2020.

2013/791/Euratom[131], at EUR 2 915 million (in current values.) The revenue received from Euratom is earmarked for operational expenditure and (i.e. procurements for in-kind contributions) for administrative expenditure of F4E (running costs).

Since the establishment of F4E, as of 31 December 2017, F4E has received a total of EUR 5 054.9 million in commitment appropriations and EUR 3 328 million in payment appropriations (both in current values) from Euratom contributions.

During the MFF 2014-2020, as of 31 December 2017, F4E has received a total of EUR 1 741.6 million in commitment appropriations and EUR 2 090.9 million in payment appropriations[132] (both in current values) from Euratom contributions.

The contribution from the ITER Host State (France) covers 9.09% of the total costs of the ITER construction phase, equivalent to 20% of the F4E budget for ITER construction excluding expenditure related to transportation and Test Blanket Modules[133]. This contribution is earmarked to ITER construction expenditure. As of 31 December 2017, the contributions amounted to a total of EUR 1 026.7 million in commitment appropriations and EUR 708.3 million; during the MFF 2014-2020, as of 31 December 2017 the amounts are EUR 509 million and EUR 445 million, respectively.

The Membership Contributions are established and adopted annually within the budget. They correspond to 10% of the administrative budget calculated at the time of the adoption of the respective annual resource estimations. The revenue from the Membership contributions is not earmarked. By end of 2017 the total revenue from Membership Contributions was EUR 39.3 million in commitment appropriations and EUR 39.7 million in payment appropriations. Only looking at 2014-2017, the two figures both amount to EUR 18.3 million.

An additional important aspect is the 'Reserve Fund' created in 2015 for the ITER project. As mentioned earlier, both the cost of the buildings works to date and the scheduled duration have substantially exceeded initial estimates as a result of numerous changes to the design, scope and implementation of design development. These changes were mostly at the request of the IO, prior to 2015. The fund now provides a mechanism to compensate F4E for subsequent change requests; however, not for those of the past.

Refunds (reimbursements) in a given year can occur for several reasons, e.g. recoveries of payments made in excess, mainly on operational contracts. Those recoveries can happen following audits or are due to changes of scope of the contracts.

Other operating revenues include e.g. bank interests and exchange rate gains.

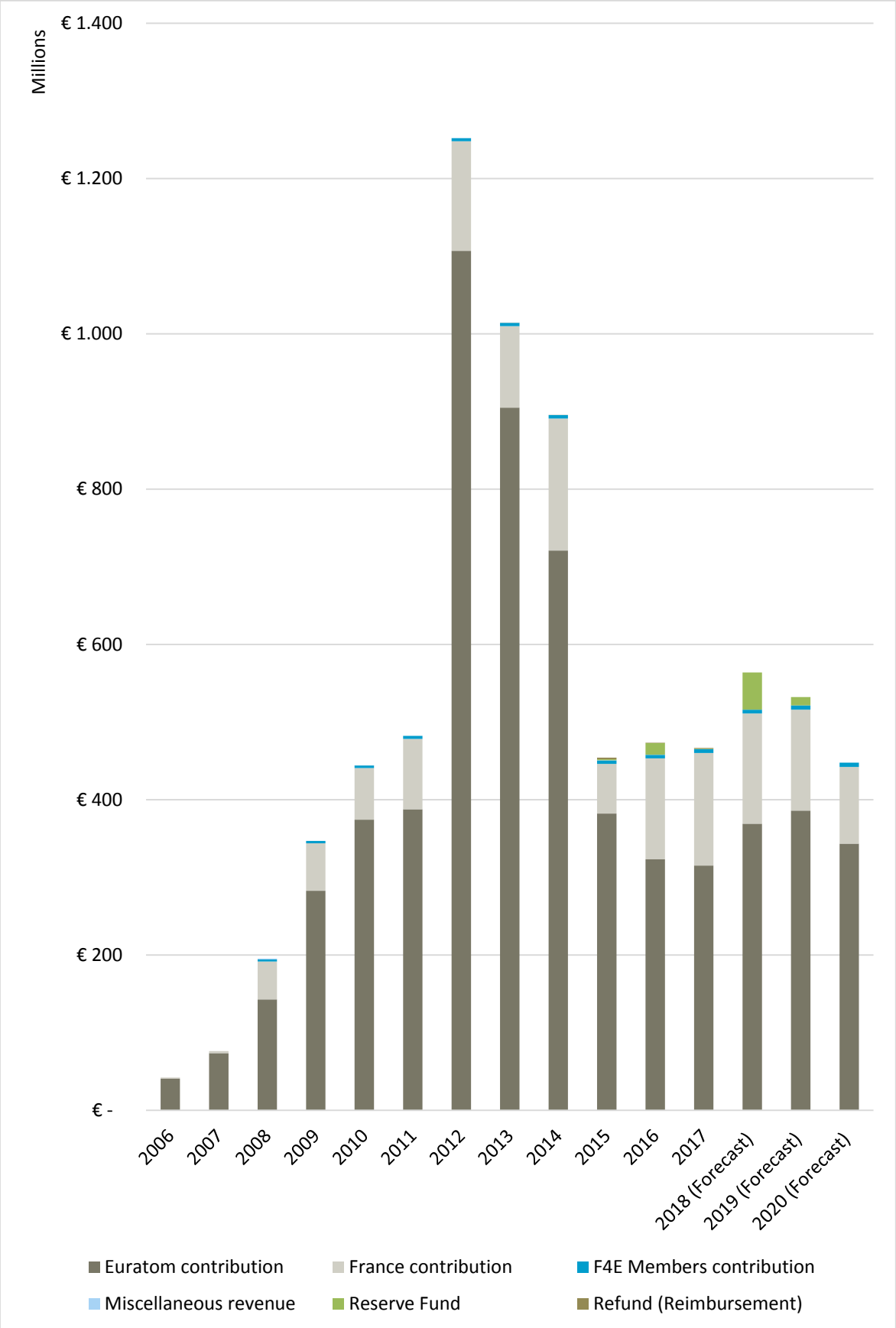
The annual slices of different sources of revenues are shown in Figure 5 and Figure 6, respectively. A chart with a running total of commitment and payment appropriations is presented in Figure 7.

[131] Council Decision 2013/791/Euratom of 13 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 (OJ L 349, 21.12.2013, p. 100–102)

[132] It should be noted that payments in the 2014-2017 period also cover the commitments made before 2014.

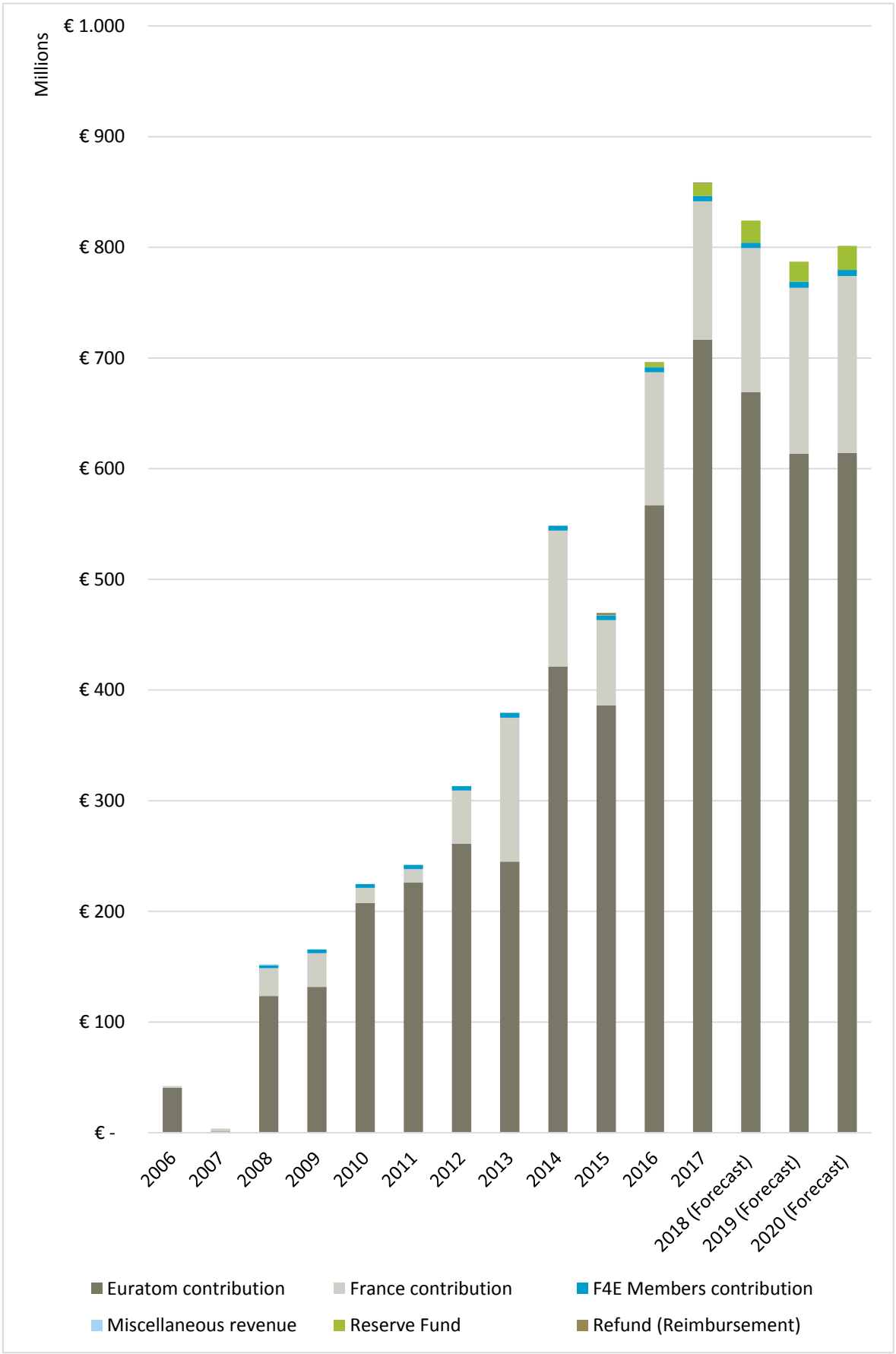
[133] The precise scope, conditions and the global amount of the French contribution for the ITER construction phase were established in a formal exchange of letters between France and the European Commission in 2011.

Figure 9 Overall F4E revenue commitment appropriations (current value in EUR million)



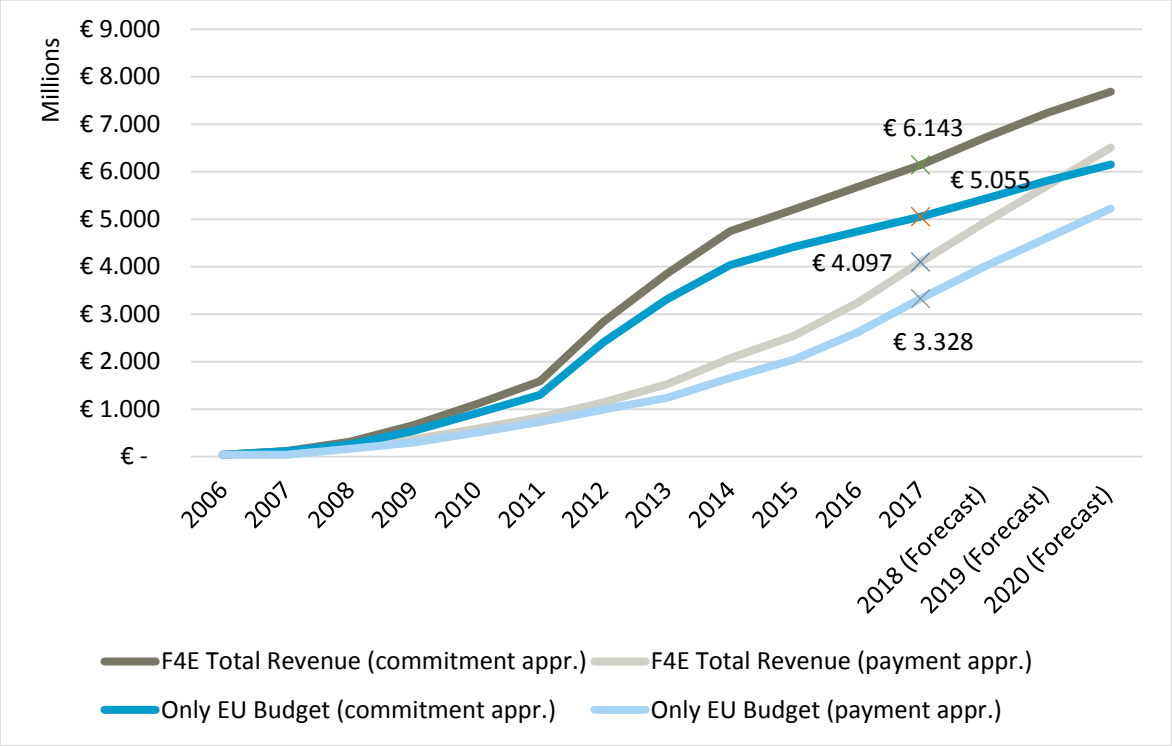
Source: F4E Draft Annual and Multiannual Programme Years 2019-2023

Figure 10 Overall F4E revenue payment appropriations (current value in EUR million)



Source: F4E Draft Annual and Multiannual Programme Years 2019-2023

Figure 11 Cumulative sums of commitment appropriations and payment appropriations (current value in EUR million)



Source: Source: F4E Draft Annual and Multiannual Programme Years 2019-2023

3.4 Resource use by F4E

3.4.1 Operational expenditure

3.4.1.1 *Overview*

The operational expenditure corresponds to F4E tasks discharging Euratom obligations regarding the three objectives as stated in the F4E statues.

The operational expenditure can be grouped as follows[134]:

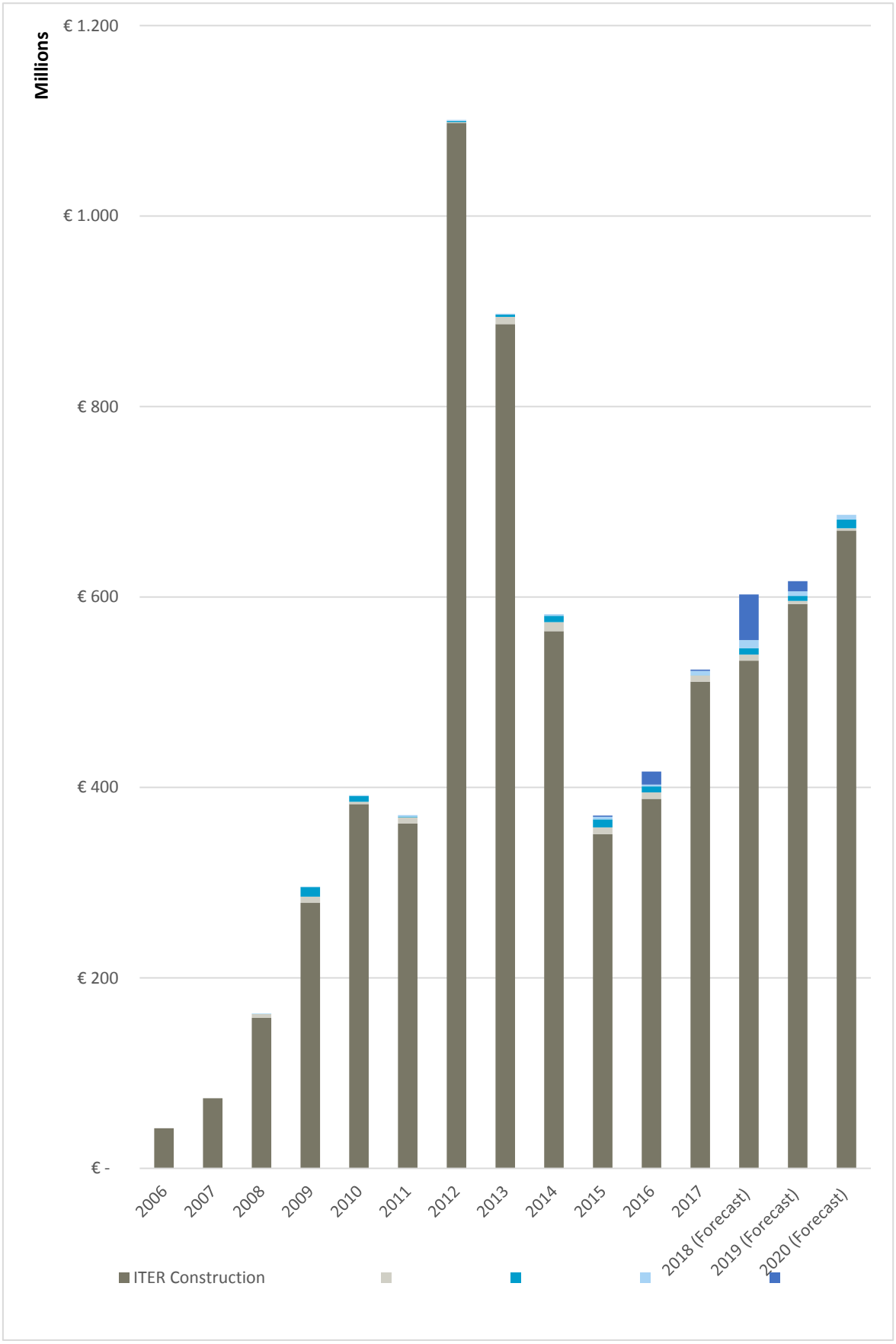
- Expenditure for ITER construction (including **in-kind contribution**, **cash to IO** and **cash to Japan**)
- Technology project groups conducting R&D activities necessary for ITER, BA and DEMO

An additional category is the expenditure to the Reserve Fund which is the expenditure (mainly amendment to existing contracts) related to the requests for change initiated by IO and approved for financing from the Reserve Fund.

Operational expenditure is presented in Figure 8and Figure 9 below in commitment and payment appropriations, respectively.

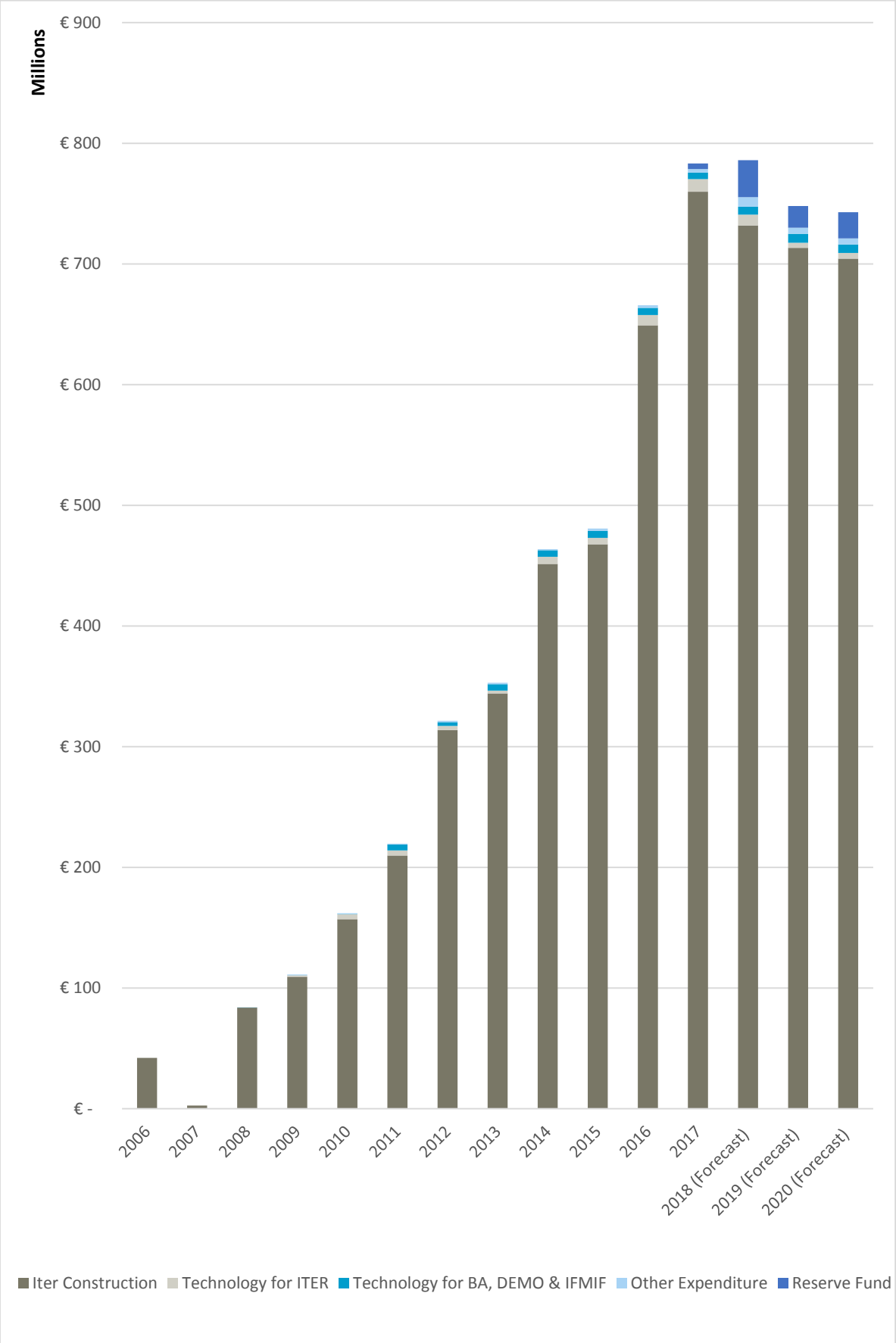
[134] F4E Draft Annual and Multi Annual Programming Document 2019-2023

Figure 12 Expenditure commitment appropriations (current value in EUR million)



Source: Draft Annual and Multiannual Programme Years 2019-2023

Figure 13 Expenditure payment appropriations (current value in EUR million)



Source: F4E Draft Annual and Multiannual Programme Years 2019-2023

3.4.1.2 *In-kind contribution to ITER*

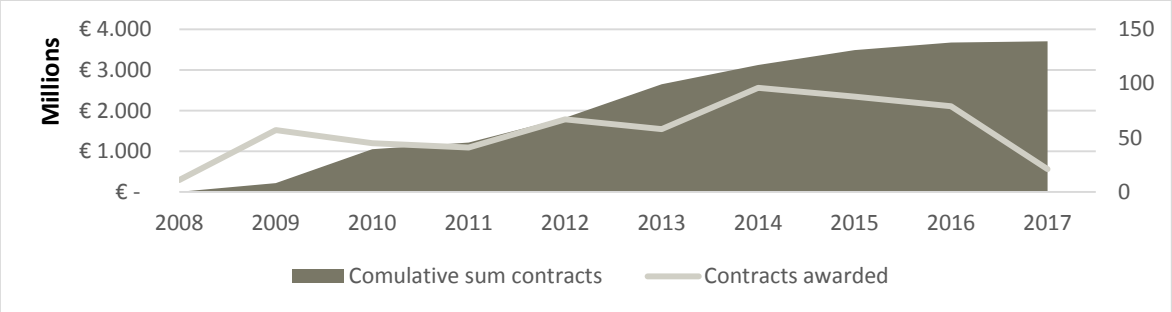
To ensure a fair cost sharing of ITER by "value", 90% of the project is built by in-kind contributions. As explained earlier, in-kind contributions have been classified into PAs which were divided among the seven parties to the ITER Agreement. The most significant challenges for F4E are related to its major task of delivering those in-kind contributions to ITER through procurements and grants.

From the founding of F4E until end of May 2017[135] contracts with a total value of EUR 3.7 billion have been awarded. From the founding of F4E until 1 January 2017[136] grants with a total value of EUR 99.51 million have been awarded. As can be seen the budget for grants is considerably smaller accounting for only 3% of the budget for in-kind contributions while contracts account for 97%[137].

From 2014 until end of May 2017 contracts with a total value of EUR 1.06 billion and grants with a value of EUR 12.36 million have been awarded. From the beginning of the project until the respective data cut-off points the values amount to EUR 3.71 billion and EUR 99.51 million, respectively.

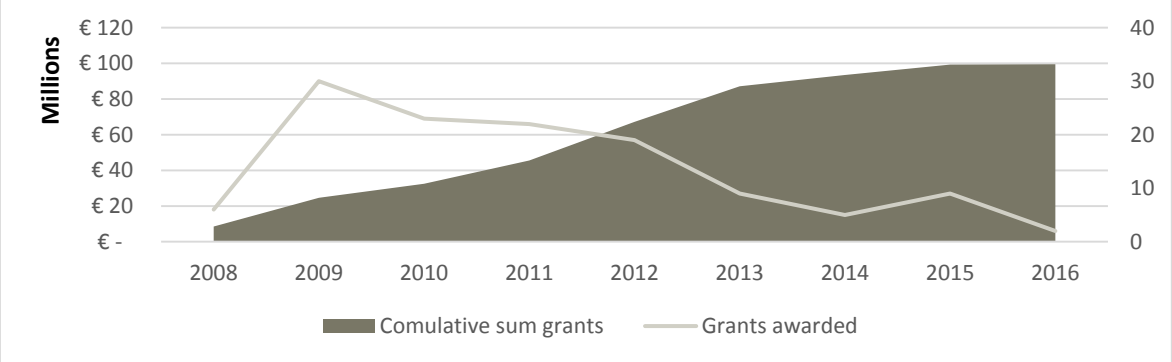
Figure 10 and Figure 11 below show the number and cumulative value of awarded contracts and grants, respectively, over the abovementioned periods.

Figure 14 Number and cumulative value of awarded contracts 2008 – May 2017



Source: Data from F4E

Figure 15 Number and cumulative value of awarded grants 2008 – January 2017

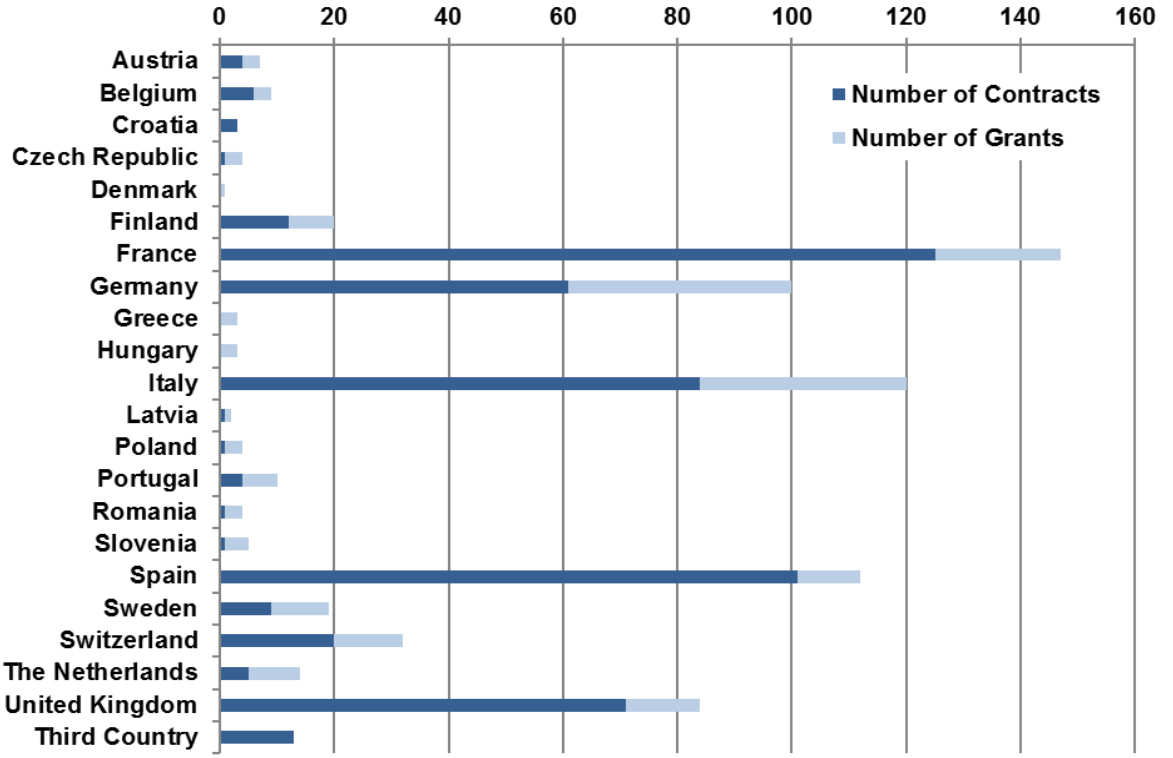


Source: Data from F4E

[135] Latest available data
[136] Latest available data
[137] The great difference stems from the different nature of the expenditures. Grants are awarded for scientific character and cover mostly human costs and prototypes, while value of contracts is directly connected to investments. As can be seen from the graphs the number of newly awarded grants has decreased after a peak in 2009 while the number of awarded contracts has steadily increased (with an exception being 2017 which is most likely due to the fact that data is only available until May 2017). This curve is normal since research is usually being done preliminarily in the beginning of a project.

Figure 12 shows the geographical distribution of awarded contracts in EU MS.

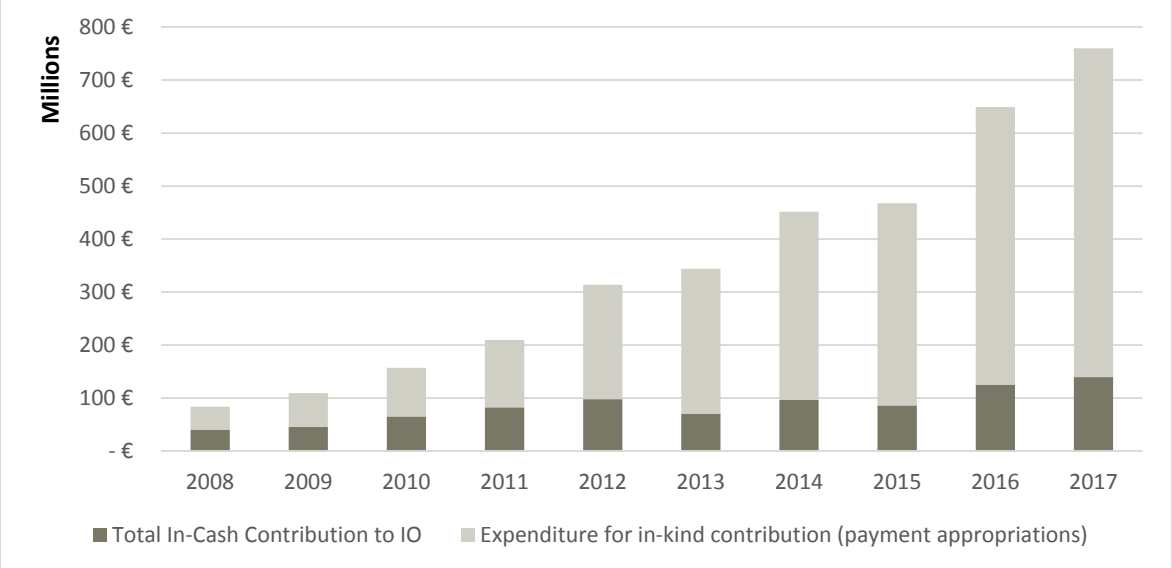
Figure 16 Geographical distribution of contracts and grants (over the period 2008-2017) based on the location of F4E's prime contractors



Source: F4E draft Consolidated Annual Activity Report 2017

The following figure shows the share between expenditure for in-kind contributions and in-cash contributions between 2008 and 2017.

Figure 17 In-cash contribution and expenditure for in-kind contribution (current value in EUR million)



Source: F4E Draft Annual and Multiannual Programme Years 2019-2023

3.4.1.3 *Cash to IO*

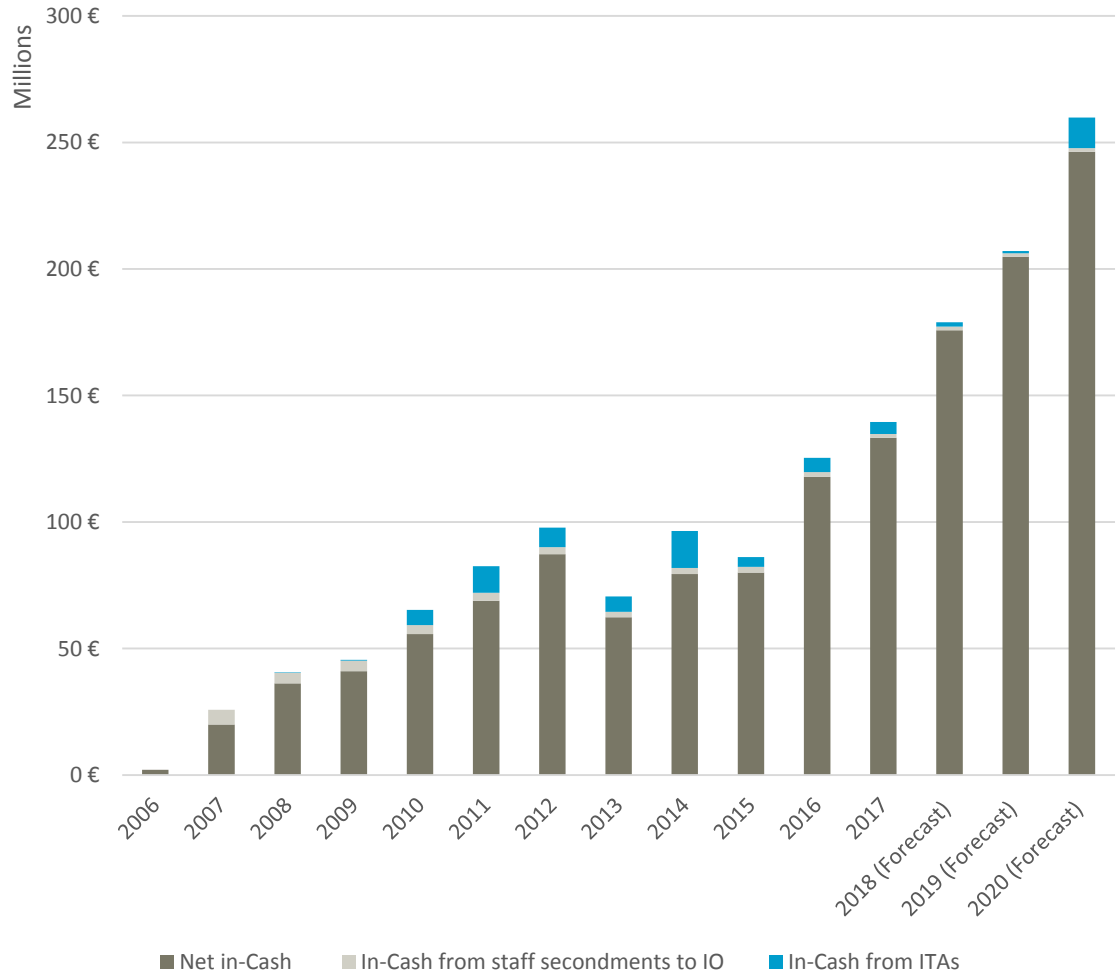
To execute its tasks related to ITER, F4E provides Euratom's direct "in-cash" (financial) contribution to IO's costs and the "in-kind" contributions of components.

In accordance with the ITER Agreement, the share of the contributions made to IO is 10% in-cash and 90% in-kind from Members. Cash contributions from ITER Members to IO are determined annually, based on estimates of the IO budget for the following year. The final figure is approved or modified by the ITER Council.

The final sum of the Euratom in-cash and in-kind contribution to ITER project is a fixed amount corresponding to the 45.46% of the total project costs during the construction phase. F4E pays its share in yearly contributions.

The graph below shows the yearly cash contribution[138] already paid to IO and the current forecast up to 2020. As can be seen the contributions are forecasted to increase significantly from 2018 on. This is due to the fact that IO is mostly responsible for assembly and installation works which are gradually increasing in importance as the in-kind contributions from the DAs are delivered.

Figure 18 EU cash contribution to IO (current value in EUR million)[139]



Source: F4E Draft Annual and Multiannual Programme Years 2019-2023

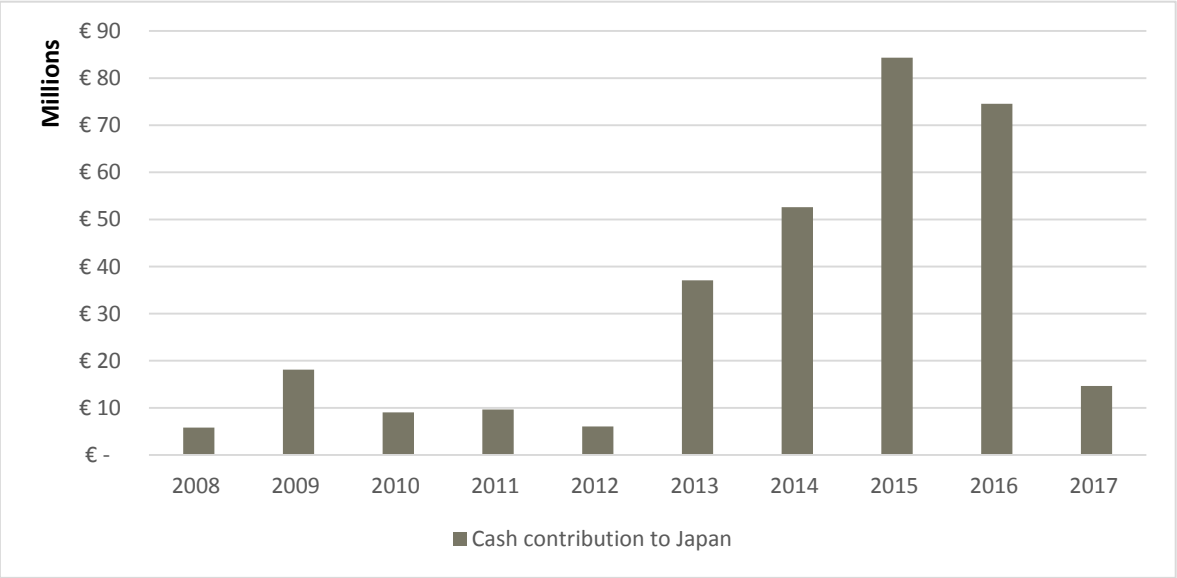
[138] It should be highlighted again that this amount is part of the "ITER construction" expenditures illustrated in section 3.4.1.1 above.
[139]Staff secondments to IO are seconded national experts for a maximum period of 4 years. ITER Task Agreements (ITA) are a mechanism used by IO in order to contract specific technical work.

3.4.1.4 *Cash to Japan*

According to the ITER Agreement, there is a transfer of 10% of procurement responsibility from Euratom to Japan under the supervision of the IO. This is financed through a cash contribution from EU to Japan paid by F4E. F4E provides a yearly payment based on the documented achievement of progress from the Japanese DA.

The figure below shows the amount of cash contributions to Japan from 2008 – March[140] 2017[141].

Figure 19 EU cash contribution to Japan (current value in EUR million)



Source: Own calculations based on data from F4E on annual budget transfer in IUA and annual IUA to EUR conversion rate

3.4.2 Broader Approach

The direct contribution of F4E through its own budget is limited in general to a supporting, qualifying or integration role. The direct procurement expenditure amounted to EUR 42.95 million until end 2017 of which between 2014 and 2017 EUR 21.36 million (both in commitment appropriations). Payment appropriations until end of 2017 and between 2014 and 2017 amounted to EUR 36.19 million and EUR 22.41 million, respectively.

To a large extent the EU activities to be undertaken in the frame of the BA agreement are provided in-kind by so-called Voluntary Contributors with some direct procurement from F4E for agreed EU contributions not covered by the Voluntary Contributors. These are some of the EU member states represented in the GB of F4E which pledged to contribute to the BA projects[142]. In turn, each Voluntary Contributor channels its contributions through the procurement arm of "Designated Institutions". F4E leads and integrates activities and concludes Agreements of Collaboration with the Designated Institutions, to secure delivery of the EU contributions and hence meet the requirements of each PA.

The value of the Voluntary Contributions (including the in-kind contributions and staff) has been estimated in the Final Report of Negotiations on the Broader Approach Agreement from 20 June 2006 as follows:

[140] Latest available data.
[141] It should be highlighted again that this amount is part of the "ITER construction" expenditures illustrated in section 3.4.1.1 above.
[142] Belgium, France, Italy, Germany, Spain.

Table 5 Estimated value of voluntary contributions for BA projects (current value in EUR million)[143]

Voluntary Contributor	Estimated value in EUR million
Spain	40.3
France	158.88
Italy	84.06
Germany	13.3
Total	**296.54**

Source: Final Report of Negotiations on the Broader Approach Agreement from 20 June 2006

3.4.3 Administrative expenditure

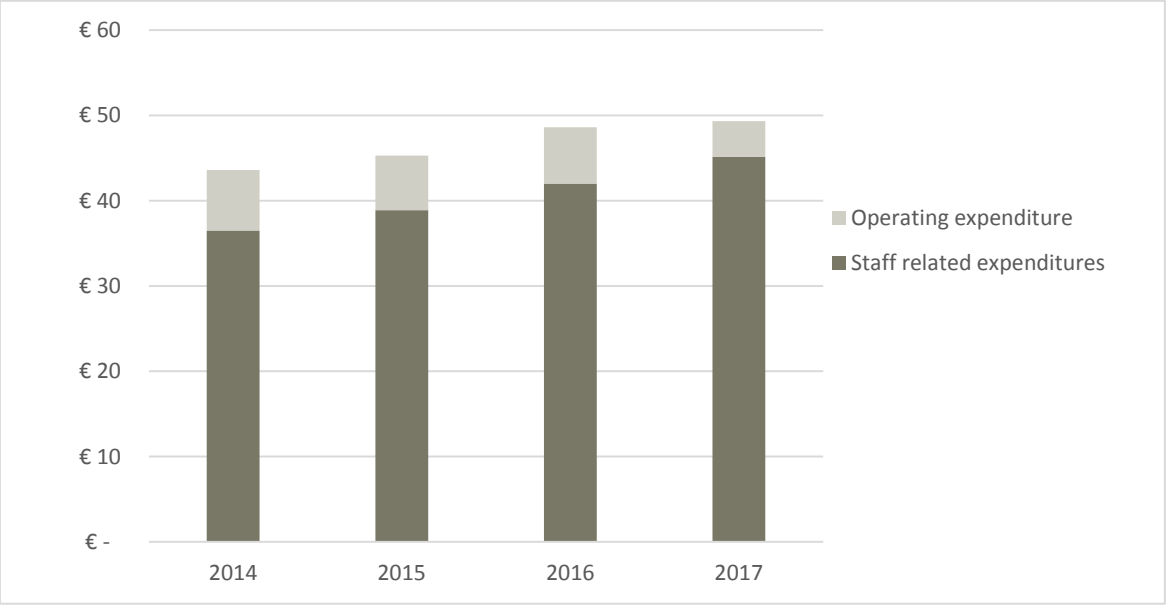
Administrative expenditures consist of two main categories:

- Staff expenditure: This expenditure is recurrent and mainly based on the establishment plan (salaries).
- Operation expenditure: This expenditure is based on the needs for the execution of the ITER and BA projects (objectives 1 and 2 of F4E) as described in the "Final Report of Negotiations on ITER Implementation", 1 April 2006 and in the Broader Approach Agreement.

The administrative expenditure is a non-dissociated appropriation (commitment and payment appropriations are in unison); therefore, any transfers or budget amendments are authorised or adopted in both commitment and payment appropriations.

The total administrative expenditure and distribution between staff expenditure and operation expenditure for the years 2014 – 2017 is plotted in Figure 16 below. It should be noted that the 2017 accounts at the time of writing are not closed yet and that the 2017 figure is based on information from the Draft Annual and Multi Annual Programming Document 2019-2023.

Figure 20 Overall administrative expenditure and distribution staff and operating expenditure (current value in EUR million)



Source: F4E 2014, 2015 and 2016 final accounts. 2017 overall administrative expenditure based on F4E Draft Annual and Multi Annual Programming Document 2019-2023

[143] As of 5 July 2006, calculated on the basis of an assumed inflation of 2%. Belgium has not been Voluntary Contributor in 2006 and its share is thus not reflected in the agreement.

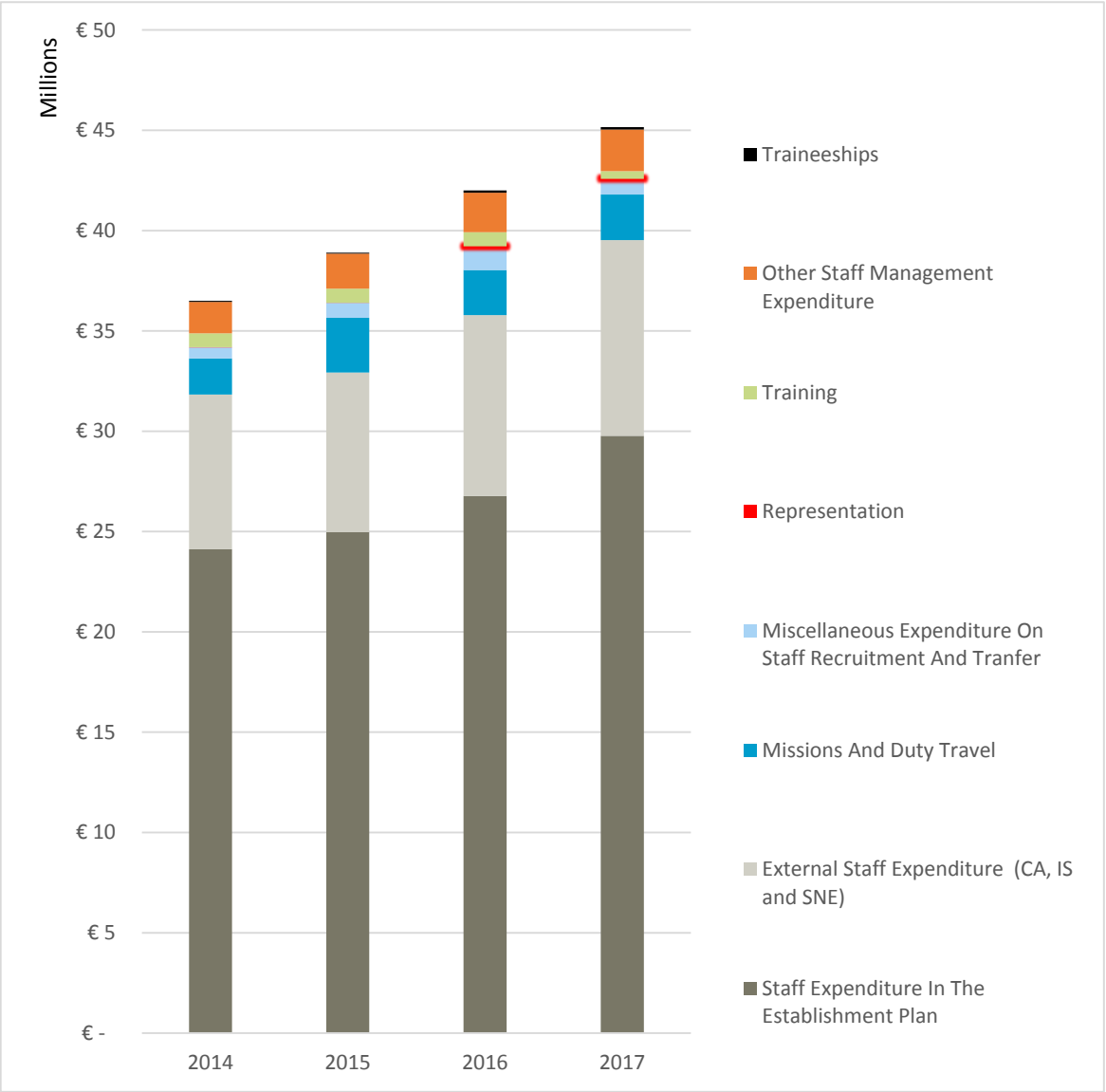
As can be seen from the figure there is an increasing trend in the administrative costs over the 2014-2017 period which is mostly due an increased number of staff of around 10 % between 2014-2017 both, due to additional posts made available and reduction of vacancy. According to the 2014 – 2017 F4E final account reports additional[144] reasons for this trend include:

- Transfer of staff from Barcelona to Cadarache, where the cost of living is about 25% higher;
- The increase of salaries for 2016 (+1%), after 3 years of decrease due to the evolution of the coefficient related to the cost of living in Spain; and
- Increase in other expenses directly linked to a higher number of staff such as international school fees or cost of health care insurance.

In Figure 17 and Figure 18 staff expenditure and operation expenditure for the years 2014 – 2017 are broken down in more detail.

[144] For more details see budget implementation section 5.1.1 in the 2014 and 2015 final account reports and section 8.5.1 in the 2016 final account report, respectively.

Figure 21 Staff expenditure (in EUR million)[145][146]

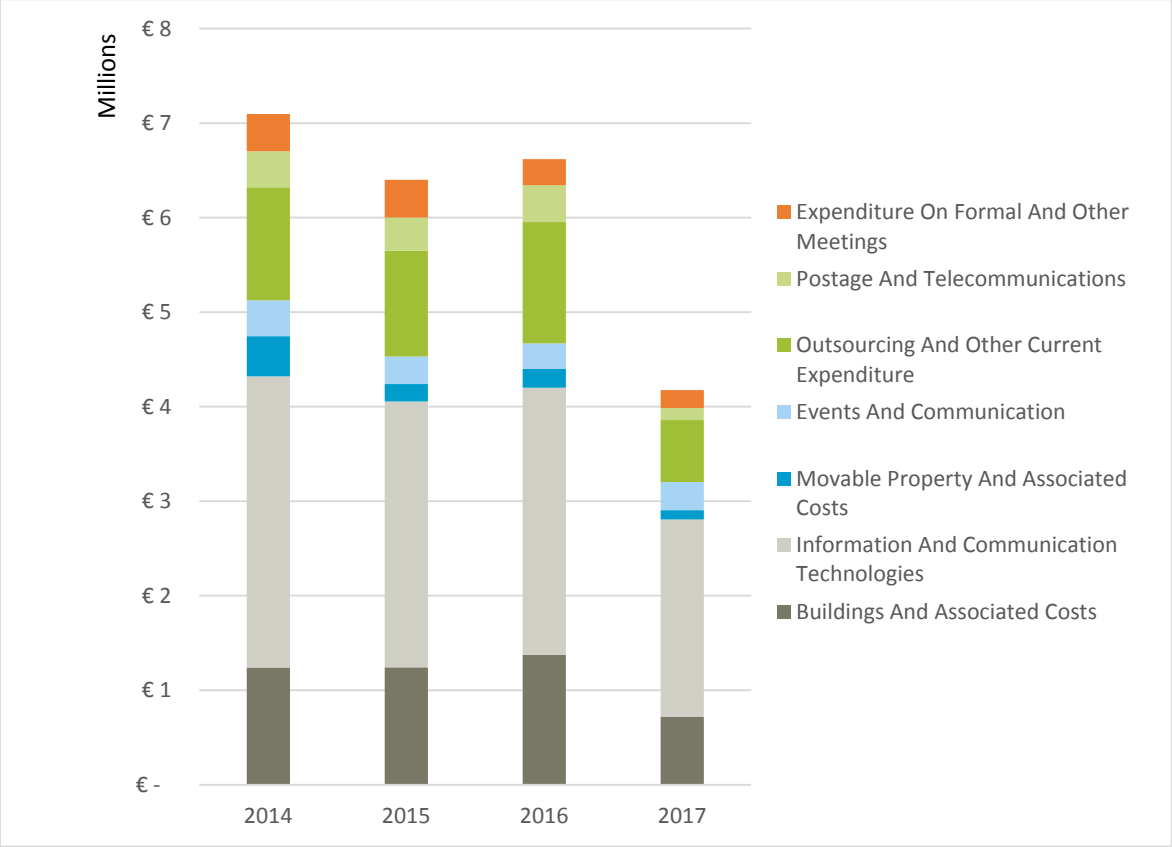


Source: F4E 2014, 2015 and 2016 final accounts. 2017 overall administrative expenditure based on F4E Draft Annual and Multi Annual Programming Document 2019-2023

The salaries for F4E staff (expenditure in the establishment plan) includes the total gross salaries including allowances, social contributions, taxes and pension contributions and employer's contribution for social security.

[145] Temporary Agents and External staff expenditure covers Contract Agents (CA), Interim Staff (IS) and Seconded National Experts (SNE).
[146] Amounts under the "Representation" category are very smaller and in order to increase visibility a frame has been added.

Figure 22 Operating expenditure (in EUR million)



Source: F4E 2014, 2015 and 2016 final accounts. 2017 overall administrative expenditure based on F4E Draft Annual and Multi Annual Programming Document 2019-2023

3.4.4 Human resources

The Fusion for Energy personnel structure consists of EU Officials, Contract Agents and Temporary Agents (interim staff). F4E can also use seconded National Experts deployed to F4E for an initial maximum period of two years, renewable up to a total maximum period of four years.

EU Officials and Temporary Agents may be recruited under two function groups:

- Administrator profiles for senior and non-senior technical/legal/financial/procurement officers, contract managers, etc.
- Assistant profiles for senior and non-senior assistant positions.

Contract Agents work under the supervision of EU Officials and Temporary Agents and may be recruited under four function groups (from FGI to FGIV). However, F4E typically recruits the majority of its contract agents at the level of:

- FGII, who are in charge of clerical and secretarial tasks
- FGIII, who are in charge of administrative and financial tasks in various support and operational units (e.g. Team Assistants) and
- FGIV, who are mainly specialized technical staff (e.g. Technical Support Officers, Project Management Support Officers) and qualified specialists in administrative fields (e.g. human resources, procurement, project management, legal, finance, etc.)

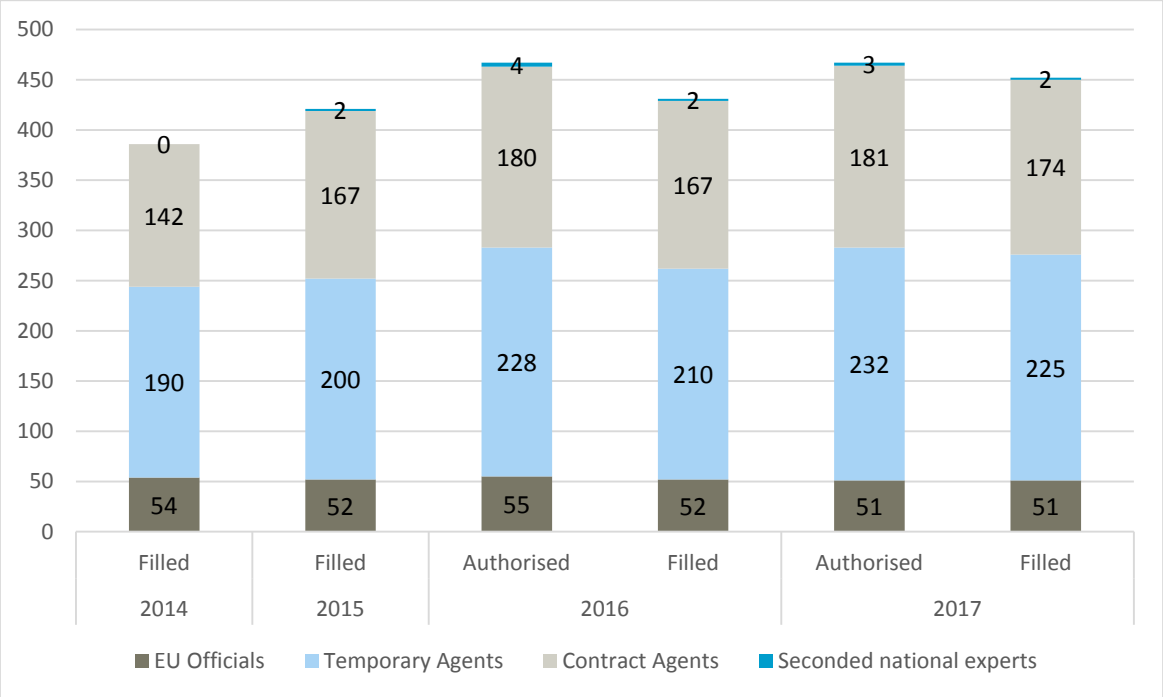
In 2014 temporary reinforcements were agreed and granted in 2015 and 2016 in form of additional short-term positions for 24 Contract Agents and 21 Temporary Agents, respectively, under the conditions that they are phased out by the end of 2019. This sets the authorised staff level since 2016 at 467. F4E lists the following reasons:

- The new baseline, which will reach FP in 2025 and not in 2020 and will delay the corresponding peak level of F4E activity by 5 years.

- F4E is increasingly placing a larger number of smaller, step-by-step contracts, as it believes that this will ultimately result in lower risk and cost.
- F4E has increased the number of staff engaged in supervision of some critical contracts such as the buildings and vacuum vessel, as recommended in the 2015 F4E annual assessment.
- An increased complexity of integration over the past years, which results in higher resourcing needs to manage the suppliers and in the future to support on site activities.

Figure 19 below shows the development of staff numbers between 2014 and 2017.

Figure 23 Annual staff numbers 2014 - 2017[147]

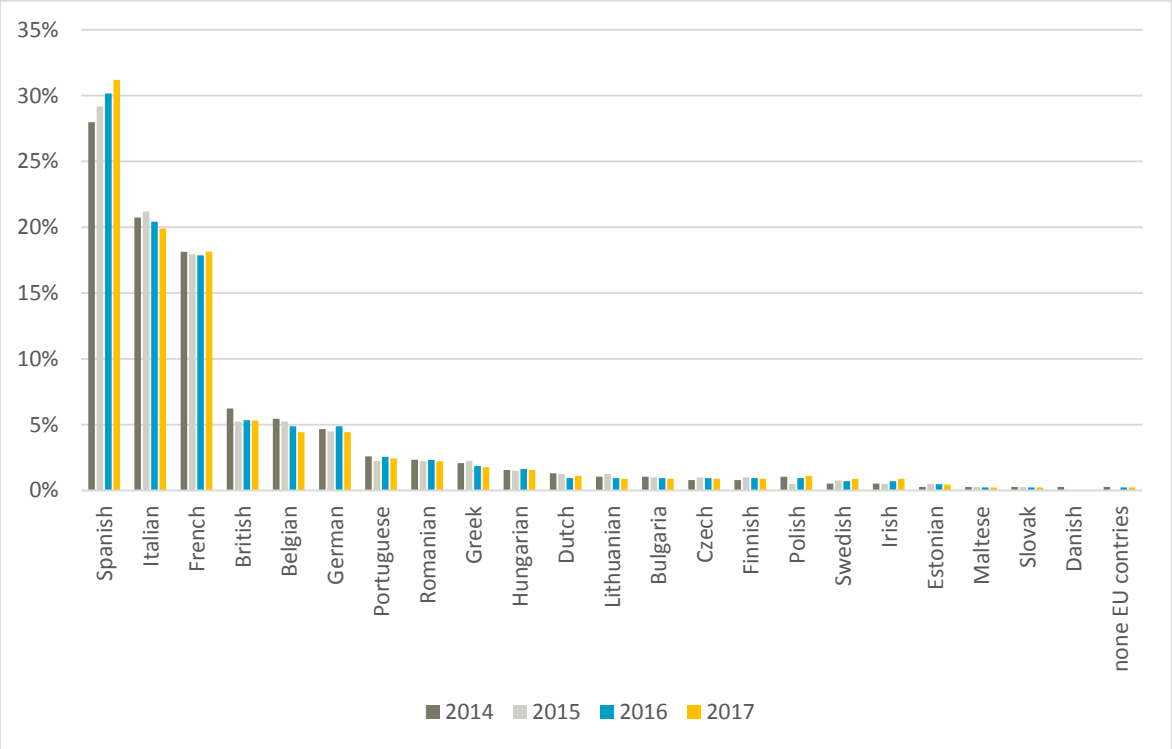


Source: F4E Annual report 2015 (for 2014 data); Annual and Multi Annual Programming Document 2018-2022 for 2015 – 2016 data; Annual and Multi Annual Programming Document 2019-2023 for 2017 data

Figure 20 below shows the Geographical distribution of staff nationality between 2014 and 2017.

[147] For 2014 and 2015 no data is available on authorised positions

Figure 24 Geographical distribution of staff nationality 2014 - 2017



Source: 2014 and 2015 F4E annual reports; Annual and Multi Annual Programming Document 2018-2022 for 2016 data; Annual and Multi Annual Programming Document 2019-2023 for 2017 data

3.5 Results achieved

3.5.1 Significant ITER components

As of November 2017, F4E has signed contracts corresponding to 87% of all ITER credits to be obtained from EU side.[148]

Euratom's responsibilities in form of the PAs can be the clustered into activities, defined as "coherent areas of action with objectives and resources" called "Actions". The most relevant of them are listed below together with their level of progress in terms of achieved credits[149].

Magnets[150]

Magnets confine, shape and control the plasma. More specifically, superconducting magnets will help to confine ITER's super-hot plasma which is expected to reach 150 million °C. The first layer of magnets will consist of the Toroidal Field (TF) coils that will entrap the hot gas and keep it away from the walls of the Vacuum Vessel. The second layer will consist of the Poloidal Field (PF) coils that will embrace the TF coils from top to bottom to maintain the plasma's shape and stability.

As of November 2017, a total of 46% of credits for in-kind contributions have been achieved.

Vacuum Vessel

The ITER Vacuum Vessel is located inside the cryostat of the ITER machine. Its basic function is to operate as the chamber that will host the fusion reaction. Within this torus-shaped vessel,

[148] F4E Draft Annual and Multiannual Programme Years 2019-2023
[149] An overall overview about achieved credits is given in the next section
[150] The explanations are based on the 2016 F4E Highlights report

plasma particles collide and release energy without touching any of its walls due to the process of magnetic confinement.

As of November 2017, a total of 34% of credits for in-kind contributions have been achieved.

In Vessel-Blanket

The blanket modules consist of the 440 modules, resembling tiles covering the walls of the vacuum vessel, and protecting the vessel and the superconducting magnets from the heat and neutron fluxes of the fusion reaction.

As of November 2017, no credits for in-kind contributions have been achieved.

In Vessel-Divertor

The extremely hot temperature of the fusion reaction will be mostly felt by the in-vessel components, otherwise known as plasma-facing components, due to their direct exposure to high heat and neutron fluxes. The divertor consisting of 54 cassettes, located at the lower part of the machine, will form the machine's massive "ashtray" where the hot ashes and impurities will fall in.

As of November 2017, a total of 9% of credits for in-kind contributions have been achieved.

Remote Handling

Remote handling allows the performance of a task without being physically present where it is being carried out. The limited space inside the ITER machine together with the weight of the tooling and the exposure of some components to radioactivity will require the use of remote handling systems during maintenance.

As of November 2017, a total of 5% of credits for in-kind contributions have been achieved.

Cryoplant and Fuel Cycle

The cryoplant will generate the cold temperatures required for the fusion machine. It will provide insulation for the superconducting magnet system and other components. Cold helium will circulate inside the magnets to bring their temperature down to -269°C in order to confine the hot plasma. The magnets, thermal shields and cryopumps will have to be cooled down and maintained with the help of the most advanced cryoplant to date.

As of November 2017, a total of 40% of credits for in-kind contributions have been achieved.

Neutral Beam and EC Power Supplies and Sources

To develop and test the Neutral Beam Injectors, one of ITER's powerful heating systems, a test facility is being set up in Padua, Italy.

As of November 2017, a total of 19% of credits for in-kind contributions have been achieved.

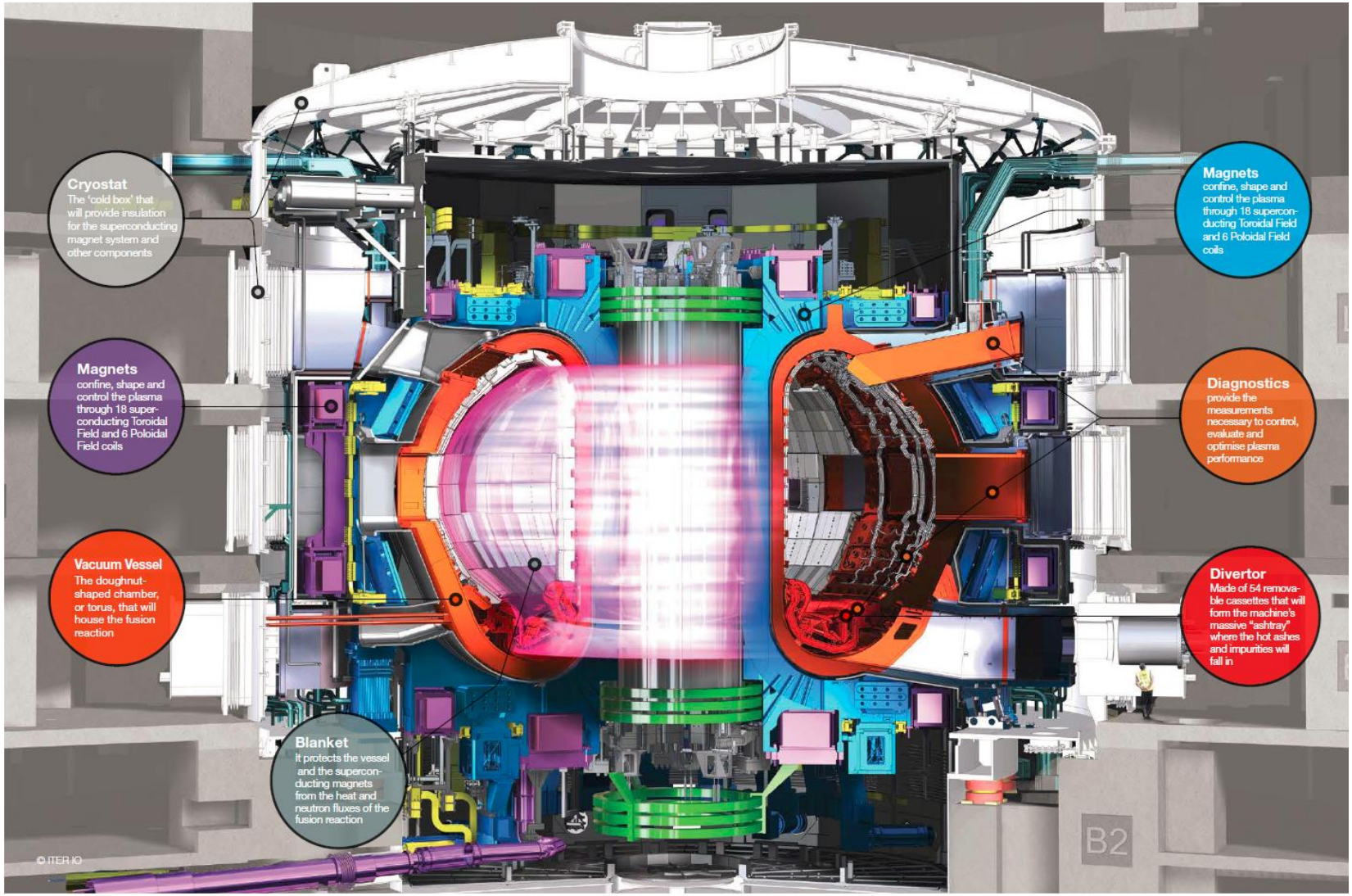
Diagnostics

The Diagnostics systems measure the conditions inside the machine thanks to a vast range of cutting edge technologies. In simple terms, diagnostics provide the measurements necessary to control, evaluate and optimize plasma performance. ITER diagnostics will help scientists to study and control the plasma behaviour, measure its properties and extend our understanding of plasma physics.

As of November 2017, no credits for in-kind contributions have been achieved.

The abovementioned actions are illustrated in Figure 21 below.

Figure 25 Main actions



Source: F4E 2016 Highlight report. Copyright: IO

Site, Buildings and Power supply

Thirty-nine buildings and areas will house the systems necessary for the operation of ITER. Work is in progress on the site on both the electrical power supplies and the buildings through the existing contracts.

As of November 2017, a total of 35% of credits for in-kind contributions have been achieved.

The progress of all actions is summarised in the table below.

Table 6 Progress per action in terms of achieved credits[151] in kIUA

Action	Achieved in Nov. 2017 (kIUA)	Forecast for total credits (kIUA)[152]
Site and Buildings and Power Supplies	181.94	516.11
Magnets	85.74	185.84
Vacuum Vessel	30.08	89.56
Cryoplant and Fuel Cycle	22.867	57.39
Neutral Beam and EC Power Supplies and Sources	19.63	103.95
In Vessel- Divertor	1.92	22.24
Remote Handling	1.8	39.73
Diagnostics	0.02	29.67
In Vessel- Blanket	0	44.85

3.5.2 ITER credits

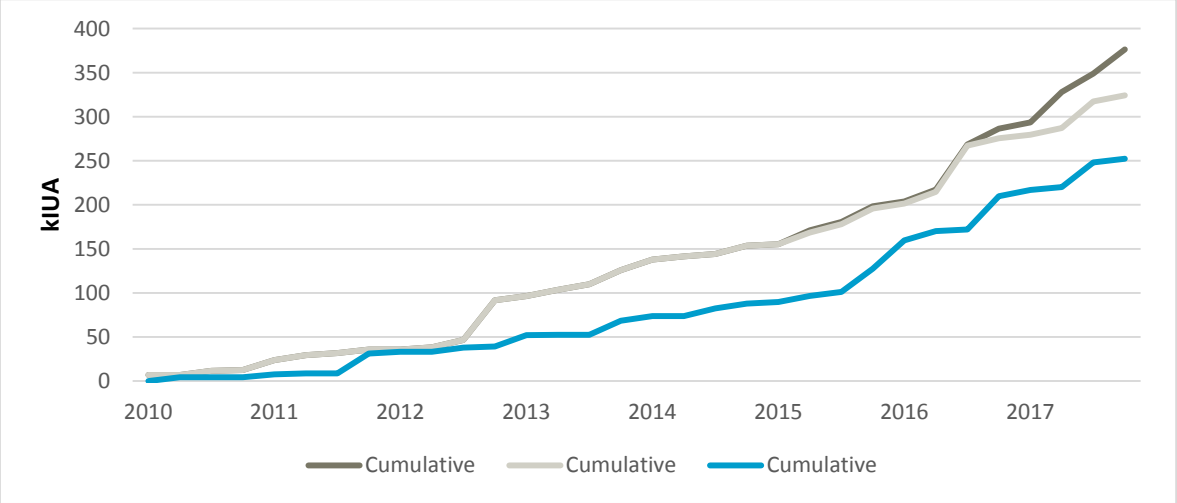
As explained above, the in-kind contribution is organised through PAs. Each of them represents specific work to be performed and delivered to IO. When a PA is developed by IO, a total credit value is assigned to the work foreseen to be performed. In particular a Credit Allocation profile is defined and a fraction of the total value is assigned to some important milestones. F4E receives credit from IO for successfully meeting specifically identified milestones.

The achieved and released ITER credits compared to the baseline from 2010 – 2017 and 2014 – 2017 are presented in Figure 22 and Figure 23, respectively. The difference between the achieved and the released credits is explained by the fact that once F4E achieves a credit milestone, all necessary data, reports and other information has to be collected and provided to IO. This information is linked to the delivery by the supplier of all the necessary documents and to the F4E approval of these deliverables. Furthermore, IO has to revise and validate the whole set of documents provided in order to confirm such achievement. For this reason, the process can take up to a few months.

[151] Based on table 2 in the F4E Draft Annual and Multiannual Programme Years 2019-2023

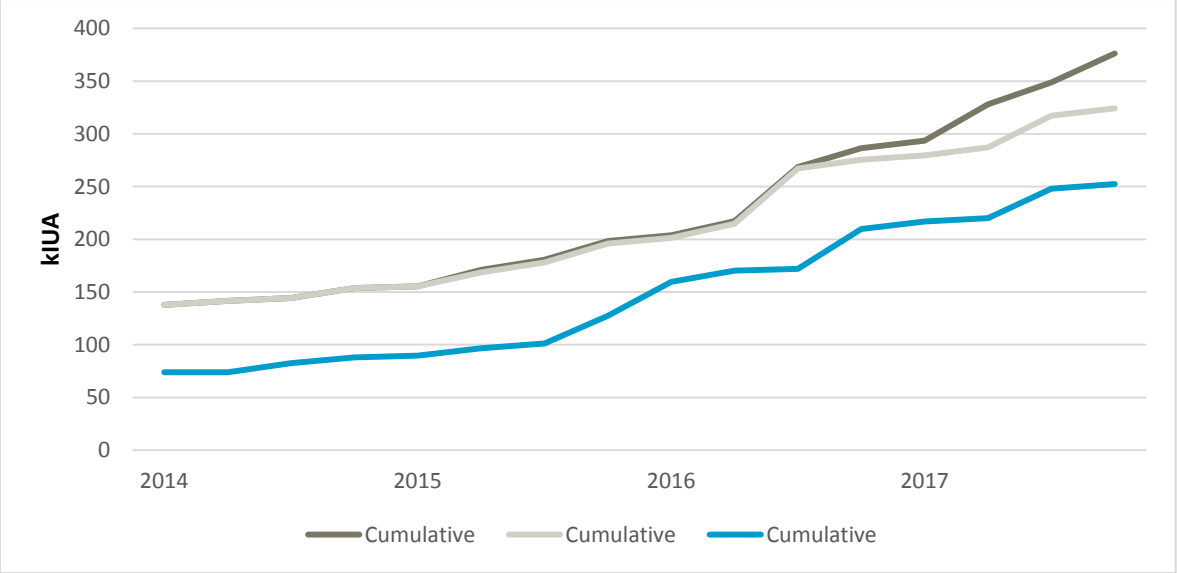
[152] Forecast credit value includes credits for not yet signed PAs. In this case values are only indicative as negotiations will be carried out prior to PA signature to finalise them

Figure 26 ITER credits 2010 - 2017 in kIUA



Source:Data from F4E. The baseline used for this chart is the F4E Current baseline; this is the schedule at the end of September 2016 plus approved baseline changes. The actuals and forecast are those in the latest Detailed Working Schedule from the 2nd Amendment of the 2017 Work Programme.

Figure 27 ITER credits 2014 – 2017 in kIUA



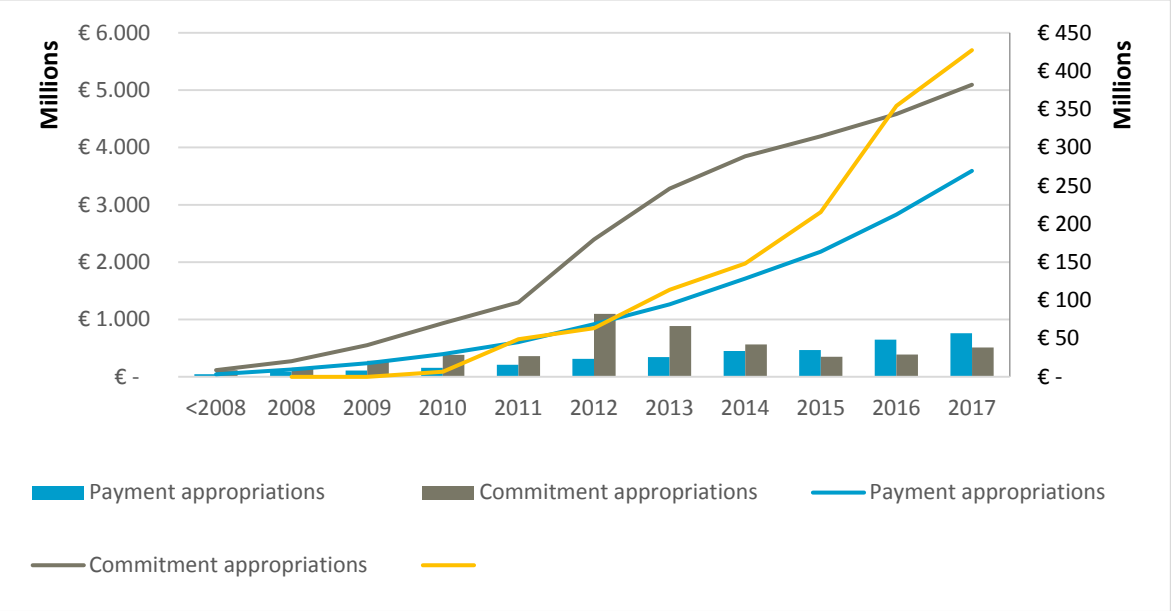
Source: Data from F4E. The baseline used for this chart is the F4E Current baseline; this is the schedule at the end of September 2016 plus approved baseline changes. The actuals and forecast are those in the latest Detailed Working Schedule from the 2nd Amendment of the 2017 Work Programme.

The following graph shows the development of creditable F4E expenditure (i.e. expenditure for the construction of ITER for which IUA are released) against the development of the value of achieved IUA.

It should be highlighted that the graph has limited informative value in terms of absolutes. This means, that it should not be used to compare the value of achieved IUA against the expenditure. To recall, IUA are achieved when in-kind contributions are delivered to IO. Before this, they have been procured and produced, a process, which can last several years. Thus, there is a considerable delay between the achievement of IUA and the commitment and payment of funds.

However, the graph shows a positive trend in terms of achievement of credits compared to expenditure for ITER construction.

Figure 28 Trend of F4E expenditure for ITER construction (EUR million in current values, primary axis) and achieved ITER Credits (value of IUA in EUR million in current values[153], secondary axis)



Source: Expenditure data from Draft Annual and Multiannual Programme Years 2019-2023; Data on achieved Credits provided from F4E's internal monitoring and reporting system.

3.5.3 Significant BA components[154]

Satellite Tokamak Programme (JT-60SA project)

All the EU Procurement Arrangements and the relevant corresponding industrial contracts have been placed and are underway. All the European contributions are in line with the baseline schedule.

The facility is going to be completed by March 2020 within the presently agreed BA period. The integrated commissioning of the system including initial plasma operation from September 2020 is foreseen to be part of BA Phase 2, presently under negotiation with Japan. In addition, a collaboration between F4E (through EUROfusion) is on-going with QST (i.e. the Japanese Implementing Agency) for the preparation of the research plan and the BA Phase 2 joint exploitation phase of the device. A "JT-60SA Research Plan" was established at the end of 2011 and the latest version was released on 1 March 2016. After 2020 the JT-60SA facility will start its joint EU-JA operation phase, which will include joint integrated commissioning, exploitation as well as machine enhancements.

IFMIF/EVEDA Project

The IFMIF/EVEDA Project started in June 2007 and has since undergone a re-scoping in 2010 and an extension until March 2020 approved by the BA Steering Committee in April 2017. Its mission is to produce the engineering design of IFMIF and to establish an experimental data base to support such design. The R&D facilities built to that end are:

- The Accelerator Facility;
- The Lithium Target Facility; and
- The Test Facilities.

[153] Plotted is not the sum of achieved ITER Credits (IUA) but rather the value of the achieved IUA in EUR through multiplying the sum of achieved IUA in a given year by the normalised conversion factor from the respective year as provided by F4E.
[154] Based on latest data available dating November 2017 from F4E Draft Annual and Multiannual Programme Years 2019-2023.

The engineering design of IFMIF as well as all the deliverables associated with the Lithium Target facility and Test Facilities have been achieved. The key objective of validating the Lithium Target by prototyping was achieved in 2016. Validation activities of the Accelerator Facility remain underway.

In addition to the above activities F4E is engaged with EUROfusion for the preparation of the necessary supporting documents for deciding and starting the IFMIF-DONES project (building a scaled down IFMIF plant with number of accelerators reduced from 2 to 1). If decided within the EU and at international level with Japan, the construction of this facility is expected to start after 2020.

IFERC Project

The IFERC activities include three sub projects:

- DEMO Design and R&D activities
- Establishment and operation of a Computer Simulation Centre (CSC),
- Establishment and operation of a Remote Experimentation Centre (REC)

DEMO Design and R&D activities

For the design activities, after an initial phase of analysis, the work moved on to more detailed studies to: a) follow-up work on key design issues and options and narrow down design options; b) define design criteria; c) evaluate ranges of DEMO parameters.

The DEMO R&D activities focus on materials for blankets in order to establish a common basis for a DEMO design. In the first years of BA this was conducted in the Voluntary Contributors laboratories and was mostly completed by 2015; activities currently continue under the DEMO Design umbrella, with EUROfusion acting as Voluntary Contributor. It should also be noted that the scope of work on DEMO design and R&D in the BA is defined for the extension of the Programme until 2019. F4E currently negotiates the following phase (BA Phase II) with the relevant stakeholders.

Computer Simulation Centre

The EU procured and delivered a supercomputer. Its operation started on schedule in January 2012, and was carried out until the end of 2016. The system had minor upgrades in 2014, 2015 and 2016, and has been used as main supercomputing tool by the EU fusion community. It was dismantled in the 1st semester of 2017. More than 400 papers have been published by EU scientists in fusion based on work with the supercomputer.

Remote Experimentation Centre

The Remote Experimentation Centre aims to facilitate broad participation of scientists into ITER experiments. Remote experimentation techniques will be tested on existing machines, such as JT60-SA and others. Most of the contribution to REC is provided by F4E.

3.5.4 Broader Approach credits

Like ITER, contributions to BA projects are formalised under PAs between F4E and the Japanese Implementing Agency, which in turn are backed by Agreements of Collaboration between F4E and institutions chosen by the Voluntary Contributors. The accounting of the parties' contributions is also tracked by an earned value management approach using credits, the so-called Broader Approach Units of Account (BAUA).

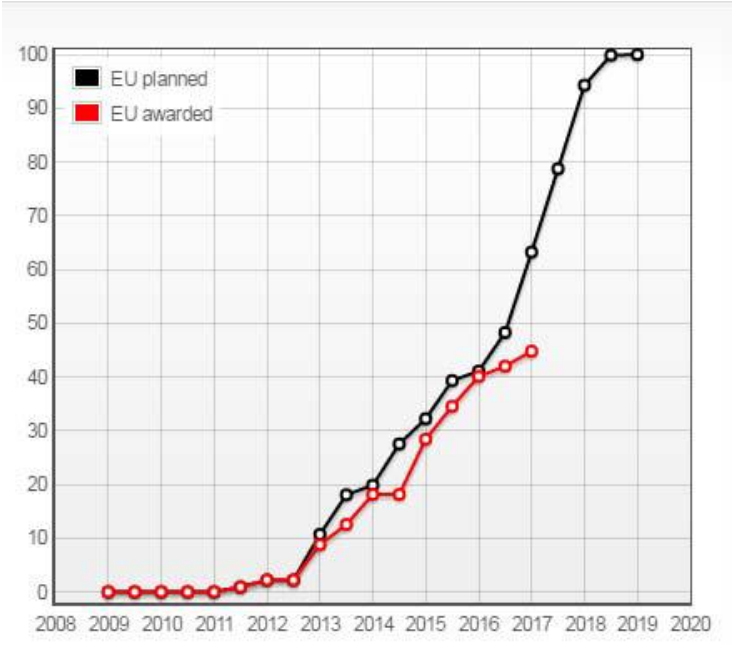
The complete scope of work covered by the BA Agreement is assessed with a value of 1 000 000 BAUA, 500 000 of which are provided by Euratom and 500 000 by Japan.

The complete scope of work covered by the BA Agreement was evaluated at EUR 339 million in 2005 (in 2005 value) on a time frame compatible with the ITER construction phase.

The graphs below show the % of total EU BAUA awarded compared to their respective baselines[155].

[155] Those graphs represent the latest available detailed data (up to the end of 2016) as presented in the F4E 2016 Final accounts and are included to show trends over the project period. Below each graph, in addition,

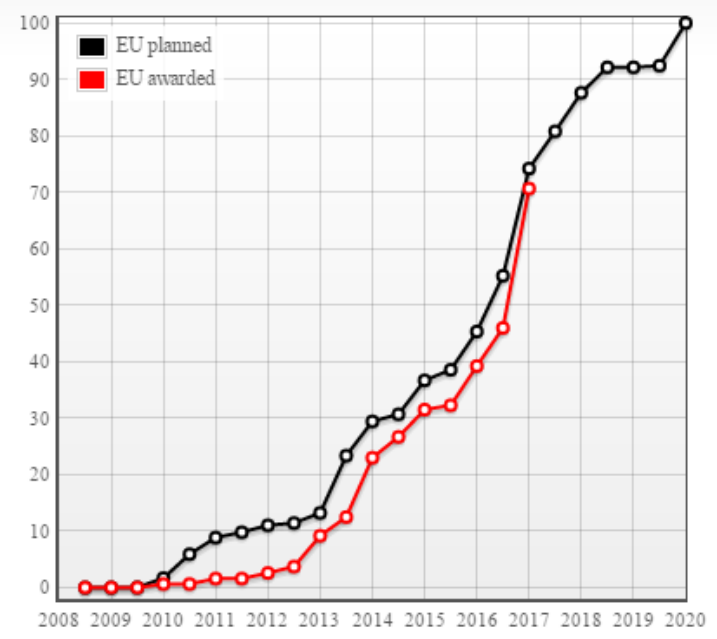
Figure 29 Trend of awarded EU BAUA in the Satellite Tokamak Programme (JT-60SA project)



Source: F4E 2016 Final Accounts

The total commitment of the EU for the Satellite Tokamak Programme amounts to 236 413 BAUA. At end November 2017 the credit awarded to EU is 171 904 BAUA (73%). The remaining credits to be earned until March 2020 amount to 64 509 BAUA (27%).

Figure 30 Trend of awarded EU BAUA in the IFMIF/EVEDA Project



Source: F4E 2016 Final Accounts

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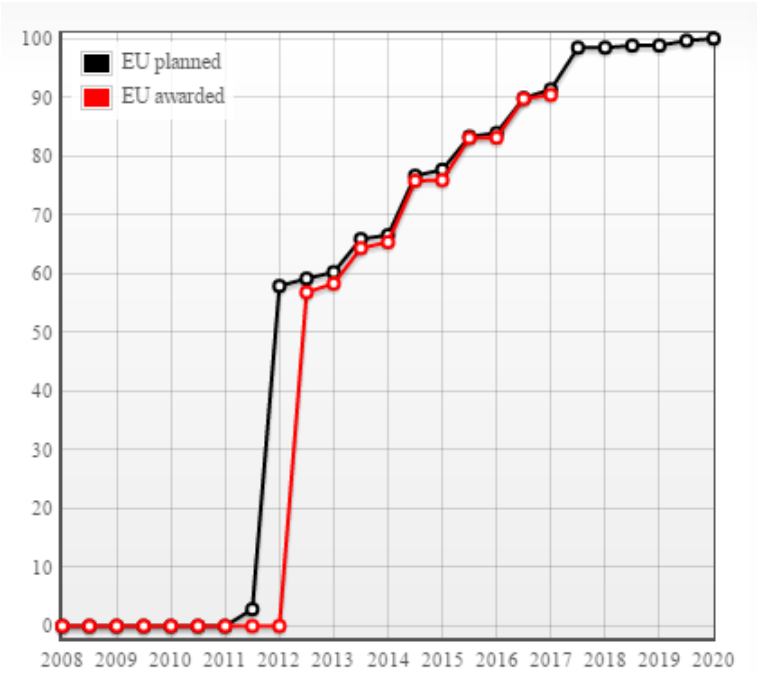
the current status is presented based on data as of November 2017 from the F4E Draft Annual and Multi Annual Programming Document 2019-2023.

The total commitment of the EU for the IFMIF/EVEDA Project amounts to 147 330 BAUA. At end November 2017 the credit awarded to EU is 120 656 BAUA (82%). The remaining credits to be earned until March 2020 amount to 26 674 BAUA (18%).

Figure 31 Trend of awarded EU BAUA in the IFERC Project



Source: F4E 2016 Final Accounts

The total commitment of the EU for the IFERC Project amounts to 116 250 BAUA. At end November 2017 the credit awarded to EU is 113 050 BAUA (97%). The remaining credits to be earned until March 2020 amount to 3 200 BAUA (3%).

3.5.5 Other horizontal F4E activities

Besides its core activities as defined by the F4E statutes the organisation also assumes a number of additional tasks as listed below.

The Technical Support Services team in F4E provides specific technical expertise in engineering and fusion technologies to the F4E Project Teams delivering systems to the ITER Project and, to a more limited extent, also supports the Broader Approach projects. Technical support is provided e.g. in the areas of design office activities, design codes and standards, metrology, materials and fabrication technologies and others. During the last available reporting period (2016) all objectives have been achieved.

In order to ensure the correct implementation and management of nuclear safety within F4E, the Nuclear Safety Group provides technical expertise to the Project Teams within the nuclear safety area, and performs some surveillance of their nuclear safety activities. In 2016, the first nuclear safety inspection was performed by F4E in three workshops of a major F4E supplier. In this case too, all objectives have been achieved.

The Plasma Engineering group provides expert support and analysis to the ITER Project, and directly to F4E Project Teams and their suppliers, in plasma control, plasma scenario development, plasma-wall interactions, and plasma operation. Plasma Engineering addresses the analysis and definition of requirements (including definition and verification of loads) coming from interfaces with the ITER plasma, and is involved in the study of the impact of design changes on the ITER machine's performance and operation. The Plasma Engineering scope also includes carrying out specific activities requested by the IO by means of ITER task agreements, supporting F4E managerial/strategic decisions, and interacting with technical and scientific committees advising F4E and the ITER Project.

The Transport activity reflects the management, on F4E's side, of technical aspects of the joint procurement with IO for the transportation of ITER components to the site in Cadarache. The

scope includes the transportation of all, large ITER components from the point of entry (the port of Marseille at Fos or Marseille's Marignane Airport) to the ITER site. In addition to the technical support activities and in order to better serve the different communities which have a vested interest in the ITER project, F4E has developed various platforms to listen, understand and respond to their needs. Likewise, F4E contributed to several events in order to promote different aspects of its work to diverse groups such as companies, technology and science communities. A series of technical meetings was either hosted by F4E or organized with its strong involvement.

4. Findings of the mid-term evaluation

The section below presents a summary of the findings of the mid-term evaluation. The summary is based on the findings from the 21 evaluation questions that have been presented in the terms of reference of this study. While each evaluation question covers a specific aspect, this summary provides a broader picture for the main topics that have been identified during the evaluation process. The overall conclusions are presented in section 5. The findings and data for each evaluation question are presented in Annex 2.

4.1 Status of F4Es three objectives[156]

The objectives of the European contribution to ITER are threefold: (a) to provide the contribution of the European Atomic Energy Community (Euratom) to the ITER International Fusion Energy Organisation, (b) to provide the contribution of Euratom to Broader Approach Activities with Japan for the rapid realisation of fusion energy and (c) to prepare and coordinate a programme of activities in preparation for the construction of a demonstration fusion reactor [DEMO] and related facilities.

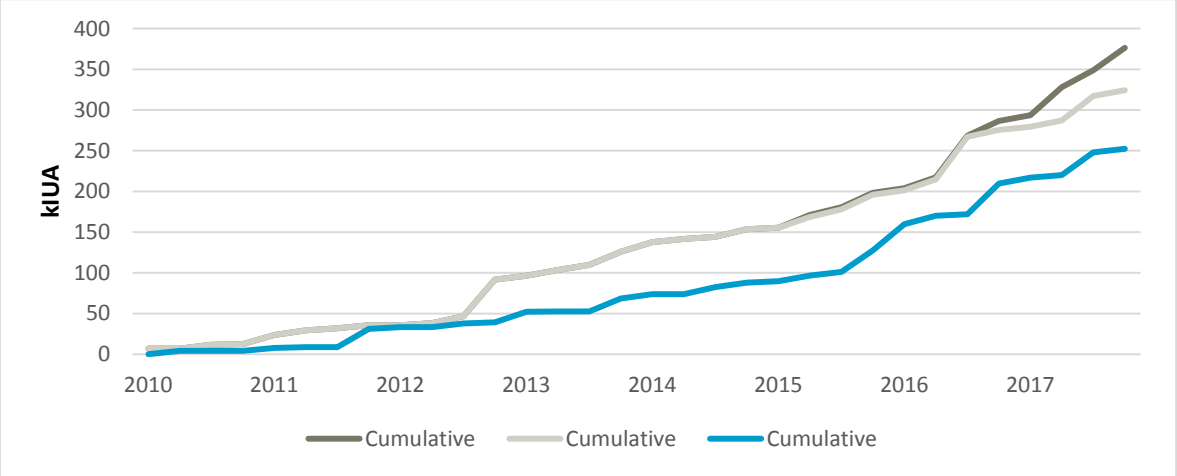
All three objectives are overall met in line with current planning.

4.1.1 Contribution to ITER

Since the new 2016 baseline, F4E has been focusing its effort and resources predominantly on achieving the first objective (a) and in particular the achievement of the First Plasma in 2025. The progress in this context can be measured in ITER credits (IUA) which F4E achieves when in-kind contributions are delivered to IO as well as for in-cash contributions. The achieved and released ITER credits compared to the baseline from 2010 – 2017 and for the evaluation period 2014 – 2017 are presented in Figure 37 and Figure 38, respectively.

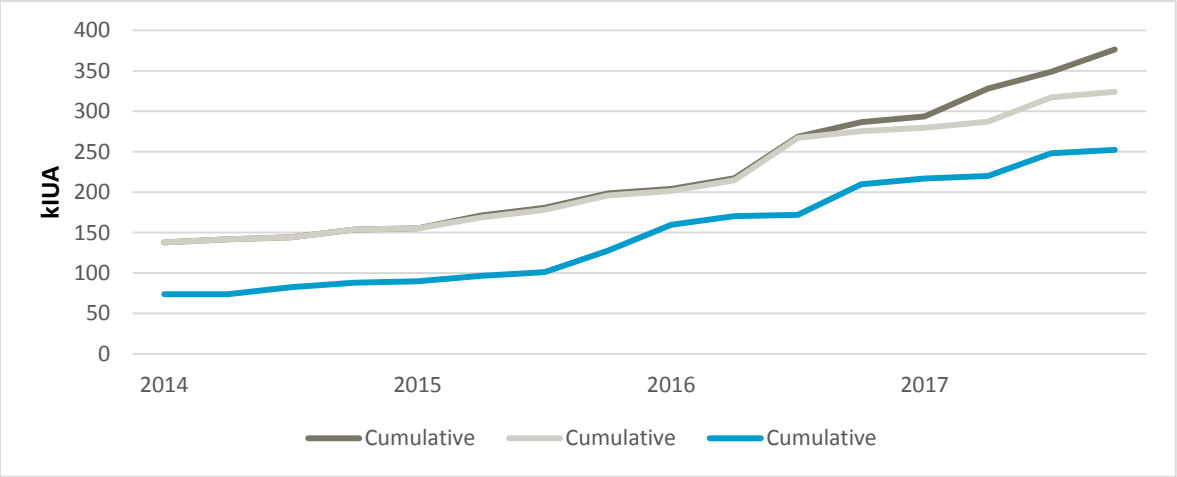
[156] This section is based on findings from the "Overview of the European contribution to ITER" section and EQ1.

Figure 32 ITER credits 2010 – 2017 in kIUA[157]



Source: Data from F4E. The baseline used for this chart is the F4E Current baseline; this is the schedule at the end of September 2016 plus approved baseline changes. The actuals and forecast are those in the latest Detailed Working Schedule from the 2nd Amendment of the 2017 Work Programme.

Figure 33 ITER credits 2014 – 2017 in kIUA



Source: Data from F4E. The baseline used for this chart is the F4E Current baseline; this is the schedule at the end of September 2016 plus approved baseline changes. The actuals and forecast are those in the latest Detailed Working Schedule from the 2nd Amendment of the 2017 Work Programme.

As can be seen in the graphs, during 2017 a small delay can be observed in terms of credits achieved vis-à-vis the 2016 baseline. In the current planning (as of November 2017) the delay is scheduled to be compensated in the coming years and to be fully back on track in 2024.

In terms of contracts, as of November 2017, F4E has signed contracts corresponding to 87% of all ITER credits to be obtained from EU side.[158]

[157] The difference between the achieved and the released credits is explained by the fact that once F4E achieves a credit milestone, all necessary data, reports and other information has to be collected and provided to IO. This information is linked to the delivery by the supplier of all the necessary documents and to the F4E approval of these deliverables. Furthermore, IO has to revise and validate the whole set of documents provided in order to confirm such achievement. For this reason, the process can take up to a few months.

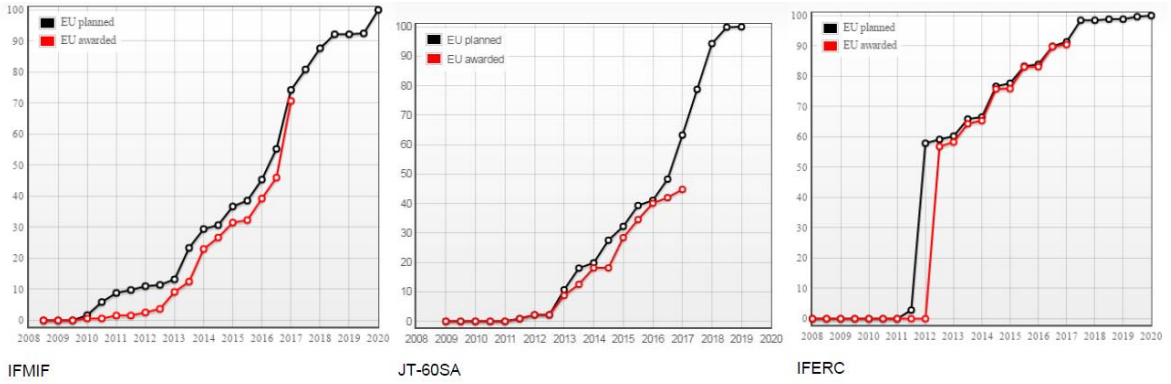
[158] Draft Annual and Multiannual Programme Years 2019-2023

Overall, F4E delivers its yearly targets according to the new baseline over the evaluation period which has not been the case before 2014 where the project experienced heavy delays and cost overruns due to, among other reasons, weaknesses in its management and governance. The data is in line with the findings from the stakeholder consultation in which stakeholders from F4E, IO and other stakeholders confirmed a regained confidence in F4E's ability to achieve its objective of delivering Euratom's contribution to ITER.

4.1.2 Contribution to the Broader Approach

Overall progress on the Broader Approach projects is satisfactory, as indicated by the ratio of credit awarded under the Broader Approach to credit planned, which was above 88% on average in 2016. Progress in achieving yearly targets is shown in Figure 34 below.

Figure 34 Ratio of credit awarded under the Broader Approach Agreement to credit planned (2016)[159]



As of November 2017, the projects have been achieved to the following extent:[160]

- The total commitment of the EU for the Satellite Tokamak Programme (JT-60SA project) amounts to 236 413 BAUA. At end November 2017 the credit awarded to EU is 171 904 BAUA (73%). The remaining credits to be earned until March 2020 amount to 64 509 BAUA (27%).
- The total commitment of the EU for the IFMIF/EVEDA Project amounts to 147 330 BAUA. At end November 2017 the credit awarded to EU is 120 656 BAUA (82%). The remaining credits to be earned until March 2020 amount to 26 674 BAUA (18%).
- The total commitment of the EU for the IFERC Project amounts to 116 250 BAUA. At end November 2017 the credit awarded to EU is 113 050 BAUA (97%). The remaining credits to be earned until March 2020 amount to 3 200 BAUA (3%).

The BA is seen as a success story by most stakeholders which performs very well and within normal deviations for long-term R&D projects.

4.1.3 Contribution to DEMO

Under the objective DEMO, F4E´s task is to prepare and coordinate a programme of research, development and design activities in preparation for the DEMO construction. The objective of DEMO is to lay the foundation of a reactor capable of generating several 100MW of net electricity to the grid around the middle of the century as a part of the EU fusion roadmap. DEMO activities are currently limited to those included in the framework of the IFERC project under the BA Agreement. EUROfusion is carrying forward preparatory work for DEMO and F4E is a limited support function.

[159] F4E 2016 Final Accounts
[160] Draft Annual and Multiannual Programme Years 2019-2023

4.2 Procurement performance (in-kind contributions)

4.2.1 In-kind contributions (public procurement contracts and grants)

In-kind contributions are F4E's input of specific components to the ITER project. Approximately 90% of the ITER project (including from other DAs) is built by in-kind contributions.

The in-kind contributions are organised through Procurement Arrangements (PAs), concluded between the IO and the individual DAs. Each of them represents specific work to be performed and delivered to IO.

As Euratom's DA, F4E is responsible for the performance of the Euratom in-kind contributions, in accordance with the PAs concluded between IO and F4E. The Euratom contribution to ITER consists mainly of buildings, magnets, ships and other technical components.

F4E is also responsible for the coordination of the European contributions to three joint fusion projects carried out in collaboration with Japan, known as the "Broader Approach".

To provide these in-kind contributions, F4E uses a combination of grants and contracts with external parties.

In relation to grants, F4E issues calls for proposals, mainly for research and other pre-fabrication activities. These grants are mainly signed with European research centres and laboratories.

In relation to contracts, F4E organises public procurement procedures to conclude the contracts. F4E then supervises the implementation of these contracts and ensures that the work is performed according to the agreed scope, schedule and cost. While F4E is responsible for procurement and contracting, the industry delivers directly to the IO, which performs acceptance.

4.2.2 The framework for F4E's public procurement and grant procedures

Large international science projects can have fairly different rules in regard to procurement and contract management.[161] In some cases, this is a reflection of distinct differences in the objectives which are pursued through the contracting procedures.[162] In other cases, it reflects that similar aims are pursued, but these aims are assigned different priorities when they are in conflict with each other.

The framework applying to F4E when performing public procurement and grant procedures is established by Titles V and VI of the Euratom Financial Regulation[163] and Rules of Application,[164] with the limited derogations provided in the F4E Financial Regulation and Implementing Rules.

Some important aspects of the regulatory framework for public procurement which applies to F4E are:

- Participation in F4E procurement procedures is always open to companies from Euratom member states. In exceptional cases, participation from third country companies may also be allowed.[165]
- F4E procurement procedures are required to respect the general EU public procurement principles of transparency, proportionality, equal treatment and non-discrimination.[166]

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[161] A recent – brief – summary of procurement rules for difference large projects can be found in "Big Science Business Forum 2018 – Procurement Handbook"; https://bsbf2018.org/wp-content/uploads/2018/02/BSBF2018-Procurement-Handbook.pdf

[162] As an example, some projects apply a "fair return" principle, which aims to achieve some level of balance between the budgetary contribution of each member country and the share of the contacts awarded to companies from this country. No such principle exists in the F4E procurement regulations, as it implies a form of intentional discrimination based on origin.

[163] Regulation (EU, Euratom) no. 966/2012 of the European Parliament and of the Council of 25 October 2012, on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002; as amended by Regulations no. 547/2014, 1142/2014 and 2015/1929

[164] Commission Delegated Regulation (EU) No. 1268/2012 of 29 October 2012 on the rules of application of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council on the financial rules applicable to the general budget of the Union; as amended by Commission Delegated Regulation (EU) 2015/2462

[165] Regulation (EU, Euratom) no. 966/2012, Article 191

[166] Regulation (EU, Euratom) no. 966/2012, Article 102

- The principle of non-discrimination means that - between tenderers from eligible countries, as described above - F4E is *not* allowed to discriminate on the basis of nationality. As a consequence, country of origin cannot be a relevant factor in any of F4E's procurement decisions, including the determination of technical specifications, choice of selection and award criteria, selection of tenderers, and award of contracts.

It was indicated in interviews[167] and a survey[168] carried out for this evaluation that, while it is reasonable to place some restrictions on the use of public sector funds, and while some relevant derogations from the Euratom rules have been obtained for F4E, the regulations on procurement and contract management are still very similar to those of EU institutions such as the European Commission, and not designed for an international experimental science project. Therefore, it was perceived by stakeholders as advantageous to consider further adaptations to the rules, to provide F4E with further agility and better reflect the specific needs of a one-of-a-kind project such as ITER.

Few specific examples were given of specific adaptations that should be considered, but reducing the restrictions on *amendments to concluded contracts* were mentioned in several cases.

Similar restrictions apply to the EU member states' contracting authorities; originally developed in the European Court of Justice's jurisprudence, and since codified and clarified in the 2014 EU public procurement directives.[169] The current restrictions on F4E – further to the derogations obtained in recent years – are largely comparable to the restrictions stated in the 2014 EU public procurement directives.

One central aim of such restrictions is to protect economic operators (other than the successful contractor) against post-tender contract changes which could have significantly impacted the results of the tender. Exemptions do exist to protect the contracting authority's legitimate interests in making necessary amendments, but these exceptions are limited in scope, e.g. to amendments of small monetary value or amendments due to unforeseeable (not just unforeseen) circumstances.

It can be argued that the legitimate interests in post-tender contract amendments may be stronger in some cases than others, and that an organisation such as F4E could have a larger need for contract management agility than the average contracting authority - partly due to the experimental nature of many of the contracted deliveries, partly due to the potentially severe consequences of re-tendering (in the worst case scenario, re-tendering a single contract on the critical path of the ITER project could lead to significant delays of the entire project). However, it should also be noted that liberalising the restrictions on amendments would not guarantee better outcomes – only provide F4E with additional opportunities for achieving better results.

The scope of this evaluation does not allow for an extensive comparison between the rules in different international science projects, but performing a detailed analysis of differences between such regimes could be a relevant activity for identifying other potentials for improvements to the F4E framework.

4.2.3 F4E's practical approach to procurement[170]

Within the given boundaries, F4E has evolved its procurement procedures constantly over its lifetime and partly in cooperation with the ILO network. Overall, this brought the procurement procedures closer to the realities of the market that F4E operates in which is defined as a limited number of companies which can supply required high-tech components.

For example, F4E's approach to procurement has evolved over the organisation's lifetime in terms of contract size. In the earlier years, F4E tended to place large procurement contracts on a fixed price basis, which did not always give the best results, e.g. because it placed a lot of risk

[167] These views were particularly prevalent among IO interviewees, where 4 out of 9 interviewees highlighted complexity or inflexibility as negative factors

[168] As indicated in Annex 2 - EQ4, 80% of survey respondents listed "complex procedures", and 60% of respondents listed "flexibility to react to unforeseen circumstances" as factors preventing the European Contribution to ITER from more successfully achieving its objectives. Source: Ramboll on the basis of European contribution to ITER survey results 2018; responses to question 3

[169] Directives 2014/24/EU, 2014/25/EU and 2014/23/EU

[170] Except where otherwise indicated, this section is based on interviews with F4E

with the contractors, which in turn increased contract prices. To address this, F4E has in recent years moved towards smaller contracts with a more variable nature. The nature of the items to be procured in recent years has also enabled smaller contracts. The current approach leads to a fairly large number of contracts to be tendered – and increases the need for contract management capacity in F4E.[171]

The new approach can have both positive and negative consequences. For instance, the unbundling can reduce the amount of "risk overhead" included in the tender prices (compared to the previous approach).

On the other hand, the new approach also implies that F4E must assume the interface management between a larger number of contracts – and that the risk of misalignment between deliverables around these interfaces will be owned by F4E. One IO interviewee specifically mentioned the splitting of deliveries into many separate contracts as an area where F4E acts differently from the other DAs – and as a source of problems and deviations.

F4E's current overall operational approach to procurement can be described as follows:

- Initially, a procurement strategy is developed. Market intelligence is an important source of information for developing the strategy; area-specific market surveys are carried out prior to some of the procurements.
- The procurement strategy will aim at 'un-bundling' deliverables where this is deemed a relevant option. This is done in order to foster competition in the tenders, potentially allowing more companies to submit tenders (including to some extent SMEs), and not forcing companies to form large consortia which could have a negative effect on competition. It is also in line with the objectives of F4E's Industrial Policy, as described above.
- Generally, the aim is to have contracts where at least 2 – and preferably more - Euratom contractors will be able to submit a tender. International tendering, i.e. tenders where participation not limited to Euratom countries, is done less than 2% of the time. There are no geographical constraints on subcontractors within the EURATOM area, but certain criteria have to be met to allow subcontracting from outside EURATOM countries – and for certain core activities, subcontracting is not allowed at all.
- Even after this 'un-bundling', the resulting contracts will still tend to have a quite large volume, typically in the tens of millions of EUR. Many of the procurements will also still be for very specific needs where the relevant market is limited, and in some cases technical monopolies currently exist.

4.3 The cost of the European contribution to ITER

F4Es budget (or operating revenues) mainly comes from three sources:

- The Euratom contribution;
- The ITER Host state (France) contribution; and
- The Membership contributions.

The contribution from Euratom constitutes the main source of revenue for F4E. The ceiling for the Euratom contribution from the general EU budget to the ITER project is set in Article 16 of the Council Regulation (EU/EURATOM) No 1311/2013[172] of 2 December 2013 for the years 2014-2020 at EUR 2 707 million (in 2011 value.) The contribution is detailed in the Council decision 2013/791/Euratom[173], at EUR 2 915 million (in current values.)

Since the establishment of F4E, as of 31 December 2017, F4E has received a total of EUR 5 054.9 million in commitment appropriations and EUR 3 328 million in payment appropriations (both in current values) from Euratom contributions. During the MFF 2014-2020, as of 31 December 2017, F4E has received a total of EUR 1 741.6 million in commitment

[171] Annual and multiannual programme – Years 2018-2022
[172] Council Regulation (EU, EURATOM) (No 1311/2013 of 2 December 2013). Laying down the multiannual financial framework for the years 2014-2020.
[173] Council Decision 2013/791/Euratom of 13 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 (OJ L 349, 21.12.2013, p. 100–102)

appropriations and EUR 2 090.9 million in payment appropriations[174] (both in current values) from Euratom contributions. The contribution from the ITER Host State (France) covers 9.09% of the total costs of the ITER construction phase, equivalent to 20% of the F4E budget for ITER construction excluding expenditure related to transportation and Test Blanket Modules[175]. As of 31 December 2017, the contributions amounted to a total of EUR 1 026.7 million in commitment appropriations and EUR 708.3 million; during the MFF 2014-2020, as of 31 December 2017 the amounts are EUR 509 million and EUR 445 million, respectively.

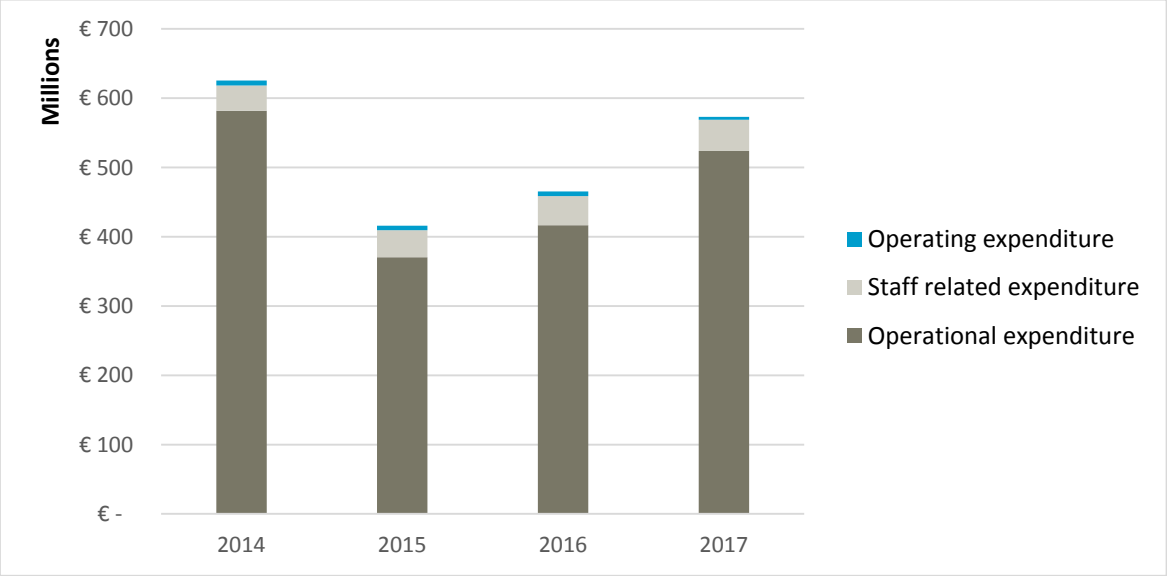
The Membership Contributions are established and adopted annually within the budget. They correspond to 10% of the administrative budget calculated at the time of the adoption of the respective annual resource estimations. By end of 2017 the total revenue from Membership Contributions was EUR 39.3 million in commitment appropriations and EUR 39.7 million in payment appropriations. Only looking at 2014-2017, the two figures both amount to EUR 18.3 million.

Those revenues cover F4Es expenditure. The revenue received from Euratom is earmarked for operational expenditure and (i.e. procurements for in-kind contributions) for administrative expenditure of F4E (running costs); France's contribution is earmarked to ITER construction expenditure and the revenue from the Membership contributions is not earmarked.

F4Es expenditure consists of operational expenditure (mostly including in-cash and in-kind contributions to ITER) and administrative expenditure (consisting of operating expenditure and staff related expenditure).

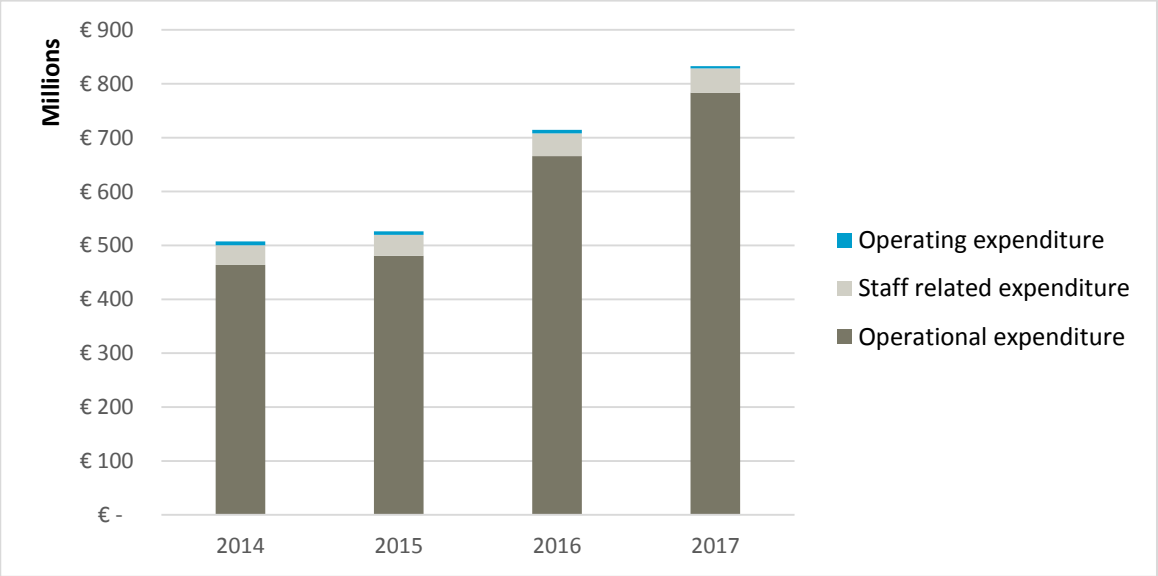
The development of those expenditures over the evaluation period is presented below. The ITER project over the years 2014-2017 has been progressing and entered into execution phase of construction and manufacturing of larger contracts, which require more personnel for monitoring. The administrative and operating costs have increased in line with this development.

Figure 35 Total expenditure 2014 – 2017 (commitment appropriations current value in EUR million)



[174] It should be noted that payments in the 2014-2017 period also cover the commitments made before 2014.
[175] The precise scope, conditions and the global amount of the French contribution for the ITER construction phase were established in a formal exchange of letters between France and the European Commission in 2011.

Figure 36 Total expenditure (payment appropriations current value in EUR million)



Source: F4E Annual and Multiannual Programme Years 2019-2023

The ITER project runs over 25 years and this evaluation is focusing on the period 2014-2017, therefore it is very difficult to evaluate cost effectiveness over such short period of time for a mega project like ITER. Also, ITER is a first-of-a-kind research and development project to develop a new source of energy, and no relevant benchmark exists to assess the overall cost effectiveness of the project and European contribution to ITER.

Large infra-structure projects that have several international stakeholders and suppliers and runs over many years tend to have delays and cost overruns due to the complexity of the project. To compare, the Finnish nuclear power plant Olkiluoto 3, was procured 2003 and supposed to be finalised in 2009, has been delayed several times and is now planned for completion in 2019 at the earliest with almost the double investment cost from 3.2 billion € to 5.5 billion €. Also the new Berlin Brandenburg International Airport has had several delays and cost overruns from planned start in 2011 and now delayed until 2020.

Thus, given the complex tasks and high number of procurement procedures and project follow-ups the ITER project can be considered as being managed efficiently and cost-effective

4.3.1 Administrative expenditure

The total administrative expenditures over the years 2014-2017 represent approximately 9% (at the level of commitment appropriations) and 7% (at the level of payment appropriations) of the total expenditure.

As can be seen from the figure there is an increasing trend in the administrative costs over the 2014-2017 period which is mostly due an increased number of staff of around 10 % between 2014-2017 both, due to additional posts made available and reduction of vacancy. According to the 2014 – 2017 F4E final account reports additional[176] reasons for this trend include:

- Transfer of staff from Barcelona to Cadarache, where the cost of living is about 25% higher;
- The increase of salaries for 2016 (+1%), after 3 years of decrease due to the evolution of the coefficient related to the cost of living in Spain; and
- Increase in other expenses directly linked to a higher number of staff such as international school fees or cost of health care insurance.

Overall the split between administrative and operational costs is in line with similar large infrastructure projects of this size and international co-operation. For example, in comparison Norra Länken, one of the largest road tunnel infrastructure projects in northern Europe, with 15

[176] For more details see budget implementation section 5.1.1 in the 2014 and 2015 final account reports and section 8.5.1 in the 2016 final account report, respectively.

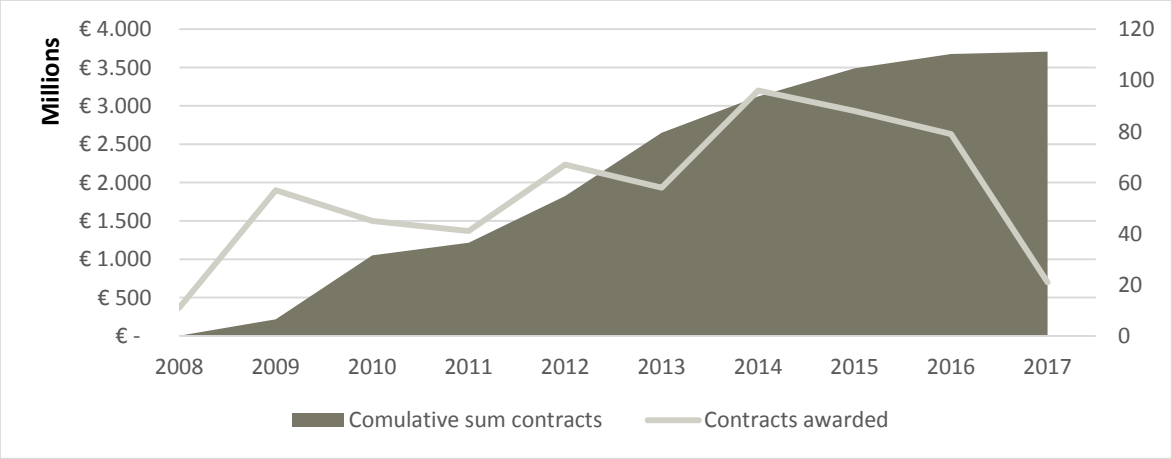
kilometres of rock and concrete tunnels under the City of Stockholm, had 8% project management and administration cost of the total investment of EUR 1.6 billion over the ten years of project implementation. Interviewees from IO and other stakeholders also generally had the perception that the administrative cost of F4E is appropriate compared to the budget that the organisation administers.

4.3.2 Operational expenditure

In-cash contributions are Euratom's direct financial contributions to the IO, which are paid out through F4E. The F4E processes for handling these contributions are limited to follow-up on planning and executing the payments, including checking that the requested cash transfers are within the total limits for the European contribution before payments are executed. The IO has the full decision competence as to how these contributions are spent, and F4E is not mandated to perform any form of follow-up on how these contributions are spent by the IO. Within this framework, the F4E management of in-cash contributions is efficiently carried out, but whether the funds are spent efficiently depends on the IO, and F4E does not have direct insight into this.

The largest share in F4E's expenditure is used to manufacture the in-kind contributions to ITER (in the form of contracts and grants). From the founding of F4E until end of May 2017[177] contracts with a total value of EUR 3.7 billion have been awarded for producing in-kind contributions. From the founding of F4E until 1 January 2017[178] grants with a total value of EUR 99.51 million have been awarded. As can be seen the budget for grants is considerably smaller accounting for only 3% of the budget for in-kind contributions while contracts account for 97%. From 2014 until end of May 2017 contracts with a total value of EUR 1.06 billion and grants with a value of EUR 12.36 million have been awarded. The figures below show the number and cumulative value of awarded contracts and grants, respectively, over the abovementioned periods.

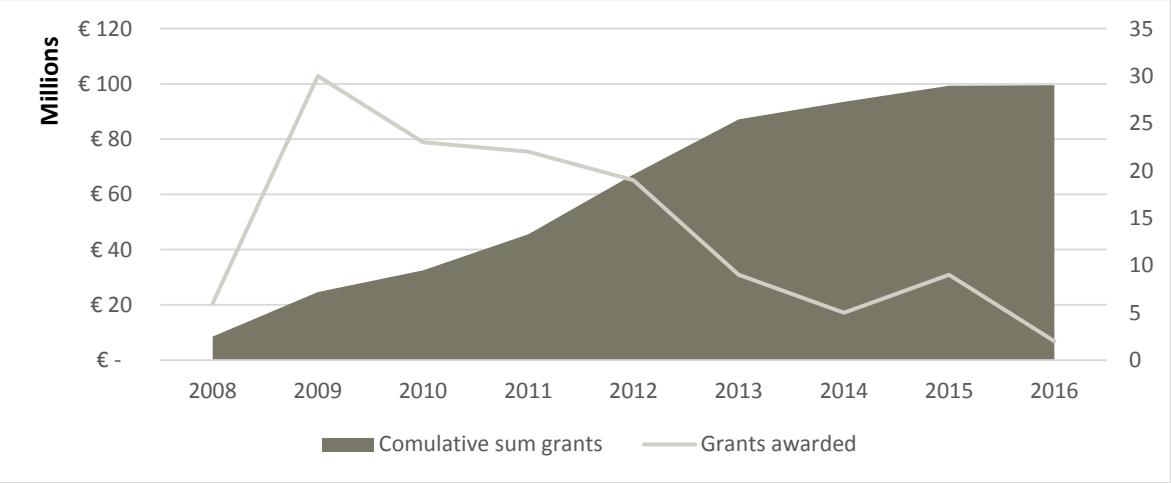
Figure 37 Number and cumulative value of awarded contracts 2008 – May 2017



Source: Data from F4E

[177] Latest available data
[178] Latest available data

Figure 38 Number and cumulative value of awarded grants 2008 – January 2017



Source: Data from F4E

Cost-effectiveness of the kind-contributions from an F4E perspective is inherently linked to the adequateness of the procurement procedures as described in the section above. However, there are many other factors that influence the efficiency of those contributions. ITER is a state of the art technology project and the in-kind contributions entail components that have never been manufactured before which imposes uncertainties and potentially influences the progress and costs. For example, the larger components with very high technical requirements such as the vacuum vessel, toroidal and poloidal field magnets together with the breeding blanket modules (TBM) are a challenge to design, manufacture and commission in different locations over the world. F4E's approach to procure and deliver its in-kind contributions is described in the last section and also is a factor that potentially impacts the cost-effectiveness e.g. by allocating the risk between the contractor and the client or by steering the size of contracts. As mentioned, the current approach of procurement can have both positive and negative impacts. Quantitatively those impacts can only become evident in the future due to the generally long timeline for large procurements. Also, for individual in-kind deliveries, their individual timelines matter to the potential impact. For ongoing projects, e.g. individual tenders, the potential impact may be restricted by decisions already taken in earlier project stages. These decisions may be difficult - or even impossible - to roll back with positive results. Attributability of impacts is also a challenge since the cost-effectiveness of the in-kind deliveries do not only depend on F4E's procurement and contract management, but also on developments in market and research etc. which are outside F4E's control. Also, the first-of-a-kind nature of the project will remain an important source of uncertainty.

4.4 The benefits of the European contribution to ITER[179]

As stated, to execute its tasks related to ITER, F4E, among others, steers the "in-kind" contributions of components. For this, F4E organises procurement procedures in view of concluding contracts mainly with European industries. F4E then supervises the implementation of these contracts and ensures the work is performed according to the agreed scope, schedule and cost. F4E also issues calls for proposals for research and other pre-fabrication activities in view of concluding grants. These grants are mainly signed with European research centres and laboratories.

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.

[179] This section is based on EQ 2 and EQ3.

4.4.1 Contracts and grants awarded

As stated above, from the establishment of F4E in 2007 until end of May 2017[180] contracts with a total value of EUR 3.7 billion have been awarded. From the founding of F4E until 1 January 2017[181] grants with a total value of EUR 99.51 million have been awarded. As can be seen the budget for grants is considerably smaller accounting for only 3% of the budget for in-kind contributions while contracts account for 97%.

From 2014 until end of May 2017 contracts with a total value of EUR 1.06 billion (99% of total) and grants with a value of EUR 12.36 million (1% of total) have been awarded.

Overall, the contracts signed by F4E have involved more than 440 companies and 65 R&D organisations[182]. The companies, including SMEs from about 20 different EU Member States and Switzerland, have benefited from this investment on ITER activities. IO as well as the DAs and industries of other ITER Members have also signed contracts with European industry to support the manufacture of their own components for ITER.[183]

For the majority of contracted parties, implementing F4E contracts is seen as part of their core business. However, for a substantial minority of the contracted parties, a F4E contract is regarded as a stepping stone towards realising longer term spin-offs and benefits. Firms judge that working on ITER bolsters their reputation as a leading high-tech company and many also have a positive appraisal of the indirect benefits outside of fusion and big science and more than a third of firms have developed new cutting-edge technologies as a result of their work on ITER. Whilst only a handful of these have led to specific spin-offs this is a longer-term process, and one could expect that these benefits will become more visible in future. Finally, around a quarter of firms reported that the work on ITER has helped them to access new business opportunities both inside and outside fusion. Consortium working is utilised by almost 40% of firms with many of these firms reporting synergies and new opportunities[184].

4.4.2 Contribution of the F4E Industry Policy

F4E´s Industrial Policy, defined in 2012 by the F4E Members,[185] defines a set of objectives for how the European contribution to ITER should be performed[186].

There have been significant efforts made by F4E to address the objectives of the F4E Industrial Policy with focus on assessing the outcomes of the F4E's procurement activities in terms of the tender process and award of contracts in Europe, the extent to which they lead to collaboration, innovation and competition and the scope of participation of SMEs in the procurement procedures, and overall the evaluation concludes that the objectives of the F4E´s industrial policy are met.

Procurement rules ensure fair allocation of contracts, despite barriers to matching the capacity and technology requirements. A procurement strategy, consisting of unbundling large procurement packages and assessing the market capacity, is in place to ensure participation of as many economic operators as possible, including SMEs.

F4E engages actively with the industry and research communities to promote participation in calls for tenders and calls for proposals. This includes cooperation with the network of Industrial Liaison Officers (ILOs) and the European Fusion Laboratory Liaison Officers (EFLO) Network.

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[180] Latest available data
[181] Latest available data
[182] F4E Highlights 2016
[183] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[184] This paragraph is based on preliminary findings from the Value for Money study (2018)
[185] F4E(201212)-GB26-10.4 "Industrial Policy of Fusion for Energy", 2012
[186] The objectives of the F4E's industrial policy are:

- Objective 1. Deliver the European contributions to ITER and the Broader Approach within the agreed budget and schedule making best use of the industrial and research potential and capabilities of all F4E members, in line with competition rules
- Objective 2. Broaden the European industrial base for fusion technology for the long-term development of fusion as a future energy source and to ensure a strong and competitive European industrial participation in the future fusion market
- Objective 3. Foster European innovation and competitiveness in key emerging technologies to further the development of the Innovation Union and its impact at the international level

This also includes communication and information initiatives to raise awareness and capability. In this respect, the Industry Portal is pivotal.

In spite of this, it is recognised that the participation to ITER activities by the industry and SMEs remains a challenge. The high complexity of the technologies, due to the "first-of-a-kind" nature of ITER, constitutes a barrier for the participation of companies. Also, the process covering procurements and contracts and leading to the outcomes is experienced by interviewees as rather long and complex.

4.4.3 Economic impact

The recent Impact Assessment (2018) study found that spending on ITER by F4E is having significant positive economic impacts, with 34 000 job years created to date, including 74 00 in 2017 alone; and almost EUR 4.8 billion in Gross Value Added to date, with more than EUR 1.1 billion in Gross Value Added estimated in 2017. Under the current baseline for the period between 2020 and 2030 this trend is expected to continue by creating 14 500 new jobs, contributing EUR 3 668 million (in 2015 values) Gross Value Added and by leading to the creation of more than 6 963 SMEs.

In the host region, the ITER project is expected to have contributed to the creation of work for local people working on-site, increasing industry capacity, especially in the region. Also, different side effects have been mentioned such as creation of new schools in the region, economic development by renting houses, establishing agencies all connected to this logistic and infrastructure.

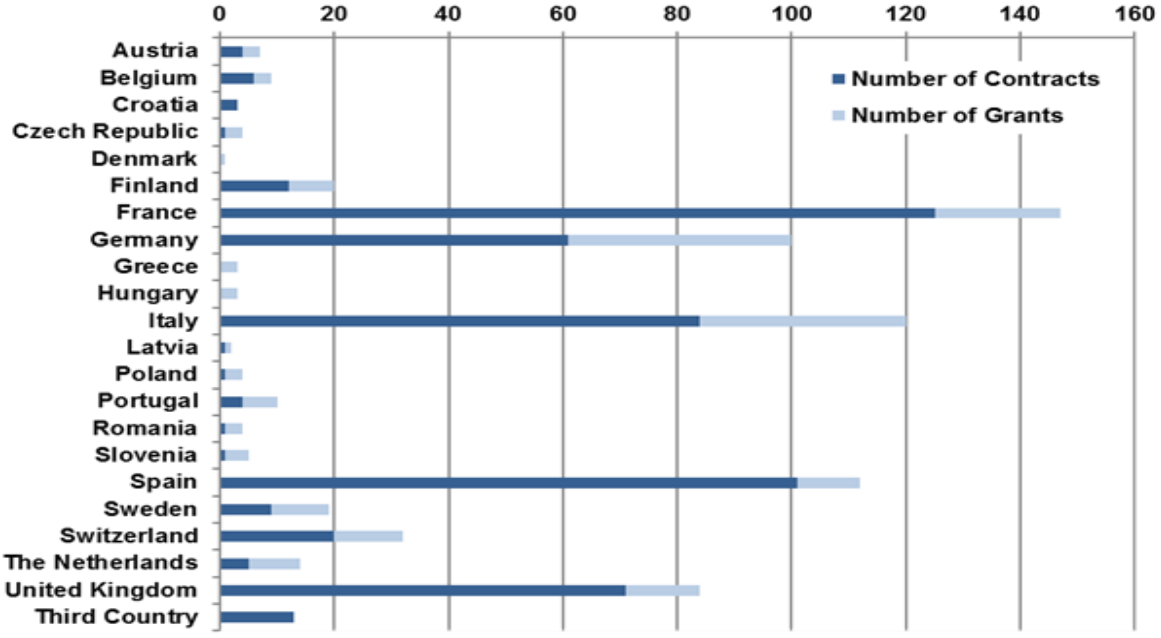
From a more qualitative perspective, participating companies and research institutions benefit from taking part in cutting-edge technology projects and networks, which give them an advantage in terms of innovation and competitiveness. This effect, while not measurable directly, is considered to be of high importance by representatives from the ILO network and other interviewees.

Impact on Member States

F4E does not make any positive discrimination to favour geographical spread, as the EU public procurement and competition rules apply. Consequently, there is an imbalance in the geographical spread of contracts and grants.

The following figure shows the geographical distribution of awarded contracts in EU Member States.

Figure 39 Geographical distribution of contracts and grants (over the period 2008-2017) based on the location of F4E's prime contractors



Source: F4E draft Consolidated Annual Activity Report 2017

In addition, cross-border subcontracting[187] does have a significant impact on the geographical value distribution, in particular for some countries: for Finland, Portugal and Japan, the value of subcontracting exceeds the value of primary contracting.

The graph shows a fairly uneven distribution of number of contracts over the Euratom members, with a very significant part going to France, Spain, Italy, Germany and the United Kingdom. There are several factors which can help explain this, including the following:[188]

- France is the host nation for ITER, where most of the deliveries must be made. Geographical proximity to the delivery site tends to increase the interest and competitiveness for contractors, particularly for construction contracts and other contracts requiring significant on-site presence. A similar effect may apply to a smaller extent to Spain, the host nation of F4E.
- Relevant expertise for specialised contracts – e.g. fusion expertise or related nuclear expertise - may be unevenly distributed over the Euratom members.

However, it should be noted that F4E does not publish any analysis of the reasons for the actual geographical distribution.

Impact on SMEs

According to F4E interviews, SMEs constitute about 48% of F4E's number of contracts and 15% of the contract value. The new strategy of un-bundling may increase the potential for SMEs tendering for contracts, although only to a limited extent, since the individual contracts still tend to be fairly large. Also, there is a limit to how much procurement can be adapted for SMEs without interfering with project needs. Subcontracting may also present relevant opportunities to SMEs. It was noted that large projects such as the construction of buildings are coming to an end, while small scale projects are in their start-up phase; this could increase SME participation in future years. In the survey,[189] a majority of respondents indicated disagreement with the statement that the "procurement practices of F4E benefit SMEs to the extent possible". All ILO respondents disagreed with this statement, whereas 37% of GB respondents disagreed. In telephone interviews with ILOs, it was also indicated that there was still scope for reducing the barriers for SME participation in tenders.

4.5 Impact of the project turnaround and reorganisation

The construction of the ITER scientific installation in St-Paul-les-Durance, France, began in 2007 and was initially expected to last ten years. However, the project experienced delays and cost overruns which were due, among other reasons, to weaknesses in its management and governance[190].

4.5.1 Turnaround and reorganisation[191]

In 2015, IO and F4E both presented Action Plans preceded by critical assessments that identified managerial shortcomings in both organisations. In 2013, the "ITER Management Assessment" report[192] revealed several problems in the management and organisation of the ITER project and identified 11 recommendations for urgent action, including among others the need to create a project culture, install a strong Nuclear Safety Culture and develop a realistic ITER Project Schedule[193]. In 2015 an Action Plan[194] was proposed by IO and since then implemented to correct the deficiencies identified by the Management Assessment.

Also in 2013, the European Parliament's Budgetary Control Committee published a report by Ernst & Young which revealed some shortcomings in the organisation of F4E. Following this, F4E

[187] I.e., primary contractors using sub-contractors from other countries
[188] Interviews with F4E, IO and external stakeholders
[189] Ramboll on the basis of European contribution to ITER survey results 2018; responses to questions 3, 5c, 8 and 10c
[190] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[191] This section gives a short introduction to the turnaround in F4E and IO, the new 2016 Baseline as well the events leading to them.
[192] Final report of the 2013 ITER Management Assessment, 18 October 2013.
[193] The outcome of this exercise, the new baseline, is assessed in the next question.
[194] 2015 ITER Action Plan – Foundations for a new phase of ITER

presented in 2015 an Action Plan[195] that identified measures in order to address supplementary issues to those planned under the ITER Action Plan. Planned actions under the F4E 2015 Action Plan include the establishment of an appropriate level of risk-appetite (acknowledging that "a risk-averse approach at local level is often generating high risks at global level"); the improvement of the uptake of project and contract management tools (e.g. earned value reporting using the ITER Credit Allocation System milestones, better integration of Primavera[196] and a Contract Tracker tool); working towards full coherence between F4E and IO annual work- and project plans; the need to increase F4E presence at supplier premises and the ITER site; and investigation of the possibilities to benefit from an increased level of flexibility within the implementing regulations.

In 2014 and 2015 a new Director General (DG) for the IO was nominated and then confirmed by the ITER Council. The DG proposed several measures to resolve the present difficulties. The most important one was to build an integrated team of the IO and the Members' Domestic Agencies under leadership of the DG.[197]

In November 2015, the IO presented a proposal for the updated ITER long-term schedule to the ITER Council. The ITER Council rejected the proposal due to not taking into account the existing constraints from the members and the lack of sufficient risk mitigation actions to provide confidence in the proposed schedule. The proposal also required significant additional cash contribution from the ITER Members. The ITER council decided to conduct an independent review of the updated schedule and the associated level of resources.

In April 2016, the independent review of the ITER schedule and its associated resources concluded that the long-term schedule is feasible. The reviewers also recommended a 'Staged Approach' as a means of improving focus and optimising resources. This involved having four phases of ITER assembly and operation from First Plasma at the end of 2025 up to Deuterium-Tritium operations in 2035 to reduce technical and budget risks. The milestones in the staged approach would be used to measure the overall progress of the project while also managing and reducing the risks.

The new ITER Baseline was prepared on the basis of the recommendations of the independent review. At the ITER Council meetings in June and November 2016, IO obtained approval *ad referendum* (i.e. subject to domestic processes of obtaining approval) of the schedule, resources and milestones until achievement of the First Plasma in 2025—commonly referred to as the 2016 baseline.[198] The new baseline was finally approved by the ITER Members at the ITER Council meeting in June 2017[199].

In January 2016 the F4E Director launched the strategy called 'Straight Road to First Plasma' (SR2FP) with the overall objective of concentrating resources (funding and staff) on the activities critical to the achievement of First Plasma at the end of 2025. This objective is fully consistent with the updated IO's overall Project Schedule, and is considered as an essential enabler to maximize the chance of project success from F4E's side.[200] To that end, non-First Plasma projects were either suspended or slowed down until after 2020 to make resources available for the critical First Plasma projects and ensure remaining within the EUR 6.6 billion budget (in 2008 values) until 2020 and allowing for a reserve. This approach has now been fully integrated into F4E's planning and operations.

4.5.2 Impact of the turnaround and reorganisation

The 2015 ITER and F4E Action Plans, and the associated reorganisations at ITER and F4E, appear to have had a positive impact on the performance of the ITER project and the European contribution to ITER,[201] and have contributed to the reestablishment of trust in the capacity to carry out the ITER project to the demonstration stage and prove the feasibility of fusion as a source of energy.

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[195] F4E 2015 Action Plan
[196] A project portfolio management software.
[197] Report of ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources (ICRG)
[198] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[199] http://fusionforenergy.europa.eu/mediacorner/newsview.aspx?content=1140
[200] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[201] 6th Annual Assessment of F4E - Report to the Governing Board

As mentioned earlier, F4E delivers its yearly targets according to the new baseline over the evaluation period which has not been the case before 2014 where the project experienced heavy delays and cost overruns due to, among other reasons, weaknesses in its management and governance. The data is in line with the findings from the stakeholder consultation in which stakeholders from F4E, IO and other stakeholders confirmed a regained confidence in F4E's ability to achieve its objective of delivering Euratom's contribution to ITER.

However, it is too early to determine whether the positive impact can be sustained in the long term, and there is still potential for further improvements.

Specific improvements achieved in ITER include improvements to risk management,[202] introduction of Integrated Project Teams between F4E and ITER IO,[203] reviewing and refining the interface management process,[204] the setting of milestones against which progress can be measured, and the creation of a Reserve Fund to provide a fairer distribution of cost increases due to changes in the technical specifications.[205]

Specific improvements achieved within F4E include:[206]

- implementing a new organisational structure in October 2016, which includes a separate Project Management Department (already established in 2015) and an integrated CFO/Commercial Department[207],
- improvement of project management, both in terms capabilities and tools, e.g. for monitoring and contract management
- the introduction of milestones for monitoring the status of the execution of the European contribution,
- substantial strengthening of risk management and risk mitigation[208] including the establishment of a cost risk register[209] and a "risk appetite" policy[210],
- structured follow-up on audit recommendations, leading to the closing of several open issues, and achieving all pending actions on previous internal audit recommendations in June 2016[211], and
- an improvement in the cooperation between the IO and F4E, an increased joint team spirit, and an increased F4E on-site presence in Cadarache.

Interviews with staff of F4E and ITER IO supported that these improvements have had a positive impact on the performance of the European contribution to ITER, a view that was also shared by F4E Governing Board members (GBs) in a survey carried out for the purposes of this evaluation – but not by the Industrial Liaison Officers (ILOs) who responded to the same survey. While 75 % of the GB members strongly agreed and agreed that the management reorganisations had a positive impact on the relevance of the project, no survey participant from the ILOs agreed with the statement while 57 % neither agreed nor disagreed. The results should be seen against the background of the interfaces of the two groups with the F4E and IO. The GB group is closely involved in the development of F4E and has direct contacts with IO. The ILOs, on the other hand, are predominantly receivers of information about upcoming procurements[212].

It was indicated in the interviews that there was scope for further improvement in several of the abovementioned areas, including:

- Cooperation between the IO and F4E, particularly on the technical levels;

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[202] Report from the In-Depth Independent Review on Risk Management
[203] Report by the expert group charged by the F4E GB in June 2016 to perform an independent review of the capacity of F4E to deliver the European contribution to the new ITER schedule on time and within budget
[204] Report from the In-Depth Independent Review Panel on Freezing the Design Interfaces
[205] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project" "
[206] In addition to the referenced documents, interviews with F4E and ITER IO staff have been used as sources for this section
[207] F4E Annual Activity Report 2016
[208] Fusion for Energy (F4E) Assessment and Review – The F4E Review Group (RG), 31 October 2016
[209] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[210] "Risk Appetite" Policy, 2016 (F4E(16)-GB36-10)
[211] F4E Annual Activity Report 2016
[212] In addition, they also work with F4E on the improvement of procurement procedures.

- Communication from F4E on performance issues in areas within F4E's responsibilities; and
- Additional co-location between the IO and F4E at the site in Cadarache.

The *2016 project baseline* has had a strong positive impact on the European contribution to ITER. While the new baseline foresees a significantly longer construction phase and increased costs for all ITER members, this made the baseline more realistic, which was a key factor for re-establishing trust in the ITER project from its funding parties, staff and other stakeholders.[213]

The new baseline provides a sounder foundation for planning, execution and monitoring of the European contribution to ITER.

An independent assessment of the capacity of F4E to deliver the European contribution to the new ITER baseline[214] confirmed the capacity of F4E to deliver the Euratom contribution to the new ITER schedule on time and coherently with the staged approach and within the current available budget until 2020.

A survey of GBs and ILOs conducted as part of this evaluation also supported the statement that the new baseline had a positive impact on the efficiency of the F4E contribution to ITER, and its ability to deliver on time and within budget. 86% of GB respondents and 43 % of ILO respondents expressed agreement with the statement, while only 5% and 14% expressed disagreement.[215]

The introduction of the *'Straight Road to First Plasma'* strategy by F4E to all of ITER[216], focusing resources on the activities and scope needed for ITER's First Plasma at the end 2025 has had a positive result in cost-control, project culture and a stronger project oriented mindset in the organisation. However, the deferral of post-First Plasma activities entails a de-prioritisation of units and tasks in F4E that are not directly linked to the 2025 First Plasma goal, and some interviewees in F4E considered this to be a potential source of risks for the long-term performance of the Joint Undertaking.

4.6 Analysis of the performance framework

The Performance Framework of the European Contribution to ITER, including the KPIs (which are based on Milestones) set for measuring progress and performance of F4E is relevant to report on progress and deviations from plans as well as an important management tool. Milestones are regularly updated and verified. The framework has been further developed since 2013-2014 and supported by IT-based tools helping with saving data, analysing data and creating reports.

The framework covers measures on different organisational levels that monitor progress and performance. In May 2014, an assessment was performed to compare the processing time for a range of key processes before and after implementation of the changes introduced in June 2013. A set of KPIs, from the IMS on working level has been used to run this exercise. The efficiency gain was measured by comparing the number of days spent in performing a given process before and after June 2013. The exercise showed positive results overall.

In the 3rd Annual assessment of F4E for 2014, "the assessors recognise the value of the Integrated Management System and consider it a complex, robust system for efficient and effective management".[217]

Over time, the system has been continuously improved, implemented at F4E, and made available for different services. After the adoption of the F4E Action Plan in 2015, further actions were taken to improve the planning and monitoring activities.

The Integrated Management System (IMS) currently consists of KPIs that work on different levels: corporate level SPI (schedule performance index) and CPI (cost performance index) (CAS, GB, IC), then on sub-level for each service, and finally on working level. Performance

[213] U.S. Department of Energy – U.S. Participation in the ITER Project, May 2016; European Parliament resolution of 27 April 2017 with observations forming an integral part of the decision on discharge in respect of the implementation of the budget for the European Joint Undertaking for ITER and the Development of Fusion Energy (Fusion for Energy) for the financial year 2015 (2016/2194(DEC))
[214] Fusion for Energy (F4E) Assessment and Review – The F4E Review Group (RG), 31 October 2016
[215] Ramboll on the basis of European contribution to ITER survey results 2018; responses to question 10c
[216] F4E Consolidated Annual Activity Report 2016
[217] F4E Annual Report 2014

indicators are automatically extracted and calculated in Primavera system based on input data. CAS, GB and IC are used by Stakeholders, and they are common with ITERs KPIs.

In order to quantify progress made by F4E a number of overall KPI are used:[218]

- Project Plan Milestones;
- PA signatures;
- Calls for tenders published;
- Contract signatures; and
- Contract execution milestones.

F4E staff's opinion regarding the KPIs is divided. The two major KPIs at corporate level measure what they are intended to, but are not a sufficient indication of F4E's own performance – they are more focused on project performance as a whole, and as such they are very relevant on a corporate level, but they can still be used as an indication of whether there is something that needs to be changed.

F4E staff's opinion concerning the working level KPIs is generally positive. Indicators are adequate to monitor progress towards milestones, and identify cost deviations at contract level.

The process for reporting and monitoring is largely supported by interactive IT systems available for most F4E staff. These systems are intimate elements of an Integrated Reporting System (IRS). The IRS, together with policies and strategies of monitoring and reporting, provides a reliable and familiar environment for on-time reporting activities. The IRS also allows availability of reports when needed since the system is on-line. Interviewees from F4E confirmed that usage of interactive systems in combination with F4E units' specific services enables them to meet deadlines and make reports available and the administrative burden was reported in interviews to be reasonable. However, interviews also revealed that the quality of monitoring data could be improved. One possible reason that was mentioned might be not fully corresponding IT systems for monitoring and reporting. There are different reporting platforms in use by different departments that are integrated in IRS, but probably are not fully compatible. Another aspect that has been highlighted as a possible reason is that input data might be not entered correctly because of lack of competence of person carrying out this activity.

4.7 Technology and scientific adaptation

Fusion research started in the second half of the 20th century and the first tokamak began operation in 1958. Today, technological evolution in the field of fusion research is linear and is not moving at a critical speed. However, ITER is a long-term project with a design and construction phase of almost 20 years that has started in 2007 and technological and scientific advances are to be expected during this timeframe. Those can only be incorporated to a very limited extent since the core of the project cannot be changed. This is for two reasons: the governance structure of ITER as agreed on in the IA does not allow for major changes since allocation of machineries and costs have been agreed on in this agreement. Additionally, the nature of the project with the interface based in-kind contributions from different actors requires a steady design.

Within this framework F4E has limited space to adapt for example in the design of smaller components. Interviews confirmed that F4E shows interest in new developments and uses this limited space adequately by adapting procurements to technological and scientific advances. On the other hand, concerns have been raised that the procurement processes might rely too heavily on selection criteria such as references, numbers of years of experience and financial strength for innovative SMEs to be able to join the procedures.

4.8 Contribution to the EU strategic agenda

Desk research indicates that the objectives of F4E – (a) to provide Europe's contribution to ITER, (b) to support the BA, (c) and to contribute to DEMO[219] – and ITER – to demonstrate the

[218] F4E Annual Report 2014, 2015, 2016
[219] As defined in Article 1(2) of F4E's Statutes

scientific and technological feasibility of fusion energy[220] - are relevant to the present European Union's needs and policies.

Currently, F4E focuses largely on the first objective, ITER, which is mainly a research project. For this reason, the research outcomes from ITER can only emphasize the potential of nuclear fusion as a large-scale, safe, green and carbon-free energy source[221][222][223]. Nuclear energy is also expected to be a complement to energy from renewables in the future[224].

Within this context, the objectives of F4E and ITER fit within the wider Strategic Energy Technology (SET) Plan[225] (which highlights Europe as a key player in nuclear fusion) , the main aim of which is to accelerate the development and deployment of low-carbon technologies in accordance with the European Union's 2050 Energy Strategy[226]. The effort devoted by F4E to ITER research and development in nuclear fusion is also in line with the European Commission's Energy Security Strategy[227], which aims to ensure a stable and abundant supply of energy for European citizens and the economy.

ITER is not designed to deliver energy which means that it will not effectively contribute to the 2050 transition to a low-carbon competitive economy[228].

Having said that, ITER project can be seen to support other EU needs and policies, in context of two key features of the Energy Roadmap 2050[229]. First, as a key contributor to European growth and jobs, boosting European technological development[230]. Second, as a lead project in the shift towards a 'Global-EU' research and innovation policy[231], according to its international outlook and broad scope.

Insights from desk research also suggest that the European contribution to ITER is coherent with other European Commission's initiatives and the wider EU policy regarding energy, climate and environment.

The ITER project is supported by several European initiatives (cfr. Roadmap to Fusion Electricity[232], EUROfusion and the Joint European Tours[233], Euratom Research and Training Programme[234]), and vice versa, ITER is in line with the first objective of the Commission's political agenda, that is, 'boosting jobs, growth and investment in future high potential technologies'[235].

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[220] Information Circular (IAEA) INFCIRC/702 Date: 25 April 2007 Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project
[221] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[222] Sanchez, J. (2014). Nuclear fusion as a massive, clean, and inexhaustible energy source for the second half of the century: brief history, status, and perspective. Energy Science and Engineering. 2(4): 165–176
[223] Statement of Bernard Bigot, Director-General ITER International Fusion Energy Organization before the Subcommittee on Energy Committee on Science, Space and Technology (U.S House of Representatives) The ITER Project: Moving Forward. April 20, 2016
[224] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[225] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[226] The EU has set itself a long-term goal of reducing greenhouse gas emissions by 80-95%, when compared to 1990 levels, by 2050. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Energy Roadmap 2050 {COM(2011) 885 final}
[227] Communication from the commission to the european parliament and the Council. European Energy Security Strategy {SWD(2014) 330 final}
[228] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions, and the European Investment Bank. Accelerating Clean Energy Innovation {COM(2016) 763 final}
[229] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Energy Roadmap 2050 {COM(2011) 885 final}
[230] Around 300 companies from about 20 different EU Member States and Switzerland, as well as some 60 research organisations have benefited from this investment on ITER activities. Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[231] European Commission (Ed.). (2012). Global Europe 2050. Luxembourg: Publ. Off. of the Europ. Union.
[232] EFDA (2012) Fusion Electricity. A roadmap to the realization of fusion energy.
[233] European Parliament Research Service (EPRS) (2017) Briefing How the EU budget is spent.
[234] European Commission Decision C(2017)7123 of 27 October 2017. Euratom Work Programme (2018)
[235] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

Most importantly, the ITER project fits in the Framework Strategy for the Energy Union. The Energy Union outlines the three objectives of EU energy policy – security of supply, sustainability and competitiveness[236]. These goals are of concern to the ITER project, yet with a long-term, research-oriented approach. For this reason, nuclear fusion cannot be the sole driver of the transition towards a low-carbon economy, as technological advancements in other energy sources, such as those from renewables, continue to be supported by the EU[237].

Finally, the European contribution to ITER is coherent to EU international obligations under the Paris Agreement and the Sustainable Development Goals. The European Contribution to ITER does not directly support the Paris Agreement goal of limiting global warming to below 2°C above pre-industrial levels by the end of this century due to the late expected realisation of commercially viable fusion power. The European Contribution to ITER can be seen as coherent with the Sustainable Development Goals.

4.9 EU added value

EU added value describes the benefits of an intervention at EU level compared to what could be achieved at level of the EU Member States. Insights from the available data strongly suggest that an intervention at Euratom level is crucial in terms of resource availability as well as for project complexity. Euratom's contribution, consisting of the EU budget (80%) and France (20%), is with 45% share of costs during the construction phase by far the largest compared to other stakeholders on the ITER project. This required amount would present a considerable share of the public R&D funds of even the biggest EU Member States and thus it is very likely that, in the absence of a coordinating role of the EU, two or more EU Member States would need to join the IA to assume the contribution of Euratom which is per IA the host party of the ITER project and has as such not the right to withdraw from the agreement. This would have led or would lead to even higher complexity of the ITER project accompanied by problems that a higher complexity entails.

It can be assumed that a more complex governance structure with several MS being direct stakeholders instead of F4E instead could increase the risk of delays in the project due to the required coordination of more stakeholders. The ITER project is highly sequenced; for example, due to the staged approach, the sequence and duration of future activities are fully mapped in the ITER master schedule[238]. Interviews at IO suggest that this delay in contribution of one party has the potential to significantly disrupt the overall construction process. The complex governance structure of the ITER project and the system of in-kind contributions, even though they are a required given the parties involved and the uniqueness of the project, are a significant challenge for the management of the project.

Economies of scale can be expected from bundling European resources[239] as experience suggests and as assumed in general for EU agencies such as F4E[240]; also based on statements from interviewees and the survey results there is a high agreement that the intervention at EU level provides efficiency gains (e.g. lower administrative and operating costs) compared to what could have been achieved at national level. However, no data is available to underline these assumptions also due to the unique form of the ITER and the system of in-kind contributions which is not easily comparable to other projects. A proxy for this assumption would be a comparison of the efficiency (in terms of comparing the share of administrative costs to the overall budget) of the other DAs which all have smaller shares on the contribution towards ITER. However, no data is available from the other DAs. As described in section 4.3 above the findings of this study suggest that the contribution of F4E is cost-effective, given the complex tasks and high number of procurement procedures and project follow-ups.

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[236] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[237] In the EU, these renewable energies shall account for about 20% of the gross final energy consumption by 2020 and 60% by 2050. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A policy framework for climate and energy in the period from 2020 to 2030. {COM(2014) 15 final}
[238] 2016 Report ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources (ICRG)
[239] MEMO/11/938 Brussels (European Commission) European Commission proposes Supplementary Research Programme for ITER. 21st December 2011.
[240] EU Agencies Network (2016) The EU Agencies working for you. Luxembourg: Publications Office of the European Union, 2016

An important aspect of EU added value in this mega project are influence and political stability. It can be assumed that the participation at EU level, which allowed to take on the largest share in the project in terms of resources, increased the influence of Europe on important aspects of the project such as the site of the construction. Political stability is a crucial factor for such a long-term project and having the EU as a host, which as a union of several nations ensures more stability.

Another important added value factor coming from the intervention at EU level is increased coherence. As stated in Annex I of the IA Each Member and the IO shall ensure access for the IO and the other Members to inventions and other Intellectual Property generated or incorporated in the execution of the contracts provided that inventors' rights are respected. Consequently, all EU Member States and Switzerland, being members of Euratom, have access to the results of fusion related R&D from the ITER project.

As mentioned, the nature of F4E as an EU organisation has an impact on its function. Even though joint undertakings such as F4E are able to define their own procurement and financial rules and organise their own procurement procedures following rules defined by their governing board those rules, however, have to be based on the European Union's financial regulation model[241]. This is seen to be potentially detrimental to the performance (effectiveness and efficiency) of F4E which can be seen as an argument against an intervention at EU level; however, the counterfactual (i.e. the efficiency and effectiveness of MS DAs) is not certain. The recent Impact Assessment study (2018) assessed options of using other legal instruments of delivery mechanisms including as a public-private partnership, joint undertaking (the current legal form), EU agency, intergovernmental organisation, private company and as a European Research Infrastructure Consortium with the results of the impacts though the different legal forms are still pending during the time of writing.

Survey respondents of both groups unanimously agreed or strongly agreed that the objectives addressed by Euratom's participation in ITER continues to require resources and action at EU level.

With regard to resource needs, as mentioned above, the project continues to require considerable funding also after the current MFF. It is estimated that a total of EUR 7.1 billion[242] is needed until 2035 (i.e. until the beginning of high fusion power operation). This amount is unlikely to be covered by one EU Member State and would probably require the involvement of two or more states which entails the abovementioned complications.

4.10 Acceptability

Acceptability is interpreted at two levels, awareness and reputation.

The findings suggest that the awareness of both ITER and Euratom's participation in it is high among their direct stakeholders, i.e. the industry and the fusion community. One proxy for this is the "Industry and Fusion Laboratories Portal"[243], F4E's central interface with potential suppliers and partners (industry and research community) who can register in order to "give them a greater visibility at F4E", to look for partners, and for networking[244]. The graph below plots the development of entries in the database over time.

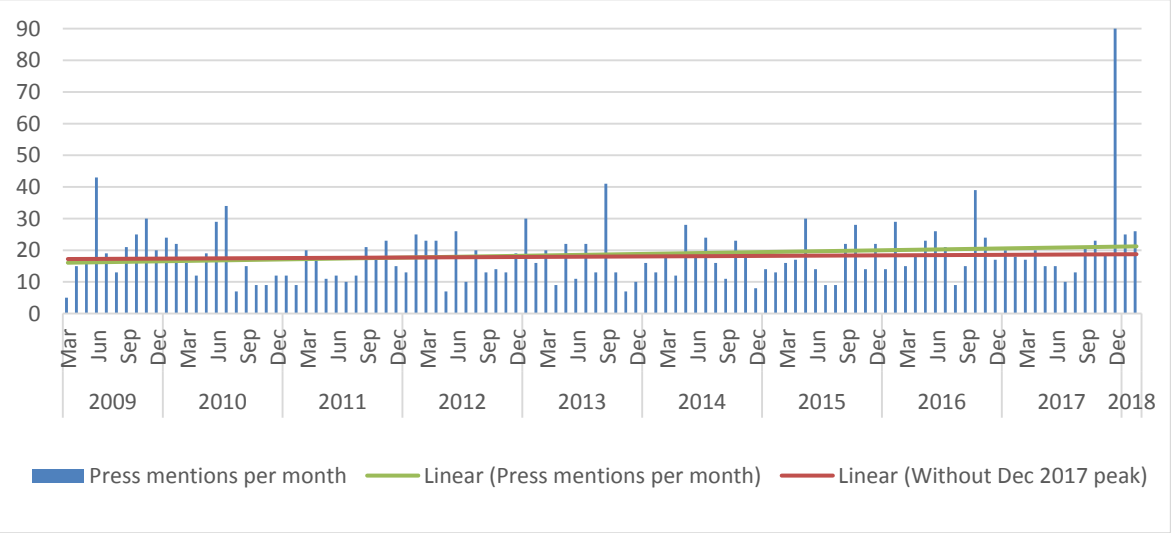
In interviews with stakeholders it was confirmed that the fusion research community is fully aware of F4E and the ITER project which is also evident from ITER being the central facility of the EUROfusion research programme[245] and the close cooperation between the FuseNet Association and the IO with IO being a member of FuseNet.

While F4E and ITER are known among their direct stakeholders there seems to be little awareness by the general public. One proxy for the interest of the general public is press mentioning. Since 2009, IO systematically tracks press mentions around the world concerning the ITER project and the publications per month are plotted in the graph below. In terms of long-term trends[246], the figure shows that media coverage has been relatively constant. A

[241] Supporting Analysis for an Impact Assessment on the Future Funding of the EU Participation in ITER Project and Broader Approach (BA) Activities under the next Multi-Annual Financial Framework
[242] In 2008 values.
[243] https://industryportal.f4e.europa.eu/IP_PAGES/ehome.aspx
[244] Those goals are stated at http://fusionforenergy.europa.eu/procurementsgrants/industryportal.aspx
[245] See https://www.euro-fusion.org/iter-2/
[246] A second trendline is plotted that does not take the December 2017 peak into account.

significant peak is shown in December 2017. This spike follows a press release by IO at about 50% completion of the ITER project[247].

Figure 40 Press mentions of ITER



While the above graph shows that awareness by the press has been constant over the years it does not provide information about the level of interest compared to other projects. The table below shows the followers[248] of IO and its DAs as well as CERN[249] on LinkedIn, Facebook and Twitter. The numbers show that F4E has a good outreach on those platforms compared to other DAs[250].

Table 7 Followers of IO and its DAs as well as CERN on LinkedIn, Facebook and Twitter

	IO	F4E	China	India	Japan	Korea	Russia	USA	CERN
LinkedIn followers	12 912	6 183	/	733	/	/	/	/	72 704
Facebook followers	22 350	1 515	/	301	323	17 774	/	/	647 395
Twitter followers	7 644	4 970	/	/	308	9 516	/	841	2.6 million

However, the comparison with another major nuclear research project, CERN, shows that interest on social media platforms of F4E and ITER is comparably low. Likewise, several interviewees in F4E stated that they feel that F4E is not well known by the general public and that this should be improved.

Interviewees at IO have highlighted the perception that F4E's communication efforts are at times too much focused on F4E and not on the overall project, also in comparison with the communication efforts of other DAs. However, it was also acknowledged that since the DAs are not only about ITER (e.g. F4E also works on the BA) they should be able to market themselves beyond ITER too while focusing on the message that ITER is a group project. IO stakeholders

[247] ITER Organisation (2017). World's most complex machine is 50 percent completed. Press release. https://www.iter.org/doc/www/content/com/Lists/list_items/Attachments/759/2017_12_Fifty_Percent.pdf
[248] On 09 March 2018
[249] European Organization for Nuclear Research
[250] This comparison should be interpreted carefully since the platforms don't have the same penetration rate or are not available in all member countries. Also, followers on a platform is not a fully reliable metric on its own since it is e.g. possible to buy followers on platforms.

also stated the perception that the communication of F4E seems to be too much focused on engineering and procurement progress instead of the unique nature of the ITER project.

In interviews with other stakeholders this point has been advanced with frequent mentioning of F4E's and IO's shortcomings in explaining and highlighting the differences between fission and fusion.

With regard to reputation of the ITER project among the general public there seems to be a perception that recent management reorganisation has restored faith and brought the project back on track as suggested by a non-systematic assessment of the press following a press announcement about half-way towards completion of ITER at the end of 2017.

The trust in F4Es ability to effectively and efficiently deliver Europe's contribution to ITER seems to have increased since the management organisation in F4E as has been stated in interviews with F4E internals, stakeholders in IO as well as other stakeholders. Interviewees from within F4E, both, from management and staff level, have stated that F4Es performance has increased over the last few years and that the atmosphere and motivation has increased notably since the management organisation. Results from the survey confirm this perception with 43% agreement and 14% disagreement from ILOs and 72% agreement or strong agreement from GB members that the perception of the respondents of Euratom's participation in ITER has changed positively over time (Q18a)[251]. This stance is also shared by external stakeholders which have stated repeatedly that that F4E's work has become more effective, results-oriented and reliable after the turnaround in the organisation. There is a general perception in IO that F4E has some systemic issues that have adverse effects on its performance (i.e. its more bureaucratic nature as compared to IO). However, at the same time interviewees at IO consistently state that F4E's reliability as a partner has increased since the 2015 turnaround.

[251] The results need to be interpreted with care since the questions only referred to developments "over time" without specifically referring to the time since the management turnaround. Even though referral was made to this specific timeframe in the introduction of the survey it is possible that respondents did not recall this referral when replying to this question.

5. Conclusions

Effectiveness

Since the new 2016 baseline, F4E has been focusing its effort and resources predominantly on achieving the objective of discharging Euratom's obligations to ITER. Overall, evidence shows that after heavy delays before 2015 the objective of the contribution to ITER is now mostly on track of being achieved within the new baseline. In 2017 F4E ran into minor delays compared to the current baseline. Progress is also being made under the BA, as the three projects are progressing for the most part according to plan. The DEMO objective is currently still in the R&D phase and the staged approach and focus on First Plasma results has decreased focus. Confidence in F4E's ability to achieve its objectives has been restored as confirmed by interviews with F4E, IO, other external stakeholders as well as by the survey.

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. From a more qualitative perspective, participating companies and research institution benefit from taking part in cutting-edge technology projects and networks, which give them an advantage in terms of innovation and competitiveness in key emerging technologies. Firms judge that working on ITER bolsters their reputation as a leading high-tech company and many also have a positive appraisal of the indirect benefits outside of fusion and big science; a view that is shared by the ILO network.

There have been significant efforts made by F4E to address the objectives of the F4E Industrial Policy with focus on assessing the outcomes of the F4E's procurement activities in terms of the tender process and award of contracts in Europe, the extent to which they lead to collaboration, innovation and competition and the scope of participation of SMEs in the procurement procedures, and overall the evaluation concludes that the objectives of the F4E´s industrial policy are met. In spite of this, the participation for companies remains a challenge. The high complexity of the technologies, due to the "first-of-a-kind" nature of ITER, constitutes a barrier for the participation of companies.

The reorganisations in recent years have yielded significant progress on addressing the actions proposed in the 2015 Action Plans; some related activities are still ongoing. The reorganisations and activities of the Action Plan are likely to have a positive impact on the future performance of the European contribution to ITER.F4E is now delivering the European contribution to ITER predominantly following the new baseline and positive changes are observed in project culture and management. There are also indications of improvement in the cooperation between the IO and F4E, as well as some early signs of improved performance within procurement and contract management. However, long-lasting evidence that a sustained improvement of total project performance has been achieved through these activities remains to be seen, as the recent improvements occur in a long-duration project, where the full impact can only be gauged later.

The framework of performance and progress indicators is relevant to report on progress and deviations from plans and is supported by IT-based tools helping with saving data, analysing data and creating reports. However, the data quality from the automated reporting systems need to be improved.

Efficiency

The administrative expenditure has increased through the evaluation period but can be considered cost-effective. The total administrative expenditures over the years 2014-2017 represent approximately 9% (at the level of commitment appropriations) and 7% (at the level of payment appropriations) of the total expenditure. There is an increasing trend in the administrative costs over the 2014-2017 period due to a number of reasons. Overall the split between administrative and operational costs is in line with similar large infrastructure projects of this size and international co-operation. Interviewees from IO and other stakeholders also generally had the perception that the administrative cost of F4E is appropriate compared to the budget that the organisation administers.

F4E fulfils its obligations for in-cash contributions to IO but it is unknow if IO is using the money cost-effectively. The F4E processes for handling in-cash contributions are limited to follow-up on planning and executing the payments, including checking that the requested cash transfers are within the total limits for the European contribution before payments are executed. The IO has

the full decision competence as to how these contributions are spent, and F4E is not mandated to perform any form of follow-up on how these contributions are spent by the IO. Within this framework, the F4E management of in-cash contributions is efficiently carried out, but whether the funds are spent efficiently depends on the IO, and F4E does not have direct insight into this.

Cost-effectiveness of the kind-contributions is inherently linked to the adequateness of the procurement procedures; however, impacts only manifest slowly**.** The procurement strategy previously has tended to place large procurement contracts on a fixed price basis. Experience has shown that this does not always deliver the most cost-effective results, and a revised procurement strategy has been developed towards smaller contracts with more variable components, such as time and materials and incentives – those changes can have both, positive and negative impacts. Quantitatively those impacts can only become evident in the future due to the generally long timeline for large procurements and due to their individual timelines. Cost-effectiveness of the kind-contributions is also subject to other influences and attributability of impacts is challenging. The nature of ITER requiring first-of-a-kind procurements imposes uncertainties and potentially influences the progress and costs. Other potential influences include developments in market and research. The attributability of potential changes in cost-effectiveness of in-kind contributions in the future remains a challenge due to this.

The EU legal framework that is imposed on F4E is not adapted to a large first-of-a kind project like ITER. The financial regulation, the staff regulation for the EC staff and other obligations coming from F4E's status as an EU body have been identified as being potentially hindering the cost-effectiveness of F4E. Impacts include high administrative burden, a lack of flexibility for procurement and project management and high dependence on legal processes. Although some relevant derogations of the legal framework have been obtained already, the regulations applying to F4E could be adapted even further to the needs of a project such as ITER – enabling F4E to act more like an international science organisation and less like an EU institution.

Coherence

Desk research indicates that the objectives of F4E – (a) to provide Europe's contribution to ITER, (b) to support the BA, (c) and to contribute to DEMO[252] – and ITER – to demonstrate the scientific and technological feasibility of fusion energy[253] - are relevant to the present European Union's needs and policies.

The research nature of the European contribution to ITER makes it highly relevant for the EU strategic agenda. The objectives of F4E and ITER fit within the wider Strategic Energy Technology (SET) Plan[254] (which highlights Europe as a key player in nuclear fusion), the main aim of which is to accelerate the development and deployment of low-carbon technologies in accordance with the European Union's 2050 Energy Strategy[255]. The effort devoted by F4E to ITER research and development in nuclear fusion is also in line with the European Commission's Energy Security Strategy[256], which aims to ensure a stable and abundant supply of energy for European citizens and the economy. The ITER project can also be seen to support other EU needs and policies, in context of two key features of the Energy Roadmap 2050[257]. First, as a key contributor to European growth and jobs, boosting European technological development. Second, as a lead project in the shift towards a 'Global-EU' research and innovation policy[258], according to its international outlook and broad scope.

Insights from desk research also suggest that the European contribution to ITER is coherent with other European Commission's initiatives and the wider EU policy regarding energy, climate and environment. The ITER project is supported by several European initiatives (e.g. Roadmap

[252] As defined in Article 1(2) of F4E's Statutes
[253] Information Circular (IAEA) INFCIRC/702 Date: 25 April 2007 Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project
[254] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[255] The EU has set itself a long-term goal of reducing greenhouse gas emissions by 80-95%, when compared to 1990 levels, by 2050. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Energy Roadmap 2050 {COM(2011) 885 final}
[256] Communication from the Commission to the European Parliament and the Council. European Energy Security Strategy {SWD(2014) 330 final}
[257] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Energy Roadmap 2050 {COM(2011) 885 final}
[258] European Commission (Ed.). (2012). Global Europe 2050. Luxembourg: Publ. Off. of the Europ. Union.

to Fusion Electricity[259], EUROfusion and the Joint European Tours[260], Euratom Research and Training Programme[261]), and vice versa, ITER is in line with the first objective of the Commission's political agenda, that is, 'boosting jobs, growth and investment in future high potential technologies'[262].

Most importantly, the ITER project fits in the Framework Strategy for the Energy Union. The Energy Union outlines the three objectives of EU energy policy – security of supply, sustainability and competitiveness[263]. These goals are of concern to the ITER project, yet with a long-term, research-oriented approach. For this reason, nuclear fusion cannot be the sole driver of the transition towards a low-carbon economy, as technological advancements in other energy sources, such as those from renewables, continue to be supported by the EU[264].

Finally, the European contribution to ITER is coherent to EU international obligations under the Paris Agreement and the Sustainable Development Goals. The European Contribution to ITER does not directly support the Paris Agreement goal of limiting global warming to below 2°C above pre-industrial levels by the end of this century due to the late expected realisation of commercially viable fusion power. The European Contribution to ITER can be seen as coherent with the Sustainable Development Goals.

EU Added Value

Insights from the available data strongly suggest that an intervention at Euratom level is crucial in terms of resource availability as well as for project complexity. The funds required for the participation in ITER would present a considerable share of the public R&D funds of even the biggest EU Member States and thus it is very likely that, in the absence of a coordinating role of the EU, two or more EU Member States would need to join the IA to assume the contribution of Euratom which is per IA the host party of the ITER project and has as such not the right to withdraw from the agreement. This would have led or would lead to even higher complexity of the ITER project accompanied by problems that a higher complexity entails.

Economies of scale can be expected from bundling European resources. This factor is assumed in general for EU agencies such as F4E. Also based on statements from interviewees and the survey results there is a high agreement that the intervention at EU level provides efficiency gains (e.g. lower administrative and operating costs) compared to what could have been achieved at national level. However, no data is available to underline these assumptions also due to the unique form of the ITER and the system of in-kind contributions which is not easily comparable to other projects.

An important aspect of EU added value in this mega project are influence and political stability. It can be assumed that the participation at EU level, with allowed to take on the largest share in the project in terms of resources, increased the influence of Europe on important aspects of the project such as the site of the construction. Political stability is a crucial factor for such a long-term project and having the EU as a host, which is as a union of several nations more stable.

Another important added value factor coming from the intervention at EU level is increased coherence. As stated in Annex I of the IA Each Member and the IO shall ensure access for the IO and the other Members to inventions and other Intellectual Property generated or incorporated in the execution of the contracts provided that inventors' rights are respected. Consequently, all EU Member States and Switzerland, being members of Euratom, have access to the results of fusion related R&D from the ITER project.

The nature of F4E as an EU agency is not necessarily conducive to optimal functioning. As highlighted earlier F4E, being an EU agency, is subject to a set of regulations which is seen to be potentially detrimental to the performance of F4E. The recent Impact Assessment study (2018) assessed options of using other legal instruments of delivery mechanisms including as a

[259] EFDA (2012) Fusion Electricity. A roadmap to the realization of fusion energy.
[260] European Parliament Research Service (EPRS) (2017) Briefing How the EU budget is spent.
[261] European Commission Decision C(2017)7123 of 27 October 2017. Euratom Work Programme (2018)
[262] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[263] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[264] In the EU, these renewable energies shall account for about 20% of the gross final energy consumption by 2020 and 60% by 2050. Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A policy framework for climate and energy in the period from 2020 to 2030. {COM(2014) 15 final}

public-private partnership, joint undertaking (the current legal form), EU agency, intergovernmental organisation, private company and as a European Research Infrastructure Consortium with the results of the impacts though the different legal forms still pending during the time of writing.

With regard to resource need, as mentioned above. the project continues to require considerable funding also after the current Multiannual Financial Framework. It is estimated that a total of EUR 7.1 billion is needed until 2035 (i.e. until the beginning of high fusion power operation). This amount is unlikely to be covered by one EU Member State and would probably require the involvement of two or more states which entails the abovementioned complications.

Finally, the member of F4E's Governing Board and Industry Liaison Officers unanimously agreed or strongly agreed that the objectives addressed by Euratom's participation in ITER continues to require resources and action at EU level. However, continued involvement of the EU should be reconfirmed after the construction phase, i.e. in the operational phase of ITER as well as for DEMO.

Acceptability

The findings suggest that the awareness of both ITER and Euratom's participation in it is high among their direct stakeholders, i.e. the industry and the fusion community.

There seems to be little awareness by the general public. One proxy for the interest of the general public is press mentioning. Since 2009, IO systematically tracks press mentions around the world concerning the ITER project. A significant peak happened in December 2017 following a press release by IO about 50 % completion of the ITER project. Else from that the media coverage has been relatively constant and no growing trend can be seen. On social media platforms, compared to other DAs, F4E has a good outreach. However, the comparison with another major nuclear research project, CERN, shows that interest on social media platforms of F4E and ITER is comparably low. Likewise, several interviewees in F4E stated that they feel that F4E is not well known by the general public and that this should be improved.

F4E's communication efforts may appear too much focussed on F4E and not on the overall project, also in comparison with the communication efforts of other DAs. However, it also was also acknowledged that since the DAs are not only about ITER (e.g. F4E also works on the BA) they should be able to market themselves beyond ITER too while focusing on the message that ITER is a group project. IO stakeholders also stated the perception that the communication of F4E seems to be too much focused on engineering and procurement progress instead of the unique nature of the ITER project.

With regard to reputation of the ITER project among the general public there is a perception that recent management organisations have restored faith and brought the project back on track as suggested by a non-systematic assessment of the press following a press announcement about the half-way completion of ITER end of 2017.

Recommendations

Based on the findings a number of recommendations are formulated by the evaluation team.

The procurement rules applicable for F4E should be continued to be adapted to its needs. The character of F4E has changed significantly over its lifetime from a scientific to a procurement management agency and will continue to do so. Also, ITER is unique in its size and objectives. While the procurement rules applicable for F4E have been adapted and improved over the years to take into account the nature of F4E they are still identified as a constraint. In mega projects with significant R&D aspect (such as ITER), agility is important in regard to making changes to concluded contracts, as specifications for a specific contract could turn out to contain errors – or requirements which prove impossible to fulfil. Similarly, interfaces between contracts could turn out to be inappropriate. This could be even more important under the current F4E strategy of tendering a fairly high amount of separate contracts (with many technical interfaces). The F4E procurement rules would limit the degree to which such amendments could be made – primarily to protect the unsuccessful tenderers, at the expense of project performance in terms of time and/or cost. However, the recent derogations to the F4E public procurement rules in regard to amendment of contracts have made these rules more flexible than the rules applicable to the average EC institution – and comparable to the rules applicable to the public bodies in the EU Member States. While further liberalisation could potentially provide some benefits, it might be politically sensitive to provide F4E with more flexibility than EU Member States – only two years after the implementation Deadline for the 2014 Public Procurement Directives. In any event, more flexible rules are not a sinecure: More flexible rules only provide opportunities for improvement through agile contract management.

Even without changing the current rules, it may also be possible to design contracts which provide more flexibility for contract management. However, both would require staff with the right mindset and skills to do so.

Best practice of procurement rules in other big science projects should be identified. It could potentially provide EU added value to perform a comparative study of the different procurement approaches in the various "Big Science" mega projects, particularly in Europe – focusing on key aspects such as applicable rules, commercial approaches and procurement outcomes. Such a study could be used to determine (with sufficient data validity) whether differences procurement approaches have a strong impact on contract performance in the Big Science environment. If this is indeed the case, the study could provide factual support for proposing changes to the framework conditions for F4E, e.g. by further liberalizing the applicable procurement rules.

F4E should improve communication and cooperation with the ILO network. The ILO network is one of the most important interfaces of F4E with the European industry. Yet there seems to be limited understanding in the network about internal functioning of F4E (e.g. ratio behind the award criteria of contracts, reasons for deviations of contracts from prior information notices). Also, compared with the members of the GB, there is a less positive perception of F4Es work and its progress towards reaching its objectives. Communication and interaction with the ILO network should be improved in order to make best use of this important instrument.

F4E should continue to improve communication with IO. While on the one hand there is an appreciation of IO personnel about improvements in the work of F4E there are reservations about its more complex processes and administration. Specifics and processes stemming from the nature of F4E as a public institution should be communicated more clearly and openly towards IO staff to avoid misunderstandings and reservations.

Appendices

6. Annex 1 – Overview of sources for desk research

"Risk Appetite" Policy, 2016 (F4E(16)-GB36-10)

2015 ITER Action Plan – Foundations for a new phase of ITER

6th Annual Assessment of F4E - Report to the Governing Board

Adoption of the Paris Agreement (United Nations Framework Convention on Climate Change, 2015), 22, https://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf.

Annual Accounts of F4E (for the years 2014-2016) as approved by its Governing Board which set out the use of commitments and expenditure

Annual Activity Reports of F4E (covering the years 2014-2016) including the analysis of assessment of F4E's Governing Board

Annual reports from the European Court of Auditors on F4E as well as the outcome of European Parliament discharge procedures

Annual work programmes of F4E for the years 2014-2016

B. P. Heard et al., 'Burden of Proof: A Comprehensive Review of the Feasibility of 100% Renewable-Electricity Systems', Renewable and Sustainable Energy Reviews 76 (September 2017): 1122–33.

Better Regulation Guidelines (SWD(2017)350) and Better Regulation Toolbox

COM(2017)400 Working Document Part III on Bodies set up by the EU having legal personality and Public-Private partnership (p. 578-591)

Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

Commission Delegated Regulation (EU) No 1268/2012 of 29 October 2012 on the rules of application of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council on the financial rules applicable to the general budget of the Union. (n.d.), 111.

Commission Staff Working Document SWD(2017)232 "The ITER Project Status"

Communication from the Commission to the European Parliament and the Council. The Road from Paris: Assessing the Implications of the Paris Agreement and Accompanying the Proposal for a Council Decision on the Signing, on Behalf of the European Union, of the Paris Agreement Adopted under the United Nations Framework Convention on Climate Change'. {COM(2016) 110 final}

Communication from the Commission to the European Parliament and the Council. European Energy Security Strategy {SWD(2014) 330 final}

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A European Strategic Energy Technology Plan (SET-Plan) "Towards a low carbon future" {COM(2007) 723 final}

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A policy framework for climate and energy in the period from 2020 to 2030. {COM(2014) 15 final}

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy {COM(2011) 21 final}

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Roadmap for moving to a competitive low carbon economy in 2050 {COM(2011) 112 final}

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Energy Roadmap 2050 {COM(2011) 885 final}

Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions, and the European Investment Bank. Accelerating Clean Energy Innovation {COM(2016) 763 final}

Council Decision (Euratom) 2015/224 of 10 February 2015 amending Decision 2007/198/Euratom establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it (OJ L 37, 13.2.2015, p. 8–14

Council Decision 2007/198/Euratom establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it (OJ L90, 30.3.2007, p. 58–72)

Council Decision 2013/791/Euratom of 13 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 (OJ L 349, 21.12.2013, p. 100–102)

Council of the European Union. Draft Council conclusions on ITER status and possible way forward. 7 July 2010 (Ref. 11902/10).

Council Regulation (EU, EURATOM) (No 1311/2013 of 2 December 2013). Laying down the multiannual financial framework for the years 2014-2020.

Document F4E(2012)-GB26-10.4 "Industrial Policy of Fusion for Energy"

Draft F4E Annual and Multi Annual Programming Document 2019-2023

EFDA (2012) Fusion Electricity. A roadmap to the realization of fusion energy.

EU Agencies Network (2016) The EU Agencies working for you. Luxembourg: Publications Office of the European Union, 2016

European Commission (2017). The Strategic Energy Technology (SET) Plan. Luxembourg: Publications Office of the European Union.

European Commission (Ed.). (2012). Global Europe 2050. Luxembourg: Publ. Off. of the Europ. Union.

European Commission Decision C(2017)7123 of 27 October 2017. Euratom Work Programme (2018)

European Parliament decision of 27 October 2016 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 2014 (2015/2196(DEC))

European Parliament Research Service (EPRS) (2017) Briefing How the EU budget is spent. http://www.europarl.europa.eu/RegData/etudes/BRIE/2017/608715/EPRS_BRI(2017)608715_EN.pdf

F4E 2014, 2015 and 2016 Final Accounts and Consolidated Annual Activity Reports.

F4E 2016 Highlight Report

F4E 2017 overall administrative expenditure based on F4E Draft Annual.

F4E Multi Annual Programming Document 2018-2022

Final Report of Negotiations on the Broader Approach Agreement from 20 June 2006

Final report of the 2013 ITER Management Assessment, 18 October 2013.

Fusion for Energy (F4E) Assessment and Review – The F4E Review Group (RG), 31 October 2016

Information Circular (IAEA) INFCIRC/702 Date: 25 April 2007 Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project

Interim Recommendations (High-Level Panel of the European Decarbonisation Pathways Initiative), 1,

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Louis M. Rea and Richard A. Parker, *Designing and Conducting Survey Research: A Comprehensive Guide*, Fourth edition (San Francisco, CA: Jossey-Bass, a Wiley brand, 2014), 198.

MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.

MEMO/11/938 Brussels (European Commission) European Commission proposes Supplementary Research Programme for ITER. 21st December 2011.

Milan P, Wächter M and Peinke J (2013) Turbulent character of wind energy. Phys. Rev. Lett. 110 138701

NEA, IEA (2015). Technology Roadmap. Nuclear Energy. 2015 Edition. https://www.iea.org/publications/freepublications/publication/Nuclear_RM_2015_FINAL_WEB_Sept_2015_V3.pdf.

Other publications from F4E including the annual Highlights report on its main achievements

Progress reports by F4E to the Council of the EU (sent also to the EP)

Reflection paper on the Future of EU Finances (June 2017)

Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002. (n.d.), 96.

Report by the expert group charged by the F4E GB in June 2016 to perform an independent review of the capacity of F4E to deliver the European contribution to the new ITER schedule on time and within budget

Report by the expert group charged by the F4E GB in June 2016 to perform an independent review of the capacity of F4E to deliver the European contribution to the new ITER schedule on time and within budget

Report from the Commission to the European Parliament, the Council and the European Economic and Social Committee. Interim evaluation of the Euratom Research and Training Programme 2014-2018 {COM(2017) 697 final}

Report from the In-Depth Independent Review on Risk Management

Report from the In-Depth Independent Review Panel on Freezing the Design Interfaces

Report on the annual accounts of the European Joint Undertaking for ITER and the Development of Fusion Energy for the fiscal year 2016

Reports and other documents prepared by F4E for the meetings of the Governing Board

Reports from the annual assessments by an expert group nominated by the F4E Governing Board

Report of ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources (ICRG)

Sanchez, J. (2014). Nuclear fusion as a massive, clean, and inexhaustible energy source for the second half of the century: brief history, status, and perspective. Energy Science and Engineering. 2(4): 165–176

Statement of Bernard Bigot, Director-General ITER International Fusion Energy Organization before the Subcommittee on Energy Committee on Science, Space and Technology U.S House of Representatives. *The ITER Project: Moving Forward* (April 20, 2016). https://www.pppl.gov/sites/pppl/files/basic_pages_files/ITER%20Progress%20Report_US_Congress_20_April_2016_final.pdf

Supporting Analysis for an Impact Assessment on the Future Funding of the EU Participation in ITER Project and Broader Approach (BA) Activities under the next Multi-Annual Financial Framework.

T. W. Brown et al., 'Response to "Burden of Proof: A Comprehensive Review of the Feasibility of 100% Renewable-Electricity Systems"', Elsevier, no. Preprint (15 March 2018), https://arxiv.org/pdf/1709.05716.pdf.

Trinomics, Value for Money study (2018)

U.S. Department of Energy – U.S. Participation in the ITER Project, May 2016; European Parliament resolution of 27 April 2017 with observations forming an integral part of the decision on discharge in respect of the implementation of the budget for the European Joint Undertaking for ITER and the Development of Fusion Energy (Fusion for Energy) for the financial year 2015 (2016/2194(DEC))

Woyte A, Belmans R and Nijs J (2007) Fluctuations in instantaneous clearness index: analysis and statistics. Sol. Energy 81 195

7. Annex 2– Findings evaluation questions of the mid-term evaluation

This annex presents the findings of the study and it is structured according to the evaluation criteria, namely**, effectiveness, efficiency, relevance, coherence, EU added value** and **acceptability**. The results of the research are presented per evaluation question considering findings from all data sources, i.e. *desk research, interviews and a survey*. This report focuses on the main findings. A synopsis report of stakeholder consultations is in Annex 3.

7.1 Effectiveness

EQ1: To what extent have the objectives of European participation to ITER as stated in Article 1(2) of F4E's Statutes been achieved so far?

SHORT REPLY

The objectives of the European contribution to ITER are threefold: (a) to provide the contribution of the European Atomic Energy Community (Euratom) to the ITER International Fusion Energy Organisation, (b) to provide the contribution of Euratom to Broader Approach Activities with Japan for the rapid realisation of fusion energy and (c) to prepare and coordinate a programme of activities in preparation for the construction of a demonstration fusion reactor [DEMO] and related facilities.

Since the new 2016 baseline, F4E has been focusing its effort and resources predominantly on achieving the first objective (a) and in particular the achievement of the First Plasma in 2025. In December 2017, the IO milestone called "total construction work scope through First Plasma" was half way complete, which is in line with the 2016 baseline, and the achieved ITER credits were on track compared with the new baseline. Overall, evidence shows that while delays were encountered for the period before 2015 – leading to the ITER project turnaround and the new baseline – the objective of the contribution to ITER is now on track of being achieved within the new baseline.

Progress is also being made under the Broader Approach (b), as The Satellite Tokamak Project (or JT-60SA), The Linear IFMIF Prototype Accelerator – LIPAc (IFMIF/EVEDA) Project and the DEMO Design and materials R&D activities are progressing for the most part according to plan.

The DEMO objective is currently still in the R&D phase and the staged approach and focus on First Plasma results is has decreased focus for the preparation of a demonstration fusion reactor (c).

Overall, F4E delivers its yearly targets according to the new baseline and confidence in F4E's ability to achieve its objective has been restored as confirmed by interviews with F4E, IO, other external stakeholders as well as by the survey. However, in 2017 F4E ran into minor delays compared to the current baseline.

INTRODUCTION

The tasks of F4E, as defined in Article 1(2) of the constituting Council Decision (Council Decision 2007/198/Euratom) are as follows:

- To provide the contribution of the European Atomic Energy Community (Euratom) to the ITER International Fusion Energy Organisation;
- To provide the contribution of Euratom to Broader Approach Activities with Japan for the rapid realisation of fusion energy; and
- To prepare and coordinate a programme of activities in preparation for the construction of a demonstration fusion reactor [DEMO] and related facilities including the International Fusion Materials Irradiation Facility (IFMIF).

FINDINGS

Desk research

New baseline and focus on First Plasma (objective a)

The construction of the ITER scientific installation in St-Paul-lez-Durance, France, began in 2007 and was initially expected to last ten years. In June 2013, following a critical independent assessment of the project[265], the ITER Council decided to develop an updated ITER long-term schedule since the previous schedule was considered to be unrealistic as it did not take in due consideration the technical challenges and the real capability of both the IO and the Domestic Agencies (DAs) to deliver their in-kind contributions.

In 2014 and 2015 a new Director General (DG)for the IO was nominated and then confirmed by the ITER Council. The DG proposed several measures to resolve the present difficulties. The most important one was to build an integrated team of the IO and the Members' Domestic Agencies under leadership of the DG.[266]

In November 2015, the IO presented a proposal for the updated ITER long-term schedule to the ITER Council. The ITER Council rejected the proposal due to not taking into account the existing constraints from the members and the lack of sufficient risk mitigation actions to provide confidence in the proposed schedule. The proposal also required significant additional cash contribution from the ITER Members. The ITER council decided to conduct an independent review of the updated schedule and the associated level of resources.

In April 2016, the independent review of the ITER schedule and its associated resources concluded that the long-term schedule is feasible. The reviewers also recommended a 'Staged Approach' as a means of improving focus and optimising resources. This involved having four phases of ITER assembly and operation from First Plasma at the end of 2025 up to Deuterium-Tritium operations in 2035 to reduce technical and budget risks. The milestones in the staged approach would be used to measure the overall progress of the project while also managing and reducing the risks.

The new ITER Baseline was prepared on the basis of the recommendations of the independent review. At the ITER Council meetings in June and November 2016, IO obtained approval *ad referendum* (i.e. subject to domestic processes of obtaining approval) of the schedule, resources and milestones until achievement of the First Plasma in 2025—commonly referred to as the 2016 baseline.[267] The new baseline was finally approved by the ITER Members at the ITER Council meeting in June 2017[268].

In January 2016 the F4E Director launched the strategy called 'Straight Road to First Plasma' (SR2FP) with the overall objective of concentrating resources (funding and staff) on the activities critical to the achievement of First Plasma at the end of 2025. This objective is fully consistent with the updated IO's overall Project Schedule, and is considered as an essential enabler to maximize the chance of project success from F4E's side.[269] To that end, non-First Plasma projects were either suspended or slowed down until after 2020 to make resources available for the critical First Plasma projects and ensure remaining within the EUR 6.6 billion budget (in 2008 values) until 2020 and allowing for a reserve. This approach has now been fully integrated into F4E's planning and operations.

Figure 8 and Figure 9above confirm a strong focus on objective a.

Credit allocation from ITER (objective a)

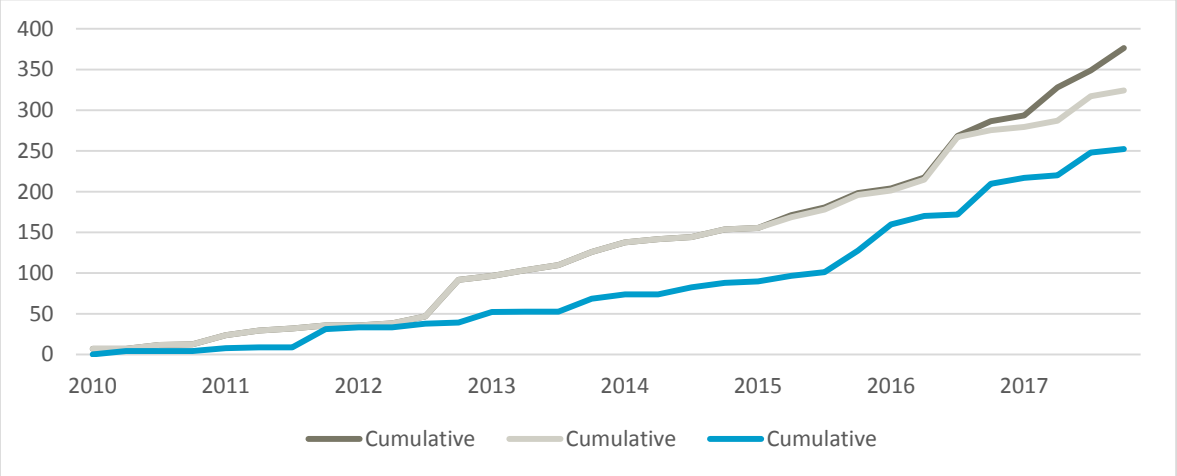
To have a better assessment of the advancement in discharging the EU obligations towards ITER, an Earned Value Management approach has been introduced within the ITER project using the so-called 'ITER credits' that F4E and other DAs receive for the implementation of deliveries. The in-kind contribution to IO is organized through Procurement Arrangements (PAs). Each of

[265] Final report of the 2013 ITER Management Assessment, 18 October 2013
[266] ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources (ICRG)
[267] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[268] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[269] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"

them represents specific work to be performed and delivered to IO. When a PA is defined, a total credit value is assigned to the work foreseen to be performed. In particular, a Credit Allocation profile (CAS) is defined and a fraction of the total value is assigned to some important milestones. F4E receives credit from IO for successfully meeting specifically identified milestones. The IO and each DA agree such credits as part of each PA and providing thus as 'proof' that an in-kind contribution is accepted.

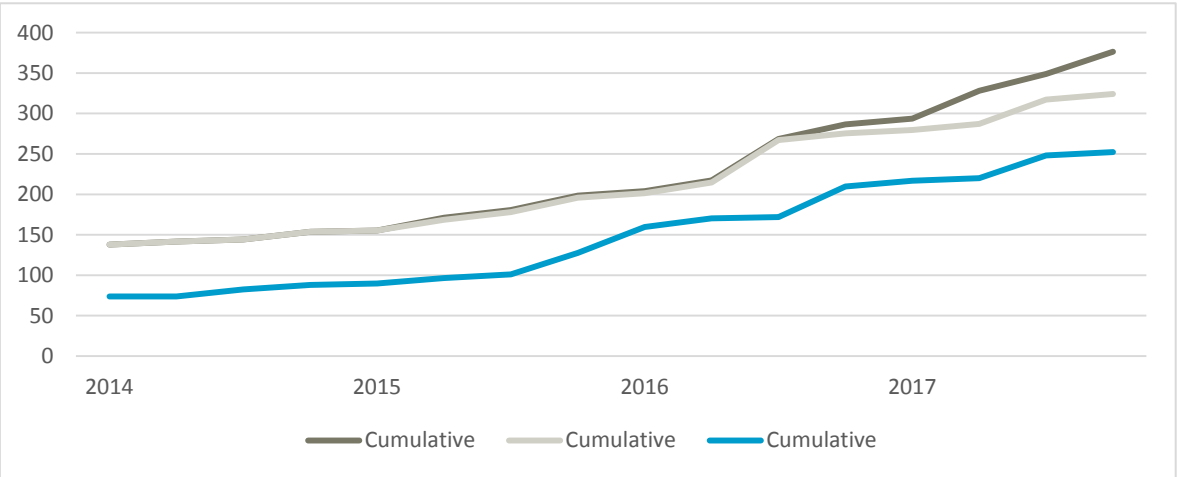
The achieved and released ITER credits compared to the baseline from 2010 – 2017 and 2014 – 2017 are presented in Figure 22 and Figure 23, respectively. The difference between the achieved and the released credits is explained by the fact that once F4E achieves a credit milestone, all necessary data, reports and other information has to be collected and provided to IO. This information is linked to the delivery by the supplier of all the necessary documents and to the F4E approval of these deliverables. Furthermore, IO has to revise and validate the whole set of documents provided in order to confirm such achievement. For this reason, the process can take up to a few months.

Figure 41 ITER credits 2010 - 2017



Source: Data from F4E. The baseline used for this chart is the F4E Current baseline; this is the schedule at the end of September 2016 plus approved baseline changes. The actuals and forecast are those in the latest Detailed Working Schedule from the 2nd Amendment of the 2017 Work Programme.

Figure 42 ITER credits 2014 - 2017



Source: Data from F4E. The baseline used for this chart is the F4E Current baseline; this is the schedule at the end of September 2016 plus approved baseline changes. The actuals and forecast are those in the latest Detailed Working Schedule from the 2nd Amendment of the 2017 Work Programme.

As can be seen in the graphs, during 2017 a small delay can be observed in terms of credits achieved vis-à-vis the 2016 baseline. In the current planning (as of November 2017) the delay is scheduled to be compensated in the coming years and to be fully back on track in 2024.

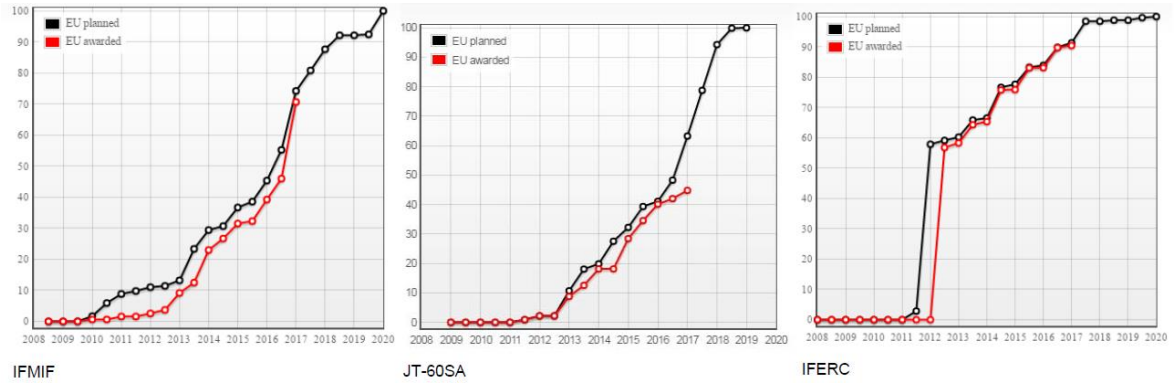
In terms of contracts, as of November 2017, F4E has signed contracts corresponding to 87% of all ITER credits to be obtained from EU side.[270]

Broader Approach (objective b)

F4E coordinates the voluntary contributions (from France, Italy, Germany, Spain, Switzerland, and later, Belgium) and is also in charge of a limited amount of procurement. Member States pledged support for the Broader Approach projects and committed to provide approx. 90% of the EU contributions in-kind.[271]

Overall progress on the Broader Approach projects is satisfactory, as indicated by the ratio of credit awarded under the Broader Approach to credit planned, which was above 88% on average in 2016. Progress in achieving yearly targets is shown in Figure 39 below.

Figure 43 Ratio of credit awarded under the Broader Approach Agreement to credit planned (2016)[272]



As of November 2017, the projects have been achieved to the following extent:[273]

The total commitment of the EU for the Satellite Tokamak Programme (JT-60SA project) amounts to 236 413 BAUA. At end November 2017 the credit awarded to EU is 171 904 BAUA (73%). The remaining credits to be earned until March 2020 amount to 64 509 BAUA (27%).

The total commitment of the EU for the IFMIF/EVEDA Project amounts to 147 330 BAUA. At end November 2017 the credit awarded to EU is 120 656 BAUA (82%). The remaining credits to be earned until March 2020 amount to 26 674 BAUA (18%).

The total commitment of the EU for the IFERC Project amounts to 116 250 BAUA. At end November 2017 the credit awarded to EU is 113 050 BAUA (97%). The remaining credits to be earned until March 2020 amount to 3 200 BAUA (3%).

DEMO (objective c)

Under the objective DEMO F4E´s task is to prepare and coordinate a programme of research, development and design activities in preparation for the DEMO construction. The objective of DEMO is to lay the foundation of a reactor capable of generating several 100MW of net electricity to the grid around the middle of the century as a part of the EU fusion roadmap. DEMO activities are currently limited to those included in the framework of the IFERC project under the BA Agreement. EUROfusion is carrying forward preparatory work for DEMO and F4E is a limited support function. F4E will take over from EUROfusion when the ITER First Plasma will be achieved.[274]

[270] F4E Draft Annual and Multiannual Programme Years 2019-2023
[271] F4E Annual Activity Report 2016
[272] F4E 2016 Final Accounts
[273] F4E Draft Annual and Multiannual Programme Years 2019-2023
[274] F4E Multi annual programming document 2018-2022

Interviews with F4eE

Interviews with F4E staff show that the changes made in the past two years had a positive impact on F4E to achieve the objectives of the European Contribution to ITER. To illustrate such progress, interviewees from F4E mentioned the number of Procurement Arrangements that have been signed with ITER, as well as the number of contracts and progress delivered by the contractors. However, interviewees acknowledge that while much progress is being made for the first objective (a) and the second objective (b), the Staged Approach has resulted in postponing the construction of a demonstration fusion reactor.

Overall, interviewees from F4E have great confidence in their ability to achieve their objectives.

Interviews with IO

IO considered the contribution from EU critical because of the fact that they are the largest contributors and in charge of most critical components. The interviews confirm that there have been problems with delays in EU´s contribution but after the new baseline and the reorganisation the confidence have increased. There is a general perception of the interviewees that F4E is delivering on its objectives even though there are some reservations about efficiency.

Interviews with external stakeholders

External stakeholders are generally aware that the ITER project and European Contribution to ITER encountered serious delays, which where explained either by organisational or political issues. That said, stakeholders generally agree that the reorganisation of the project, as well as the appointment of the new directors at ITER and F4E, have put ITER back on track. This is noticeable by the deadlines and deliverables that are met. It is a commonly shared opinion among interviewees that trust in the project and project organisations has been regained.

The perception of the interviewees is that the projects under the BA are progressing very well. For the DEMO, the perception is that the original timeline was very optimistic and that it is not a focus anymore. Some slow progress of DEMO is however being made under the BA.

Survey

In the survey, the two groups of respondents show similar opinion on F4E's fulfilment of its objectives.

Concerning providing F4E contribution to ITER, 75% of the GB respondeents agreed or strongly agreed that F4E fulfils its objectives towards ITER while; for the ILOs this number amounted to 50% while 25% stated "do not know". .

Concerning F4E contribution to BA, we could recognise that app. 86% of GBs respondents strongly agreed or agreed that F4E successfully fulfils objectives, and app 50 percent of ILOs respondents agreed with the statement.

Concerning F4E contribution related to the objective c), app. 62% of ILOs respondents agreed that F4E is successful in fulfilment of the objective, and app. 48% of GBs respondents represented the same opinion.

Survey with members of GBs and ILOs gave a clear indication concerning which elements are mostly experienced as obstacles in achieving objectives of F4E contribution to ITER. Over 87% of respondents strongly agree or agree that complex procedures prevent achievement. Approx. 57% of respondents expressed that lack of flexibility at F4E to react to unforeseen circumstances is hinder for achieving objectives.

EQ2: What have been the quantitative and qualitative effects on growth, jobs, innovation, enterprises and SMEs linked to the European contribution to ITER?

SHORT REPLY

This question is also in the focus of two separate projects, a "Value for Money study (2018)"and "Supporting Analysis for an Impact Assessment on the Future Funding of EU Participation in ITER Project and Broader Approach (BA) Activities under the next MFF" carried out in parallel. The analysis presented here mentions and complements preliminary results from this study.

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.

From the founding of F4E until end of May 2017[275] contracts with a total value of EUR 3.7 billion have been awarded. From the founding of F4E until 1 January 2017[276] grants with a total value of EUR 99.51 million have been awarded. As can be seen the budget for grants is considerably smaller accounting for only 3% of the budget for in-kind contributions while contracts account for 97%.

From 2014 until end of May 2017 contracts with a total value of EUR 1.06 billion and grants with a value of EUR 12.36 million have been awarded.

More than 1000 companies are registered on F4E industry portal, and according to information from F4E over 150 SMEs are detected being subcontractors for projects with a value over EUR 10 million.

From a more qualitative perspective, participating companies and research institution benefit from taking part in cutting-edge technology projects and networks, which give them an advantage in terms of innovation and competitiveness.

It has been also recognised that F4E contribution to ITER fosters the European innovation and competitiveness in key emerging technologies.

However, there are different opinions on making best use of the industrial and research potential and capabilities, as well as varying opinion on broadening the European base for fusion technology leading to long-term development of fusion.

The Value for Money study (2018) focusses on the economic benefits that have been generated by the EU's participation in ITER to date. The study does not attempt to value the potential future benefits of a clean and plentiful source of energy but instead considers ITER more as a 'big science' project where the ongoing benefits of employment and the development of new and improved technologies and expertise are the focus. The report summarises the main economic effects emerging from the implementation of F4E contracts as significant in terms of job years created, gross value added and in importance for the high-tech industry.

INTRODUCTION

This evaluation question focuses on the quantitative and qualitative effects of ITER in terms of growth, jobs, innovation, enterprises and SMEs. For this question, only some preliminary insights based on procurement data and interviews are presented.

FINDINGS

Desk research

F4E's annual highlight reports emphasise the economic effects of the European contribution to ITER. The rationale is that, as Europe is the largest contributor to ITER, the project represents work and opportunities for the industry, SMEs and fusion laboratories that want to engage. Through their participation, companies and laboratories have the opportunity to broaden their expertise; develop a more competitive profile, get acquainted with an advanced technology and gain access to an energy market promising to generate substantial economic benefits.[277]

The industry, SMEs and research organizations also get opportunities to work together with diverse cutting-edge technologies and build commercial partnerships through Europe's participation in ITER. This leads them to improve their know-how, gain new knowledge that will trigger spin-offs and become acquainted with an energy source promising to pay dividends in the future.[278]

The involvement of industry to produce a lot of high-technology components has offered a one-of-a-kind opportunity to fusion laboratories to offer their know-how and contribute towards a culture of manufacturing. One of ITER's side-like effects has been its capacity to create a pool of excellence and create innovation clusters[279].

[275] Latest available data
[276] Latest available data
[277] F4E Highlights 2014
[278] F4E Highlights 2016
[279] F4E Highlights 2016

Preliminary findings from the study "Supporting Analysis for an Impact Assessment on the Future Funding of EU Participation in ITER Project and Broader Approach (BA) Activities under the next MFF"

Based on economic modelling, the study found that under the current ITER baseline (and the corresponding funding) for the period between 2020 and 2030 the following impacts are to be expected compared to a do-nothing-scenario:

- 14 500 new jobs created
- EUR 3 668 million (in 2015 values) Gross Value Added
- A total of 6 936 new SMEs created

Preliminary findings from the Value for Money study

The Value for Money study (2018) focusses on the economic benefits that have been generated by the EU's participation in ITER to date. The study does not attempt to value the potential future benefits of a clean and plentiful source of energy but instead considers ITER more as a 'big science' project where the ongoing benefits of employment and the development of new and improved technologies and expertise are the focus. The report summarises the main economic effects emerging from the implementation of F4E contracts as follows:

- Spending on ITER by F4E is having significant positive economic impacts compared to no spending, with 34 000 job years created to date, including 7 400 in 2017 alone; and almost EUR 4.8 billion in Gross Value Added to date, with more than EUR 1.1 billion in Gross Value Added estimated in 2017;
- For the majority of contracted parties, implementing F4E contracts is seen as part of their core business. However, for a substantial minority of the contracted parties, an F4E contract is regarded as a stepping stone towards realising longer term spin-offs and benefits;
- Firms judge that working on ITER bolsters their reputation as a leading high-tech company and many also have a positive appraisal of the indirect benefits outside of fusion and big science;
- More than a third of firms have developed new cutting-edge technologies as a result of their work on ITER. Whilst only a handful of these have led to specific spin-offs this is a longer-term process, and one could expect that these benefits will become more visible in future;
- Around a quarter of firms reported that the work on ITER has helped them to access new business opportunities both inside and outside fusion. Consortium working is utilised by almost 40% of firms and many of these firms reporting synergies and new opportunities; and
- Finally, 85% of surveyed firms noted that working on ITER had required them to develop new knowledge and skills, with 25% substantially developing their knowledge and skills.

Value of contracts and grants

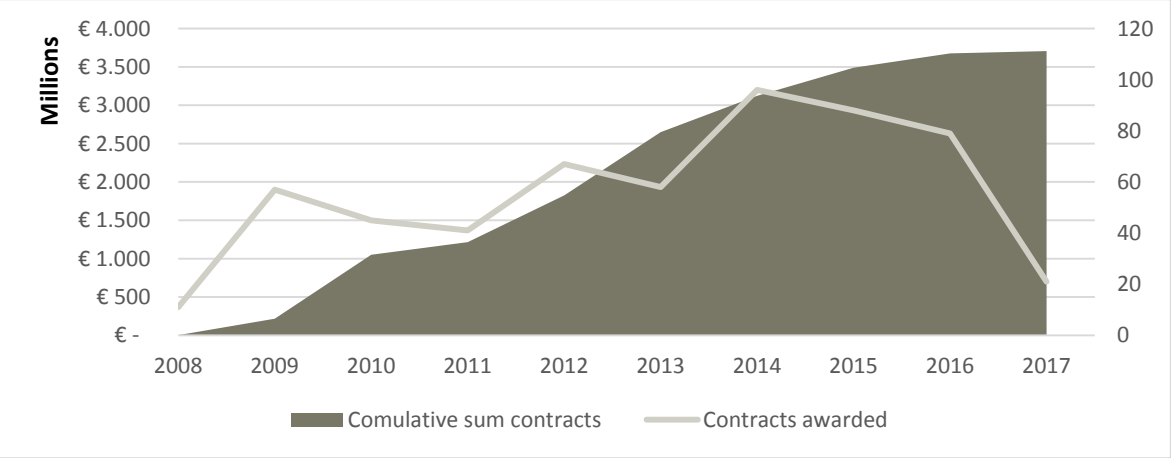
From the founding of F4E until end of May 2017[280] contracts with a total value of EUR 3.7 billion have been awarded. From the founding of F4E until 1 January 2017[281] grants with a total value of EUR 99.51 million have been awarded. As can be seen the budget for grants is considerably smaller accounting for only 3% of the budget for in-kind contributions while contracts account for 97%.

From 2014 until end of May 2017 contracts with a total value of EUR 1.06 billion and grants with a value of EUR 12.36 million have been awarded.

Figure 40and Figure 41below show the number and cumulative value of awarded contracts and grants, respectively, over the abovementioned periods.

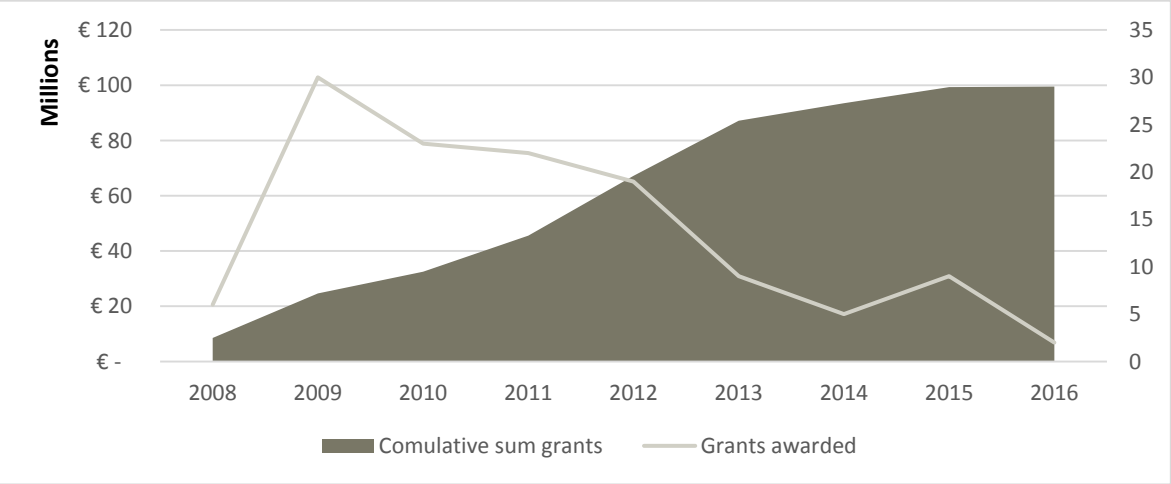
[280] Latest available data
[281] Latest available data

Figure 44 Number and cumulative value of awarded contracts 2008 – May 2017



Source: Data from F4E

Figure 45 Number and cumulative value of awarded grants 2008 – January 2017



Source: Data from F4E

The contracts signed by F4E have involved more than 440 companies and 65 R&D organisations[282]. The companies, including SMEs from about 20 different EU Member States and Switzerland, have benefited from this investment on ITER activities. IO as well as the DAs and industries of other ITER Members have also signed contracts with European industry to support the manufacture of their own components for ITER.[283]

Geographical distribution of contracts and grants

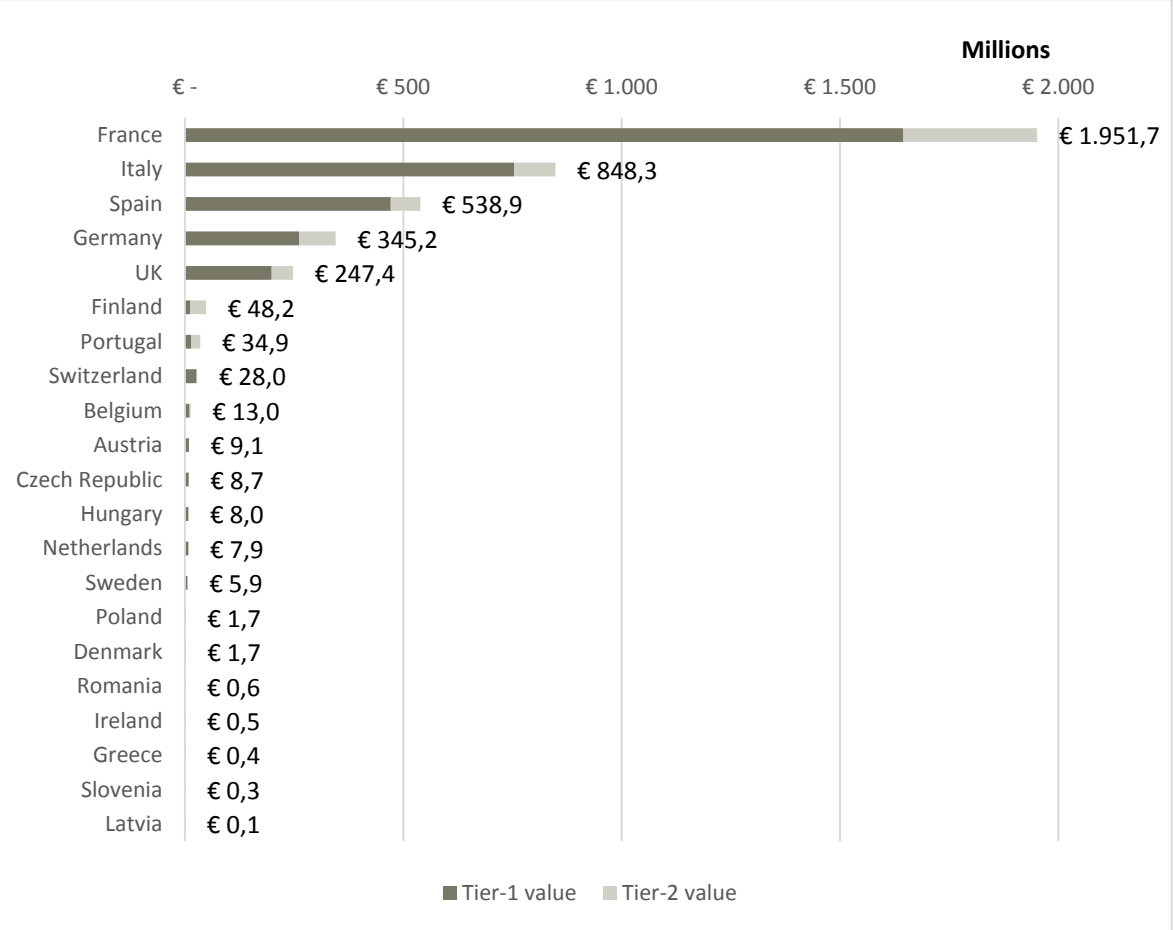
The analysis of the Geographic distribution of value from contracts and grants in Europe from 2008 to 2017 shows that the United Kingdom, Germany, Spain, Italy and France were awarded most of the contracts from F4E. This observation is however nuanced by the fact that these countries represent largest economies in Europe and also that the industries in different MS has different availability of expertise in fusion. Also, since many of the current contracts include civil

[282] Highlights 2016
[283] Commission Communication COM(2017)319 to the European Parliament and the Council on "the– EU Contribution to a Reformed ITER Project"

engineering, companies established in the host state France and neighbouring countries have a competitive advantage for those contracts[284].

The figure below shows the geographical distribution of awarded contracts in EU MS. The data includes values of direct contracts (Tier 1) and main sub-contractors (Tier 2). F4E asks contractors assigned contracts with a value above 10 million EUR to identify the subcontractors used and their share of the total contract value. The numbers are based on the last annual exercise from F4E (presented end of 2017). The total value of Tier 1 and Tier is presented in the graph.

Figure 46 Geographic distribution of value from contracts and grants in Europe



Source: Data from F4E

F4E does not make any positive discrimination to favour geographical spread, as the EU public procurement and competition rules apply.

Interviews with IO

Some particular effects related to F4E contribution to ITER in the host region have been mentioned, such as creation of work for local people working on-site, increasing industry capacity, especially in the region. Also, different side effects have been mentioned such as creation of new schools in the region, economic development by renting houses, establishing agencies and connected to this logistic and infrastructure.

[284] In turn France as ITER host state covers 9.09% of the total costs of the ITER construction phase, excluding expenditure related to Transportation, Test Blanket Modules and administrative expenditure.

Interviews with other stakeholders

Interviewees have highlighted the complementarity of ITER and BA in terms of procurements. Most of the companies working with BA have already worked with ITER before and are thus able to consolidate their gathered expertise. This consolidation aspect is very important because it makes sure that European industries stay leaders in this field and that knowledge does not get lost again. For this it is important to have a continuity in investment.

Survey

Concerning aspect of F4E contribution to ITER making best use of the industrial and research potential in line with competition rules, we found that 41% of respondents agree with the statement while at the same time 39% disagree.[285]

Approx. 29% of ILO respondents agree that F4E contribution to ITER broadens the European industrial base for fusion technology for the long-terms, but over 43 % disagree with the statement. The opposite result has been found among GB respondents, where 82 % agree with statement, but only 14 % disagree.[286]

Generally, we found opinion differences between ILO and GB respondents, but also within ILO and within GB. This indicates that perception of aspects is not homogenous, and the reason should be investigated further.

EQ3: Do the observed effects address the objectives of the European contribution to ITER?

SHORT REPLY

Given that EQ1 and EQ2 address the specific objectives of the European contribution to ITER via F4E and the attainment of general objectives/impacts, this evaluation question is interpreted in terms of the objectives of the industrial policy for the European contribution to ITER via F4E and the general objective of having European leadership in the project.

There have been significant efforts made by F4E to address the objectives of the F4E Industrial Policy with focus on assessing the outcomes of the F4E's procurement activities in terms of the tender process and award of contracts in Europe, the extent to which they lead to collaboration, innovation and competition and the scope of participation of SMEs in the procurement procedures, and overall the evaluation concludes that the objectives of the F4E´s industrial policy are met.

Procurement rules ensure efficient allocation of contracts, despite barriers to matching the capacity and technology requirements. A procurement strategy, consisting in unbundling large procurement packages and assessing the market capacity, is in place to ensure participation of as many economic operators as possible, including SMEs. However, the geographical spread of the contracts and grants remain unequal across countries.

F4E engages actively with the industry and research communities to promote participation in calls for tenders and calls for proposals. This includes cooperation with the network of Industrial Liaison Officers (ILOs) and the European Fusion Laboratory Liaison Officers (EFLO) Network. This also includes communication and information initiatives to raise awareness and capability. In this respect, the Industry Portal is pivotal.

In spite of this, it is recognised that the participation to ITER activities remains a challenge. The high complexity of the technologies, due to the "first-of-a-kind" nature of ITER, constitutes a barrier for the participation of companies. Also, the process covering procurements and contracts and leading to the outcomes is experienced by interviewees as rather long and complex.

There is a strong common positive opinion about generating jobs, growth and innovations as a result of European contribution to ITER.

[285] Q6 B - Ramboll on the basis of European contribution to ITER survey results 2018
[286] Q6 C - Ramboll on the basis of European contribution to ITER survey results 2018

Survey questions regarding two aspects, i.e. equal share of effects across EU Member States as well as the extent to which the procurement practices of F4E benefit SMEs to the extent possible, differ dramatically between respondents from ILOs and GBs.

INTRODUCTION

The question relates to the three objectives of F4E´s industrial policy in the first phase, defined in 2012 by the F4E Members (Euratom Member States, Switzerland, and Euratom)[287]:

- Objective 1. Deliver the European contributions to ITER and the Broader Approach within the agreed budget and schedule making best use of the industrial and research potential and capabilities of all F4E members, in line with competition rules
- Objective 2. Broaden the European industrial base for fusion technology for the long-term development of fusion as a future energy source and to ensure a strong and competitive European industrial participation in the future fusion market
- Objective 3. Foster European innovation and competitiveness in key emerging technologies to further the development of the Innovation Union and its impact at the international level

To execute its tasks related to ITER, F4E provides Euratom's direct ("in-cash") financial contribution to the IO's costs and the "in-kind" contributions of components. For the latter, F4E organises procurement procedures in view of concluding contracts mainly with European industries. F4E then supervises the implementation of these contracts and ensures the work is performed according to the agreed scope, schedule and cost. F4E also issues calls for proposals for research and other pre-fabrication activities in view of concluding grants. These grants are mainly signed with European research centres and laboratories.

The effects of the European contribution to ITER have been described in EQ2. In this question analyse these effects in relation to the objectives of F4E's industrial policy.

FINDINGS

Desk research

Procurement strategy of F4E

When assessing procurement data, it should be taken into consideration that ITER is a one-of-a-kind project. This means that, among other things, it is a challenge to get companies, especially smaller companies, to manage the technologies that are needed and see a long-term economic gain. This in turn poses a risk of technical monopoly that should be avoided. Also, the large size of contracts makes it difficult to involve SMEs. Finally, while it is a legitimate concern that the economic effects of the European contribution to ITER should be spread over the whole EU, it is not necessarily the most efficient and desirable from an economic perspective.

In order to increase competition in the procurement procedure, large contracts are often divided into smaller ones. At the breakdown, a market analysis and assessment are made to ensure that more than one company can bid.

In 2014, negotiated procedures constituted 58 % of the 67 operational tendering procedures launched in 2014. In 2015 the negotiated procedures constituted 45 % of the 84 operational tendering procedures. In spite of the renewed communication and dissemination efforts the F4E has done during 2016 the figures for negotiated procedures remained similar to previous years notably in the context of integrating the new Financial Regulation. The majority of these procedures were for low value negotiated procedures performed below the EU public procurement publication threshold and fully in line with the F4E financial regulations. Negotiated procedures with low value represent around 40% of F4E's yearly number of contracts (2016: 41% in number and 0.8% in value; 2015: 43% in number and 0.3% in value) but only correspond to around 1% of the annual budget.[288]

[287] F4E(2012)-GB26-10.4 "Industrial Policy of Fusion for Energy"
[288] Report on the annual accounts of the European Joint Undertaking for ITER and the Development of Fusion Energy for the fiscal year 2016

Geographical spread of contracts and grants

As reported in EQ2, there is an imbalance in the geographical spread of contracts and grants. F4E does not have a policy in place to ensure that money invested by a MS is absorbed by national industry (as e.g. the European Space Agency or CERN have); instead, F4E selects contracts on best value for money.

Getting the industrial and research community involved

In order to maintain a pipeline of potential suppliers, F4E has an Industry Portal where companies can register and receive information about contract and grant opportunities and procedures. Over 1000 companies have registered in the F4E Industry Portal, which shows significant interest in ITER as a potential customer.

A network of Industrial Liaison Officers (ILOs) from different European countries has also been established. The network works together with F4E to raise awareness regarding funding schemes and ways to get involved in the ITER project. A series of information days and seminars are held throughout the year to present the roadmap of the different procurement packages and facilitate partnerships between companies.

In order to develop and strengthen its relationship with European Fusion Laboratories who possess much of the expertise needed to build some of the systems being provided by Europe to the ITER project, F4E established in 2014 a European Fusion Laboratory Liaison Officers (EFLO) Network.

With the help ILOs and EFLOs, F4E has been trying to reach out to industry, SMEs and R&D organisations to involve them in delivering the European contribution to ITER.

Interviews with F4E

Interviews with F4E staff shed light on the importance of the purchasing strategy of F4E to ensure it is in line with competition rules, while encouraging the participation of the European industry and guaranteeing that the best use of the industrial and research potential and capabilities are met.

F4E does not make any positive discrimination to favour, for example, the geographical spread or SMEs. F4E operates under EU procurement rules and complies with competition law, and interviews with F4E staff have shown a high level of awareness of, and commitment to, these rules.

Against this backdrop, interviews with F4E staff have identified various activities that contribute to address the objectives of F4E's industrial policy:

- F4E tries to un-bundle procurement packages where they can, in order to get more competition in their tenders; also not to force large consortiums, which would not be cost-effective. This leads to a fairly large number of contracts per year, with a budget typically in the tens of millions rather than hundreds of millions, which generates more competition and facilitates participation of SMEs. It was noted that large projects such as the construction of buildings are coming to an end, while small scale projects are in their start up phase. This should lead to a situation where more SMEs will be interested in taking part in the ITER project.
- F4E provides grants to involve the research and innovation community. However, grants are very small part of the European contribution to ITER. Also, they were interesting for research organisations in the early stages of projects, during the design phase, but interest has decreased as entering into the manufacturing phase.
- F4E keep the industry informed about progress, needs and upcoming opportunities. This includes market related activities, B2B meetings, and conferences with industry and member states representatives
- The role of the F4E Industry Portal to maintain a pipeline of potential suppliers has been mentioned. According to interviewees, the portal receives a lot of interest.

The clear majority of companies registered in the Portal are European, which is consistent with the fact that F4E can normally only procure from economic operators established in Euratom countries (EU and Switzerland), unless there are specific justifications. There are no such geographical constraints on subcontractors, but certain criteria must be met to allow subcontracting from outside Euratom countries – and for certain core activities subcontracting is not possible.

It was mentioned by interviewees that during and shortly after the 2008 financial crisis, there was high interest in participating in F4E procurements. However, since the economic recovery,

companies have become less interested and prefer focusing more on their core activities. According to interviewees, this however indicates that the European contribution to ITER reinforces the resilience of the European economy. It was mentioned that the job contribution of ITER amounts to 28 000, which is a significantly positive contribution to the European economy.

Interviews with external stakeholders

Interviews with stakeholders focused on contribution in terms of innovation and technology development. Stakeholders insisted on the fact that ITER is a research-driven process that makes ITER a unique project but also contributes positively to research excellence and competitiveness. While the end goal of ITER is to contribute to the EU energy policy in terms of reduction of CO_2 emissions and security of supply, the research and innovation benefits justify the project in itself already. One example provided by an interviewee was the fact that dealing with such high levels of temperatures and reactions requires the development of new, cutting-edge materials, which is a goal that could be pursued in its own. A common view from the interviews with stakeholders is that F4E and ITER have a large impact on research and innovation in Europe.

This remark actually does not only apply to grant, but to contracts as well. When taking part in ITER projects, companies have to push their innovation to a higher level, which in turn gives them access to new markets and clients. According to interviewees, companies get involved not only because of the revenue of the contracts, but also for getting access to European technology networks and increase their knowledge and visibility.

Concerning the geographical spread of contracts and grants, stakeholders share the perception that the value is not equally shared across Europe. However, this does not appear to be an issue for the industry: F4E projects are technically very challenging and require the best of technological capabilities to be successful.

However, it was mentioned that contracts and grants are complex and time consuming, which hampers competition. According to interviewees, in some cases, there is limited competition, due to a lack of competences and resources to take part in procurement processes. Some interviewees also raised the question of differences in labour costs across the EU, which might be an obstacle for competition.

Survey

Survey with members of GBs and ILOs gave a clear indication regarding opinion on following aspects:[289]

- The European contribution to ITER generates growth, jobs and innovations
- Effects are shared equitably across EU Member States
- The procurement practices of F4E benefit SMEs to the extent possible.

83% of all respondents throughout GB members and the ILOs strongly agreed or agreed with the statement 1.

71% of ILO respondents and 58% of GB respondents strongly disagree or disagree with statement 2; on the other hand, 29% of ILO respondents and 15% of GB respondents agree with the statement.

The two groups of respondents had very different views on if the procurement practices of F4E benefits SMEs the extent possible. Not a single ILOs respondent agreed with this perception. App. 19% of GBs respondents reply that procurement practices benefit SMEs.

EQ4: To what extent did the recent management reorganisations at ITER and F4E impact the performance of the European contribution to ITER?

SHORT REPLY

The reorganisations in recent years have yielded significant progress on addressing the actions proposed in the 2015 Action Plans, although some related activities are still ongoing. The

[289] Q5 of Ramboll on the basis of European contribution to ITER survey results 2018

reorganisations and activities of the Action Plan are likely to have a positive impact on the future performance of the European contribution to ITER.

As seen in EQ1, after having faced significant delays under the 2010 schedule, F4E is now delivering the European contribution to ITER following the new baseline and positive changes are observed in project culture and management. All the project milestones due have been completed and the pace of construction is progressing steadily both on-site and off-site. There are also indications of improvement in the cooperation between the IO and F4E, as well as some early signs of improved performance within procurement and contract management.

However, long-lasting evidence that a sustained improvement of total project performance has been achieved through these activities remains to be seen, as the recent improvements occur in a long-duration project, where the full impact can only be gauged later.

It should also be noted that many of the completed activities may *indirectly* enable better performance, but not directly *generate* better performance - and many other factors may also impact the development over time in the performance of the European contribution to ITER. Therefore, a certain and direct causal link between activities and performance may not be possible to establish.

INTRODUCTION

In 2013, the "ITER Management Assessment" report by William Madia & Associates[290] revealed several problems in the management and organisation of the ITER project and identified 11 recommendations for urgent action, including among others the need to create a project culture, install a strong Nuclear Safety Culture and to develop a realistic ITER Project Schedule[291]. Also in 2013, the European Parliament's Budgetary Control Committee published a report by Ernst & Young which revealed some shortcomings in the organisation of F4E.

Subsequently, Action Plans for implementing changes in ITER and F4E were proposed and adopted in 2015, in order to address the identified issues and improve performance of the execution of the ITER project.

Among the key actions proposed in the ITER Action Plan[292] were:

- Deeper integration between the ITER Central Team and the DAs, including F4E
- Integrated Project Teams to manage important in-kind contributions
- A Central Fund to cover cost increases due to future changes to the technical specifications

The F4E Action Plan[293] lists 11 planned actions, which can be summarized in the following main categories:

- Addressing critical, open audit recommendations
- Establishing an appropriate level of risk-appetite (acknowledging that "a risk-averse approach at local level is often generating high risks at global level")
- Improving tools and procedures and limiting the use of "legacy" tools and practices – including reviewing and adjusting the use of grants to focus on "pure" Research & Development, implementing a cost management system, improving and expanding project and contract management tools (e.g. earned value reporting using the ITER Credit Allocation System milestones, better integration of Primavera and a Contract Tracker tool);
- Strengthening contract follow-up activities by closer monitoring, including by more presence on supplier's premises and the ITER site
- Closer alignment and coherence between ITER IO and F4E activities, and organisational realignment within F4E, including internal F4E staff reorganisations where some staff is moved to Cadarache
- Investigating the possibilities for more flexibility within the implementing regulations with regard to contract management.

This is a very short overview of the many action points mention in the Action Plan. Some of these changes are addressed in further details as part of other evaluation questions.

[290] Final report of the 2013 ITER Management Assessment, 18 October 2013.
[291] The outcome of this exercise, the new baseline, is assessed in the next question.
[292] F4E 2015 ITER Action Plan
[293] F4E 2015 F4E Action Plan

FINDINGS

Desk research

The available documents support that the IO and F4E have both carried out significant improvements of their functioning and co-operation in relation to the European contribution.

The 2016 assessment of the ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources[294] concluded that the turnaround in IO led to "substantial improvement in project performance, a high degree of motivation, and considerable progress".

The latest annual independent assessment of F4E[295] stated that "F4E has made significant progress in management and performance over the past 2-3 years towards its objective of delivering the European in-kind contribution to ITER"[296].

Also, the 2015 ITER Management Assessment[297] which was presented in 2016 concluded that an improved performance of the management of both, IO and the ITER project is observable.

In May 2016 the United States Department of Energy published a report[298] discussing the considerations that led to the recommendation that the U.S. remain a partner in the ITER project through FY 2018, at which time the U.S. will reassess the project. One major factor that played into the decision was a significant improvement in project management since early 2015.

Specific improvements in ITER includes improvements to risk management,[299] introduction of Integrated Project Teams between F4E and ITER IO,[300] reviewing and refining the interface management process,[301] the setting of milestones against which progress can be measured, and the creation of a Reserve Fund to provide a fairer distribution of cost increases due to changes in the technical specifications.[302]

Within F4E, specific improvements include the introduction of milestones for monitoring the status of the execution of the European contribution; substantial strengthening of risk management and risk mitigation[303] including the establishment of a cost risk register[304] and a "risk appetite" policy[305]; structured follow-up on audit recommendations, leading to the closing of several open issues, and achieving all pending actions on previous internal audit recommendations in June 2016[306]; implementing a new organisational structure in October 2016, which includes a separate Project Management Department (already established in 2015) and an integrated CFO/Commercial Department[307]; and initiating a co-operation with other European first-of-a-kind science projects in order to "foster a single market for large scientific projects, which is more stable and larger and therefore more capable of attracting companies' interest".[308]

The use of grants by F4E has reached a fairly low level,[309] and is now mostly (though not exclusively) planned to be used for Research & Development.[310] This coincides with the project

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[294] Report of ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources (ICRG)
[295] 6th Annual Assessment of F4E - Report to the Governing Board
[296] The second and third objective of F4E, i.e. the Broader Approach and work towards DEMO are not covered by this assessment.
[297] The source document has not been accessible to the project team and the information has been taken for the document "US Participation in the ITER Project"
[298] U.S. Department of Energy – U.S. Participation in the ITER Project, May 2016
[299] Report from the In-Depth Independent Review on Risk Management
[300] Report by the expert group charged by the F4E GB in June 2016 to perform an independent review of the capacity of F4E to deliver the European contribution to the new ITER schedule on time and within budget
[301] Report from the In-Depth Independent Review Panel on Freezing the Design Interfaces
[302] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[303] Fusion for Energy (F4E) Assessment and Review – The F4E Review Group (RG), 31 October 2016
[304] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[305] "Risk Appetite" Policy, 2016 (F4E(16)-GB36-10)
[306] F4E 2016 Annual Activity Report
[307] F4E Annual Activity Report 2016, pp. 76-77
[308] European Court of Auditors: Report on the annual accounts of the European Joint Undertaking for ITER and the Development of Fusion Energy for the financial year 2016
[309] F4E 2016 Annual Activity Reports
[310] F4E Annual and Multiannual Programme - Years 2018-2022

activities leading up to First Plasma having progressed to a more industrial stage, as the design of major components has been completed.

Interviews with F4E

Interviews with F4E staff confirmed the importance of the progress mentioned in the literature, and provided updated information on recent activities. According to the interviewees, several internal activities have been carried out in order to improve F4E's ability to support the efficient execution of the contribution to ITER, through addressing issues addressed in the Action Plan and improving the organization's general performance. This includes:

- Projects to streamline the internal organization and procedures, e.g. by reducing the number of separate actors necessary to take decisions, while simultaneously clarifying the responsibilities of the individual actors. In the area of procurement, this includes a project to reduce the lead time (from identified need to completed contract), which led to the reduction of reviewers of tender materials. In the area of contract management, this includes the introduction of the Commercial Officer function (yet to be implemented) – implying that each project team will have a single commercial representative, rather than three people, involved in verification of each contract deviation.
- There are described processes for every major recurring activity of F4E, through an F4E Process Manual. There is an awareness that process descriptions have currently reached different levels of maturity, and that the less mature processes should be developed further.
- Improvement of risk management activities, including heightened focus on risk management from senior executives. This includes the use of contract-specific risk assessments.
- Implementation of the Integrated Reporting System. Data quality in the system was mentioned as an issue, but this was not perceived as a performance problem with the system, but rather as due to inconsistent quality of data inputs.
- Expansion of contract management software to the DAC system, which has been used to manage all contract deviations since 2016. Additional contract management functionality is due to be implemented in 2018.

Many F4E interviewees had a perception that organizational performance has improved over the past 2 to 3 years, citing factors such as a more professional approach to risk and contract management.

In terms of in-cash contributions to ITER, F4E interviewees clarified that IO has the full decision competence as to how these contributions are spent, and therefore F4E does not perform any form of follow-up on the use of these contributions. F4E's control processes are therefore limited to follow-up on planning and executing the payments, including checking that the requested cash transfers are within the total limit for the European contribution, before payments are executed.

Interviews with IO

Interviews with ITER IO staff confirmed that there had been positive progress since the 2015 Action Plans, but also highlighted that there is still room for further improvement:

- An improvement in the cooperation between the IO and F4E, and an increased team spirit, was definitely perceived to have taken place in recent years, further to the Action Plans. However, it was also mentioned that there was still room for further improvement in this regard, particularly on the technical levels of the co-operation.
- Communication from F4E was considered to have improved – though F4E could still improve communication in relation to performance issues in areas within F4E's responsibilities.
- It was mentioned that the IO and F4E tend to have different priorities, which may at times have a negative impact on performance. The IO priorities were perceived as quality and adherence to schedule, while cost was perceived as a main priority for F4E. This could lead to issues which did not benefit the ITER project as a whole.
- Several IO interviewees indicated that there was still scope for improvement of the focus and efficiency of the F4E organisation, which was viewed as too focused on administration, while lacking sufficient resources with technical and project management competences. Over-reliance on lawyers was specifically mentioned as a source of problems.
- F4E's approach to procurement was perceived as very similar to that of EU institutions such as the European Commission, due to very similar regulations, as well as a lot of staff drawn from EU institutions. This was not considered to provide a suitable procurement framework

for a project with the characteristics of ITER. The use of F4E of a high number of separate contracts was also viewed as a cause of deviations and delays.
- In terms of contract management, F4E was perceived as behaving in a very restrictive way, compared with the other DAs, often citing limitations in their regulations, which provided difficulties for realizing the needs of the project. Some (not all) interviewees did note that improvements had been made in recent years.
- The increased F4E on-site presence in Cadarache was considered to have positive effects, but it was also noted that additional co-location would provide an opportunity for further improvement.

The 10-month delay for the tokamak building – which is within F4E's responsibility – was noted several times. This was announced shortly after the new baseline. Work is ongoing to find ways to avoid this delay having an impact on First Plasma by 2025.

Survey

The survey indicated that:[311]

- The two groups of respondents had very different views on the impact of the management reorganisations. More than 80% of GB respondents replied that the management reorganisations had a positive impact on the performance of the European contribution to ITER. Not a single ILO respondent agreed with this perception, and a minority of respondents even disagreed.
- When asked whether certain factors prevented the European Contribution to ITER from more successfully achieving its objectives, "complex procedures" was mentioned by more than 80% respondents, and "flexibility to react to unforeseen circumstances" was mentioned by 60% of all respondents (with fairly similar results for the two groups of respondents).
- A majority of respondents indicated disagreement with the statement that the "procurement practices of F4E benefit SMEs to the extent possible". All ILO respondents disagreed with this statement, whereas 37% of GB respondents disagreed.

It should be noted that the survey was directed to a small group of people, and that the response rate of ILOs to the survey was quite low; this may affect the validity of the results.

Other external stakeholders

While a positive development in the European Contribution was indicated, potential for further improvement was also noted:

- Although some relevant derogations had been obtained already, the Regulations applying to F4E could be adapted even further to the needs of a project such as ITER. Staff regulations were mentioned as a potential hindrance for adapting the F4E staffing fast enough to accommodate the changing needs of the project.
- ILOs indicated specifically that there was still scope for reducing the barriers for SME participation in tenders.
- In telephone interviews with other external stakeholders, it was perceived that in previous years, bids taking due account of risks and eventualities were at a disadvantage in F4E procurement procedures due to their higher prices. However, an improvement in evaluation criteria in recent years was noted.

EQ5: Analysis of the Performance Framework

SHORT REPLY

This question refers to the adequacy of the Performance Framework of the European Contribution to ITER, including the KPIs set for measuring progress and performance of F4E.

[311] Ramboll on the basis of European contribution to ITER survey results 2018; responses to questions 3, 5c, 8 and 10c

Based on a desk review and interviews, the evaluation concludes that the framework of performance and progress indicators is relevant to report on progress and deviations from plans. The framework established between 2013-2014 is a very important management tool. Milestones are regularly updated and verified. The framework has been further developed since 2013-2014 and supported by IT-based tools helping with saving data, analysing data and creating reports.

The framework covers measures on different organisational level that monitor progress and performance. It was necessary to implement KPIs that respond to needs on different organisational levels, an in particular on the working level, in order to ensure that relevant performance information can be monitored. However, the needs have been changed over time, so measures should be taken to control whether indicators are relevant or not.

In that respect, there are some recognised weaknesses such as: some KPIs were more relevant in the beginning of the improvement process, and are more difficult to use and analyse in the current situation; KPIs on working level e.g. number of contracts signed/man-month is recognized as one element that should be adjusted to the current needs, since according to interviewees it is no longer a critical issue for F4E to have a contract signed quickly.

INTRODUCTION

Weaknesses in Fusion for Energy's organization and management with respect to monitoring and control strategies were first identified in 2009 in an internal management assessment of Fusion for Energy initiated by the Governing Board, which underlined in particular the lack of a project culture and industrial expertise. A series of changes in the management and governance structure followed.

The Governing Board took first measures to better prepare the meetings of the Governing Board, but also to follow up specific critical issues between meetings. The Governing Board also endorsed the involvement of the Commission Internal Audit Service (IAS) in Fusion for Energy as from 2012, complying with a recommendation of the Court of Auditors and thus establishing the IAS as the internal auditor of Fusion for Energy. In parallel, the Commission also re-structured the working relations aiming at establishing efficient and transparent coordination and exchange of information between Fusion for Energy and the services of the Commission.[312]

The "Overall control and monitoring strategy" was adopted in 2012, introducing a framework to ensure that operational and financial transactions are implemented according to the highest standards expected for such a project as ITER.[313]

After the adoption of the F4E Action Plan in 2015, further actions were taken to improve the planning and monitoring activities.

FINDINGS

Desk research

The Integrated Management System (IMS) currently consists of KPIs that work on different levels: corporate level SPI (schedule performance index) and CPI (cost performance index) (CAS, GB, IC), then on sub-level for each service, and finally on working level. Performance indicators are automatically extracted and calculated in Prima Vera system based on input data. CAS, GB and IC are used by Stakeholders, and they are common with ITERs KPIs.

In March 2014 a new Planning and Monitoring Unit was created which reports directly to the Director and is in charge of improving F4E planning and monitoring activities. The new unit provides synergy between the basis for project management (i.e. planning, costing, risk evaluation, monitoring and reporting) and the overall budget cycle. F4E identified a strong need to develop a more robust function for planning and monitoring to support appropriate and timely actions across all levels of the organisation. The new unit is responsible for the overall process of establishing and maintaining schedule baselines, including management of their changes, as well as for developing standards, processes and tools. It is responsible for ensuring efficient interaction with the project teams in preparation of the monthly monitoring meetings

[312] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[313] F4E Annual Report 2014

chaired by the director. Finally, this unit provides valuable reports to all levels of F4E and continues to develop the reporting system and project management tools at F4E.[314]

In May 2014, an assessment was performed to compare the processing time for a range of key processes before and after implementation of the changes introduced in June 2013. A set of KPIs, from the IMS on working level has been used to run this exercise. The efficiency gain was measured by comparing the number of days spent in performing a given process before and after June 2013. The exercise showed positive results overall[315].

In the 3rd Annual assessment of F4E for 2014, "the assessors recognise the value of the Integrated Management System and consider it a complex, robust system for efficient and effective management"[316]

Over time, the system has been continuously improved, implemented at F4E, and made available for different services.

In order to quantify progress made by F4E a number of KPI are used:[317]

- Project Plan Milestones;
- PA signatures;
- Calls for tenders published;
- Contract signatures; and
- Contract execution milestones.

A comparison of the planned and achieved indicators runs in the end of each year.

Interviews with F4E

Interviews with F4E staff using the IMS (KPIs and Milestones) on a daily basis have been carried out. Interviews contributed to the evaluator's understanding and assessment of the tool:

The top-level milestones are the "ITER Council milestones", which are those pertaining to the ITER project as a whole; the next level milestones are "Governing Board milestones", focusing only on the EU contribution; below this, there are thousands of "working-level milestones", which are intermediate milestones used internally by the F4E management for monitoring. Since the implementation of the Prima Vera on-line system, each project has the possibility to create and follow (online) its own milestones. According to F4E interviewees, milestones are easy to measure and easy to control; also, the system is easy to use for scheduling and making adjustments.

ITER has two core KPIs: SPI and CPI. Schedule Performance Indicator (SPI) is based on the working-level milestones; it is monitored in terms of how many of the planned milestones are achieved by the planned dates. Cost Performance Index (CPI) is used at corporate level; it is monitored in terms of how close it is to the budget ceiling agreed by the ITER Council.

Besides the overall KPIs, almost all Services of F4E have their own KPIs for internal F4E uses. An example from the Procurement unit is the number of contracts signed per man-month.

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[314] Progress reports by F4E to the Council of the EU (sent also to the EP)

[315] Some exemplary results for key activities are:

• Approval of Technical specification documents (–50 %): The time needed to approve technical specification documents has been reduced by 50 % (44 days before June 2013, 22 days after).

• From Publication to Award (–59 %): This significant time reduction is the result of the simplification and elimination of bottlenecks achieved through decentralisation, even though there is an additional burden due to the strengthened controls. The net result shows a reduction in duration by 59 % (227 days before June 2013, 92 days after).

• From Publication to Signature of contract (–53 %): with the introduction of the simplified workflow and streamlined processes, the overall efficiency gain resulted in a reduction in duration of 53 % (275 days before June 2013, 128 days after).

• Pre-financing payment (–59 %): The time needed to process such payments has been reduced by 59 % (88 days before June 2013, 33 days after).

• Payments related to delivered goods and services (–20 % and –38 %): the duration from the reception of the last deliverable(s) up to payment has been reduced by 20 % (down from 97 days before June 2013 to currently 78 days).The duration from the approval of the deliverables(s) up to the reception of the invoice has decreased by 38 % (from 24 days before June 2013 to currently 15 days).

[316] F4E Annual Report 2014

[317] F4E Annual Reports 2014, 2015, 2016

F4E staff's opinion regarding the two core KPIs is divided. The two major KPIs measure what they are intended to, but are not a sufficient indication of F4E's own performance – they are more focused on project performance as a whole, and as such they are very relevant on a corporate level, but they can still be used as an indication of whether there is something that needs to be changed.

F4E staff's opinion concerning the working level KPIs is generally positive. Indicators are adequate to monitor progress towards milestones, and identify cost deviations at contract level. However, some of them would need to be adjusted to current needs, which can be different from 2014. One example mentioned particularly is KPI on working level is *number of contracts signed/man-month*. Respondents expressed opinion that it is not a critical issue to have a contact signed quickly, since there is a clearly developed framework presenting minimum and maxim of time for contract signing.

7.2 Efficiency

EQ6: To what extent has the European contribution to ITER (in kind and in cash) been cost effective?

SHORT REPLY

This question contributes to evaluating the extent to which the European contribution to ITER (in kind and in cash) has been cost effective during the years 2014-2017. Desk research indicates that the procurement strategy previously has tended to place large procurement contracts on a fixed price basis. Experience has shown that this does not always deliver the most cost-effective results, and a revised procurement strategy has been developed towards smaller contracts with more variable components, such as time and materials and incentives. During the procurement a minimum of 2-4 tenders are required per contract. If there are too few tenders F4E has the possibility to go outside the Euratom agreement and have international tendering to avoid technical monopoly and achieve more competitive tenders. A general remark from the interviews is that a more competitive purchasing between relevant companies internationally could have been more cost-effective compared to an in-kind contribution like the EU contribution. It is however the opinion from the interviews with F4E and IO representatives that under the given framework and existing pre-conditions, the European contribution to ITER is managed efficiently. The ITER project runs over 25 years and this evaluation is for the period of 2014-2017. It is very difficult to evaluate the cost effectiveness over a very short time in a mega project like ITER. During this period a new organisation has been put in place with a new F4E director in charge. The results from all interviews are that it has been a very positive change in project culture and more efficient cooperation in the F4E organisation and with the IO. However, the long-term results are too early to recognise-

INTRODUCTION

Europe supports ITER with 46% of construction costs and 34% of operating costs, deactivation and decommissioning of the plant and preparation of the plant. Most of the ITER components are to be manufactured by each of the ITER parties and contributed in-kind to ITER through domestic agencies. Europe's domestic agency is F4E, which will provide ITER components to about one third of the total value of the facility. The sum of the EU in-cash and in-kind contribution is a fixed amount corresponding to the 45.46% of the total project costs during the construction phase. F4E pays its share in yearly contributions[318].

The Euratom contribution to ITER consists mainly of buildings, magnets, ships and other technical components. While F4E is responsible for procurement and contracting, the industry delivers directly to ITER IO, which performs acceptance and acknowledges credits to F4E. F4E is also responsible for the coordination of the European contributions to three joint fusion projects carried out in collaboration with Japan, known as the "Broader Approach", which will offer Europe better insight in this field. The items designed and delivered to IO are reported as cost in the accounts and not as assets under construction. Approximately 90% of the project is built

[318] Annual and multiannual Programme – Years 2018-2022

by in-kind contributions. In-kind contributions have been classified into 85 procurement "packages" which were divided among the seven parties to the ITER Agreement.

FINDINGS

Desk research

To ensure a fair cost sharing of ITER by "value", around 90% of the project is built by in-kind contributions. In-kind contributions have been classified into about 85 procurement "packages" which were divided among the seven parties to the ITER Agreement.

The most significant challenges for F4E are related to its major task of delivering those in-kind contributions to ITER through procurements and grants.

From the founding of F4E until end of May 2017[319] contracts with a total value of EUR 3.7 billion have been awarded. From the founding of F4E until 1 January 2017[320] grants with a total value of EUR 99.51 million have been awarded. As can be seen the budget for grants is considerably smaller accounting for only 3% of the budget for in-kind contributions while contracts account for 97%.

From 2014 until end of May 2017 contracts with a total value of EUR 1.06 billion and grants with a value of EUR 12.36 million have been awarded.

The in-kind contribution is organised through Procurement Agreements. Each of them represents specific work to be performed and delivered to IO. When a PA is defined, a total credit value is assigned to the work foreseen to be performed. In particular a Credit Allocation profile (CAS) is defined and a fraction of the total value is assigned to some important milestones. F4E receives credit from IO for successfully meeting specifically identified milestones.

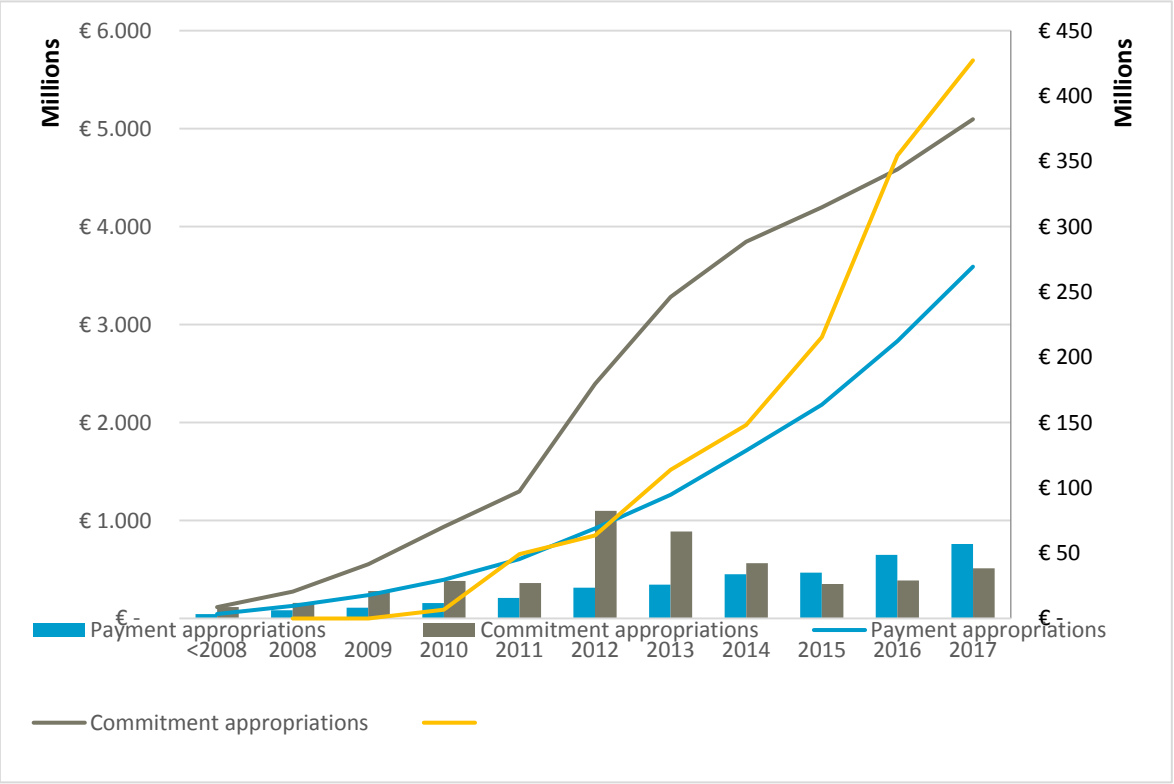
The following graph shows the development of creditable F4E expenditure (i.e. expenditure for the construction of ITER for which IUA are released) against the development of the value of achieved IUA.

It should be highlighted that the graph has limited informative value in terms of absolutes. This means, that it should not be used to compare the value of achieved IUA against the expenditure. To recall, IUA are achieved when in-kind contributions are delivered to IO. Before this, they have been procured and produced, a process, which can last several years. Thus, there is a considerable delay between the achievement of IUA and the commitment and payment of funds.

However, the graph shows a positive trend in terms of achievement of credits compared to expenditure for ITER construction.

[319] Latest available data
[320] Latest available data

Figure 47 Trend of achieved ITER Credits (value of IUA in EUR million in current values[321]) and F4E expenditure for ITER construction (EUR million in current values)



Source: Expenditure data from Draft Annual and Multiannual Programme Years 2019-2023; Data on achieved Credits provided from F4E's internal monitoring and reporting system.

Interviews with F4E

Interviews with F4E's project managers indicate that under the given framework and existing pre-conditions the European contribution to ITER is managed efficiently. However, the framework is intrinsically expensive in itself.

The contracts for large components such as vacuum vessel, toroidal field coils and poloidal field coils are new technology deliverables and as such difficult to evaluate if designed cost effectively. In the new baseline focus is on achieving First Plasma 2025 and these contracts are scrutinised and very cost effective according to the project managers.

A general remark from the interviews is that the European contribution to ITER is a political co-operation in a global research and development project of a future new source of energy that has never been done before. To evaluate the cost effectiveness in a traditional sense is very difficult. The ITER project cover over 25 years and this evaluation is for the period of 2014-2017. It is very difficult to evaluate the cost effectiveness over a very short time in a mega project like ITER. During this period a new organisation has been put in place with a new F4E director in charge. The results from all interviews are that it has been a very positive change in project culture and more efficient cooperation in the F4E organisation and with the IO. However, the long-term results are too early to recognise-

[321] Plotted is not the sum of achieved ITER Credits (IUA) but rather the value of the achieved IUA in EUR through multiplying the sum of achieved IUA in a given year by the normalised conversion factor from the respective year as provided by F4E.

Interviews with IO

Interviews with ITER staff confirmed that there is a much better cooperation and improvement in communication on all levels in the organisations between F4E and IO management. A general comment is that F4E is a joint undertaking and that all member states are stakeholders and it is necessary to assure a proper communication between F4E and IO management because all of the countries are contributing to the European budget. After the reorganisation and the actions introduced by the new director there has been much better progress and collaboration. The interviews reflected that it has resulted in a more efficient project organisation and collaboration between F4E and ITER, but the long-term effects remain to be seen.

EQ7: To what extent are the costs of the European contribution to ITER (administrative and operational) justified?

SHORT REPLY

This question covers an evaluation of the administrative and operating costs evolution over the years 2014-2017 in addition if the amount and share of administrative and operational costs are proportionate to the scope of the project and justified. Gathered data from desk research indicates that as the ITER project over the years 2014-2017 is developing and entering into execution phase of construction and manufacturing of larger contracts there is an increased need for personnel for monitoring. The administrative and operating costs have been increased in line with this development.

Field studies at F4E and interviews of representatives from F4E and the IO reflect different opinions regarding the administrative expenditure for F4E compared to the IO. The F4E organisation is built on the framework for F4E and the co-operation between the member states which imposes a larger administration while the IO has separate Domestic Agencies with their own independent organisations. One reflection is also that F4E are responsible for the procurement and contract management which also requires more administration.

Our conclusion is that the total administrative expenditures, analysed in payment appropriations annually, including staff and operating expenditure, over the years 2014-2017 represent approximately 9% (at the level of commitment appropriations) and 7% (at the level of payment appropriations) of the total expenditure of F4E, which is in line with similar large infrastructure projects of this size and international co-operation. In comparison Norra Länken, one of the largest road tunnel infrastructure projects in northern Europe, with 15 kilometres of rock and concrete tunnels under the City of Stockholm, had 8% project management and administration of the total investment of EUR 1.6 billion over the ten years of project implementation.

FINDINGS

Desk research

Administrative expenditures

The Administrative expenditure is composed of Fusion for Energy functioning and operating costs, mainly related to staff.

Administrative expenditures consist of two main categories:

- Staff expenditure: This expenditure is recurrent and mainly based on the establishment plan (salaries)
- Operating expenditure: This expenditure is based on the needs for the execution of the ITER and Broader approach projects as described in the "Final Report of Negotiations on ITER Implementation, 1 April 2006 and in the Broader Approach Agreement

The administrative expenditure is a non-dissociated appropriation (commitment and payment appropriations are in unison); therefore, any transfers or budget amendments are authorised or adopted in both commitment and payment appropriations[322].

[322] F4E 2016 Final Accounts

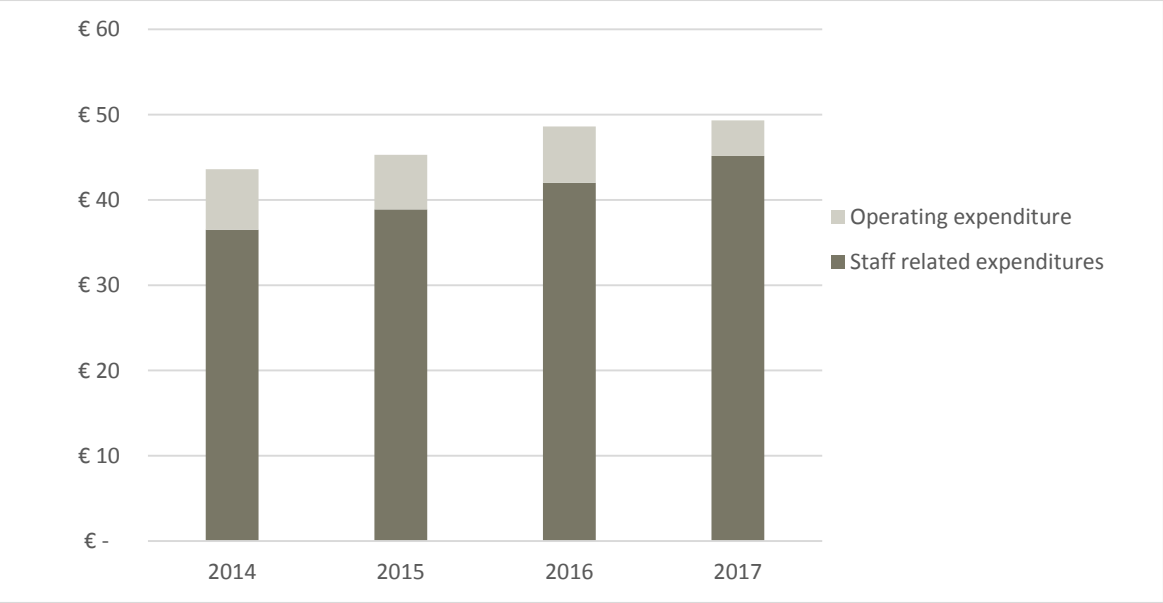
As stated in the Consolidated Annual Activity Report 2016[323], a global increase of the administrative expenditure has been needed compared to the earlier years 2014-2015 due to mainly three factors:

- The increase of salaries for 2016 (+1%), after three years of decrease due to the evolution of the coefficient related to the cost of living in Spain, while the vacancy rate was maintained at low level all along the year;
- The transfer of staff from Barcelona to Cadarache, where the cost of living is about 25% higher;
- The increase in the number of manufacturing contracts to be followed up, in order to take into account the recommendations of F4E's Management Assessors, as endorsed by the Governing Board (i.e. F4E staff should be more present at the manufacturing sites).

The staff expenditure increases proportionately over the years 2014-2017 in line with increased number of manufacturing contracts and construction activities on site in Cadarache. The operating costs are kept on the same level over the same period.

The total administrative expenditure and distribution between staff expenditure and operation expenditure for the years 2014 – 2017 is plotted in Figure 44below. It should be noted that the 2017 accounts at the time of writing are not closed yet and that the 2017 figure is based on information from the Draft Annual and Multi Annual Programming Document 2019-2023.

Figure 48 Overall administrative expenditure and distribution staff and operating expenditure (current value in EUR million)



Source: F4E 2014, 2015 and 2016 final accounts. 2017 overall administrative expenditure based on F4E Draft Annual and Multi Annual Programming Document 2019-2023

The IO in the earlier years built up an organisation for the procurement of the EU in-kind components and in later years the organisation has evolved into execution phase and construction activities, thus a larger project organization is needed for monitoring of the manufacturing of the large components and construction on site in Cadarache.

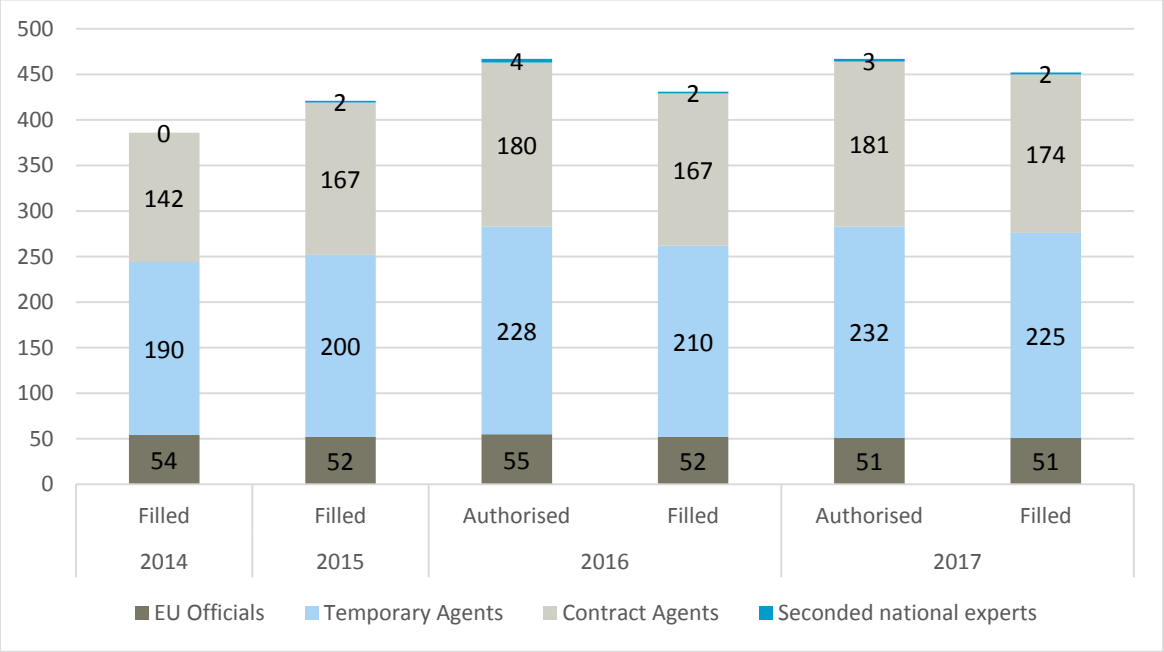
The staff expenditure increases proportionately over the years 2014-2017 in line with the increased number of manufacturing contracts and construction activities on site in Cadarache. The operating costs are kept on the same level, EUR 6.4-7.1 million over the same period.

[323] Consolidated Annual Activity Report 2016

The total administrative expenditures, including staff and operating expenditure, analysed in payment appropriations annually, over the years 2014-2017 represent approximately 9% (at the level of commitment appropriations) and 7% (at the level of payment appropriations) of the total expenditure of F4E, which is in line with similar large infrastructure projects of this size and international co-operation. In comparison Norra Länken, one of the largest road tunnel infrastructure projects in northern Europe, with 15 kilometres of rock and concrete tunnels under the City of Stockholm, had 8% project management and administration of the total investment of 1,6 billion € over the ten years project implementation.

Figure 45below shows the development of staff numbers between 2014 and 2017.

Figure 49 Annual staff numbers 2014 - 2017[324]

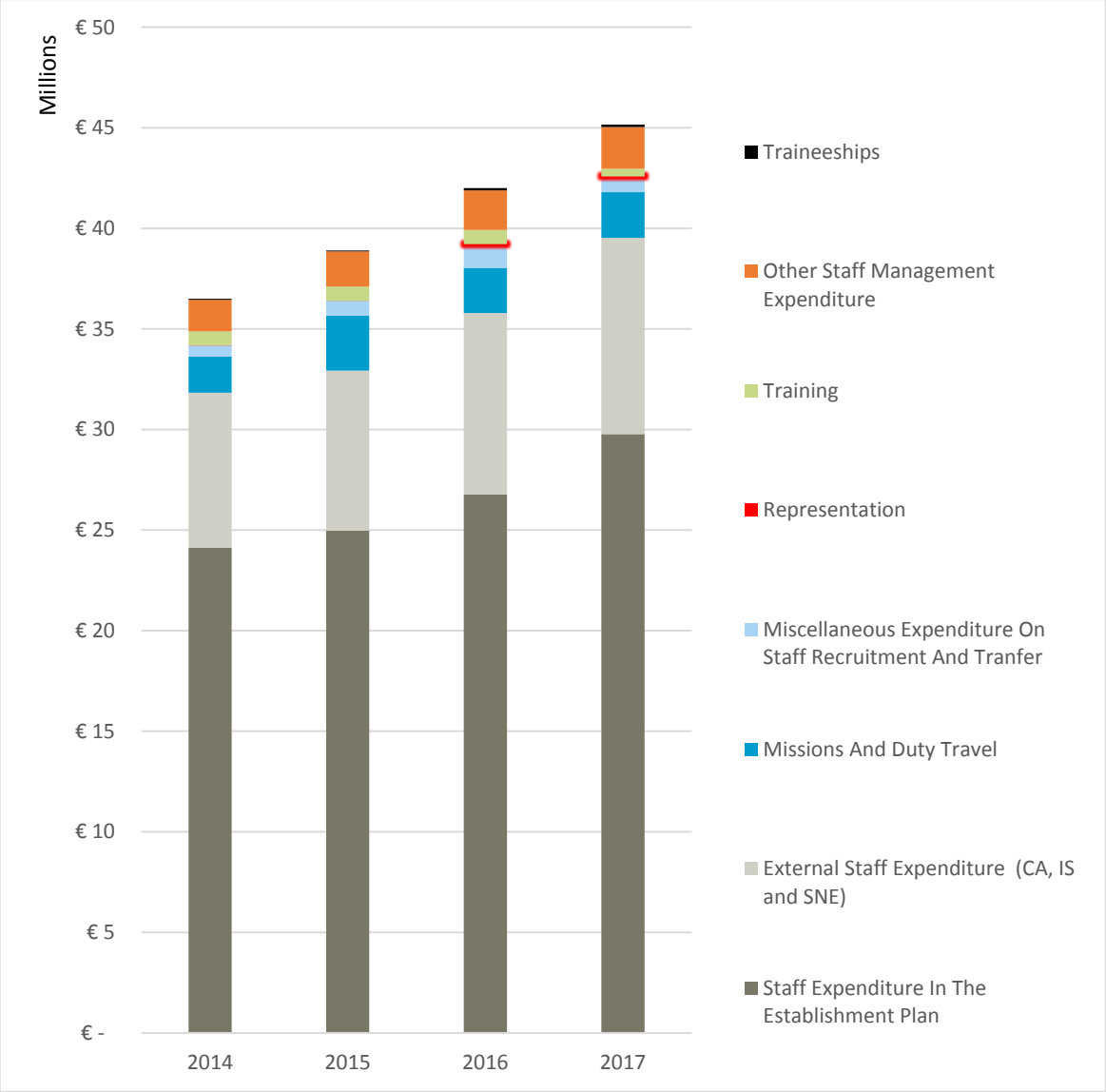


Source: F4E Annual report 2015 (for 2014 data); Annual and Multi Annual Programming Document 2018-2022 for 2015 – 2016 data; Annual and Multi Annual Programming Document 2019-2023 for 2017 data

In Figure 46 and Figure 47 staff expenditure and operation expenditure for the years 2014 – 2017 are broken down in more detail.

[324] For 2014 and 2015 no data is available on authorised positions

Figure 50 Staff expenditure (in EUR million)[325]

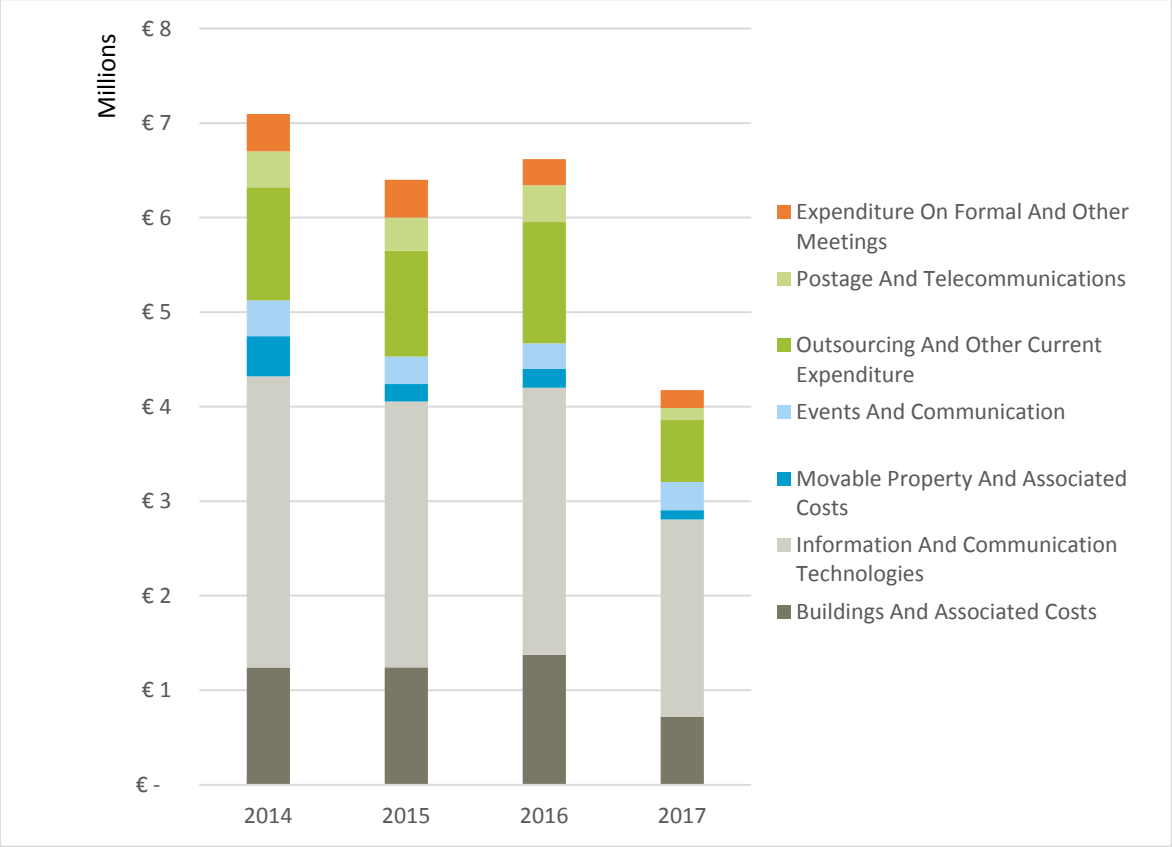


Source: F4E 2014, 2015 and 2016 final accounts. 2017 overall administrative expenditure based on F4E Draft Annual and Multi Annual Programming Document 2019-2023

The salaries for F4E staff (expenditure in the establishment plan) includes the total gross salaries including allowances, social contributions, taxes and pension contributions and employer's contribution for social security.

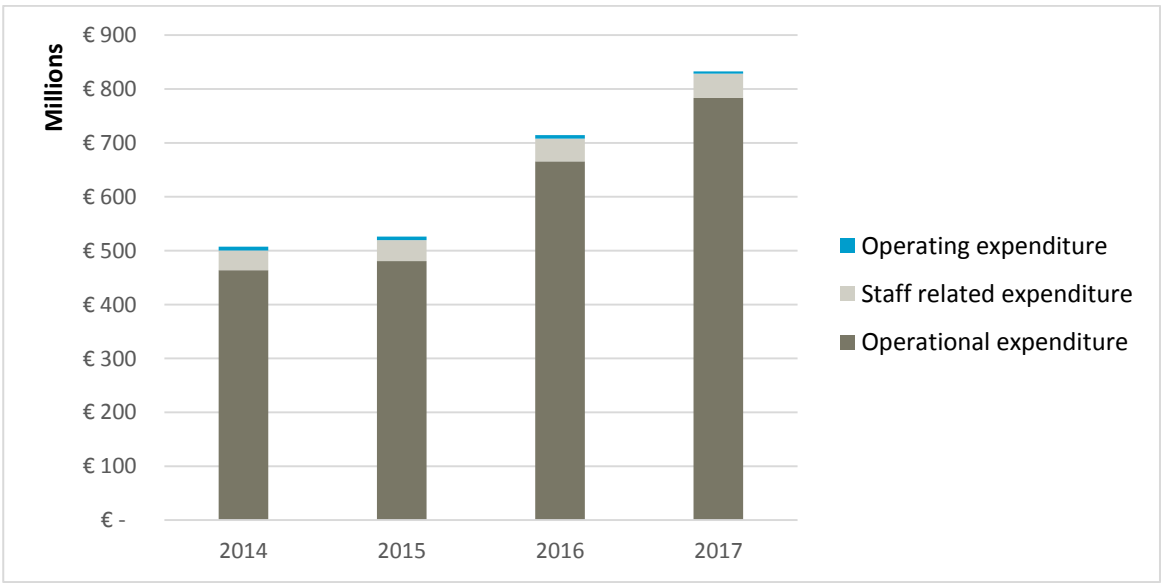
[325] Temporary Agents and External staff expenditure covers Contract Agents (CA), Interim Staff (IS) and Seconded National Experts (SNE).

Figure 51 Operating expenditure (in EUR million)



Source: F4E 2014, 2015 and 2016 final accounts. 2017 overall administrative expenditure based on F4E Draft Annual and Multi Annual Programming Document 2019-2023

Figure 52 Total expenditure (payment appropriations current value in EUR million)



Source: F4E Annual and Multiannual Programme Years 2019-2023

Interviews with F4E and IO

From the interviews of representatives from F4E and IO there are different opinions regarding the administrative expenditure. The F4E organisation is built on the framework for F4E and the co-operation between the member states which imposes a larger administration. Due to the EU procurement regulations and legal framework in the EU there is a need for larger administration compared to the other Domestic Agencies which have their own independent organisations. One reflection is also that F4E are responsible for the procurement and contract management which also requires more administration.

The results from the interviews from the IO reflect an opinion that the administrative organisation in F4E is not efficient since requests to the F4E organisation are perceived to take a lot of time due to complex administration and high involvement of legal administration.

Survey

The survey indicated that a majority of GB and ILO respondents (67%) believe the European contribution to ITER (In-kind) delivers value for money but only a minority disagree (10%). A small majority (52%) believe the Administrative and operating costs of F4E are justified and a minority (24%) disagree. When it comes to the new management a majority (81%) believes the new management reorganisation at F4E since 2015 had a positive impact on the efficiency of the European contribution to ITER and its ability to deliver on time and within budget. Regarding the new project baseline, a majority (86%) believe it had a positive impact on the efficiency of the European contribution to ITER, and its ability to deliver on time and within budget.

EQ8: What factors influenced the efficiency with which the achievements observed were attained?

SHORT REPLY

This question evaluates what factors that have influenced the efficiency of the achievements in any way, positive or negative. Evaluation is performed mainly through desk research and interviews of personnel at F4E and IO. As mentioned earlier in EQ4 the management reorganisations have significantly improved management practices and although now yet fully observed, positive effects are expected.

There are many challenges and factors that influence the efficiency of this one of a kind project ITER with its large complexity and international collaboration between F4E and the other six domestic agencies. The desk research indicates the new strategy 'Straight Road to First Plasma' has had a positive influence in project culture and progress. ITER is a state of the art technology project where the components have never been manufactured before which imposes uncertainties and influence the progress and costs. One important factor is that the ITER project has evolved from a R&D project at start into a construction project over time which requires a different organisation and project culture. Also, the larger components with very high technical requirements such as the vacuum vessel, toroidal and poloidal field magnets together with the breeding blanket modules (TBM) are a challenge to design, manufacture and commission in different locations over the world. The interviews indicate that the EU legal framework imposes large administration which leads to negative impact on costs and delivery on time. One very positive reflection from the interviews both from F4E and ITER is the new project culture and organisation structure that is implemented by the new F4E Director Johannes Schwemmer.

FINDINGS

Desk research

One major factor that influenced the efficiency and progress of the ITER project and the European contribution was the large bureaucratic organisation from start with slow progress in critical projects and cost overruns that led to the reorganisation and introduction of the new baseline. The re-structuring and improvement activities of the Action Plan will most certainly have a positive impact on the future performance of the European contribution to ITER, but it is too soon to see results. The introduction of the 'Straight Road to First Plasma' strategy by F4E

to all of ITER[326], focusing resources on the activities and scope needed for ITER's First Plasma at the end 2025 has had a positive result in cost-control, project culture and a stronger project oriented mindset in the organisation.

Two of the larger and most important F4E contributions have suffered from delays and a stronger management attention has been put into the turnaround of the ITER Buildings and the EU Vacuum Vessel segments. This is mainly due to the previous difficulties which led to the reorganisation. Extensive measures have been taken to mitigate cost and ensure progress for these two important projects in order to ensure progress. This also has ensured better co-operation between the involved parties and theF4E organisation.

Due to the Fukushima nuclear accident the French Nuclear Safety Regulator ASN (Autorité de Sûreté Nucléaire) updated the nuclear regulations in 2012. In accordance with these new regulations focus has been on introducing a nuclear safety culture within F4E to better ensure the project success and to better follow the French nuclear safety requirements of ASN. The F4E Nuclear Safety Policy was approved in 2016[327] and the nuclear safety culture has been strengthened within F4E with training and improved cooperation in nuclear safety related processes. The aim is to implement a stronger mindset of nuclear safety culture in the project organisation in the execution phase

Regarding the procurement activities, the procurement is composed of an evolution of the F4E contract strategy[328]. In the earlier years F4E has tended to place large procurement contracts on a fixed price basis. Experience has shown that this does not always deliver the most cost-effective results, a revised procurement strategy has been developed towards smaller contracts with more variable components, time and materials and incentives in order to give the contractors more flexibility and incentives to improvement.

Regarding Brexit it is stated in the Communication from the Commission to the European Parliament and the Council[329] that Brexit does not affect the overall legal commitment of Euratom to ITER, but it will have an impact on the decisions taken for the next Multiannual Financial Framework and thus it could have an indirect impact on the Euratom financing to ITER.[330]

Interviews with F4E

Several of the interviewees have commented on improvement in organisation cooperation and project culture after the management reorganisation and actions introduced by the new Director Johannes Schwemmer. These improvements had to be done to change the project culture from a R&D oriented organisation and into a more construction oriented project organisation.

One major factor influencing the efficiency of the European contribution is the large number of collaborating countries in F4E and the legal framework around F4E that is not adapted for a very large international construction project.

The interviews also confirmed that strengthened nuclear safety regulations have been imposed since the Fukushima accident which has led to stronger requirements and improved training in the project in order to have a stronger nuclear safety culture.

There were also some concerns regarding the development in Great Britain and Brexit and that it could affect the cooperation in the future, but no effect has been seen so far.

Interviews with IO

Also interviews with ITER staff confirmed that there has been much better progress and collaboration since the management reorganisation. The interviews reflected that it has resulted in a more efficient project organisation and collaboration between F4E and ITER but the long-term effects remain to be seen.

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[326] F4E Consolidated Annual Activity Report 2016
[327] F4E Consolidated Annual Activity Report 2016
[328] F4E Annual and multiannual programme – Years 2018-2022
[329] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[330] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

There is difference between the IO and F4E organisation with regards to organisational efficiency in terms of legal framework and regulations for procurement and contracting. There is a lack of flexibility for this large one-of-a-kind project which has an impact on efficiency.

Also, the interviews confirmed the perception that F4E has to follow EC regulations that are not adapted for large first-of-a kind project like ITER. This imposes a higher level of administrative burden which leads to delays and cost impact. There has to be more flexibility for project procurement and contract management in these large projects.

EQ9: To what extent are the costs associated with the European contribution to ITER under the new baseline proportionate to the benefits (direct and indirect ones) generated?

SHORT REPLY

Direct benefits are understood as improvements made to the way the European contribution of ITER is delivered; indirect benefits are focusing on the actual benefits in terms of budget and time delivery. As such, this question continues EQ4.

Gathered data during the process of desk research as well as results collected during interviews indicate that there are recognised both direct and indirect benefits to the new baseline and subsequent re-planning and re-organisation of the European contribution to ITER. The direct benefits of the new baseline, including the staged approach, reside in better project management, enhanced risk management and improved monitoring of progress.

The new baseline and subsequent reorganisations bring clarity and discipline. After the introduction of the new baseline the monitoring of milestones has been improved, which provides opportunities for a more efficient way of working: monitoring milestones allows for identifying budget or time deviation early in the process and taking corrective actions. In this way risk management is clearly improved, which in turn can lead to cost hedging when detecting risks at an early stage. By focusing effort and resources on achieving the First Plasma, the staged approach also represents an important improvement to manage and reduce risks.

Indirect benefits are yet to be seen but, there is an increased confidence in F4E's ability to deliver within budget and schedule.

INTRODUCTION

The ITER project turnaround, including the definition of a new project baseline, costs and schedule, has been described in EQ1. To meet the updated ITER schedule the F4E GB decided to establish an Expert group to do an independent review of F4Es contribution. The main finding and recommendation was to update the schedule with a focus on achieving First plasma. F4E complemented the ITER Council milestones with additional more detailed ones to enable close monitoring. The new strategy called "Straight Road to First Plasma", was launched in January 2016[331].

The objective of the new approach was to concentrate resources (funding and staff) on the activities critical to the achievement of First Plasma at the end of 2025. This objective is fully consistent with the updated IO's overall Project Schedule, and is considered as an essential enabler to maximize the chance of project success. To that end non-First Plasma projects were either suspended or slowed down until after 2020 in order to make resources available for the critical First Plasma projects and improve the likelihood of remaining within the EUR 6.6 billion budget (in 2008 values) and allowing for a reserve. This approach has now been fully integrated into F4E's planning and operations.

In June 2016, the ITER Council submitted a proposal for a schedule based on a staged approach with resources and milestones until achievement of the First Plasma in 2025 considered being the earliest possible date to archive the high-tech project. The proposal took into account F4E strategy Straight Road to First Plasma.

[331] F4E Annual Report 2016

FINDINGS

Desk research

Below is a summary of the various direct and indirect benefits of the new project baseline that were identified through desk research (and interviews). They are listed below.

Direct benefits

- a complete schedule and cost including staffing estimate for the period up to 2025 in the form of updated:
  - Overall Project Schedule (OPS)
  - Overall Project Cost (OPC)
  - Project Plan and Resource Estimate (PPRE)
- an indicative schedule and cost baseline for the period from 2026 to 2035
- A staged approach to the project, focusing on successful achievement of First Plasma as a first step, and with each following stage focused on clearly identified key project deliveries.[332]
- Enhance the IO risk mitigation management by prioritising risks (in terms of occurrence and impact), quantifying the cost contingency needed and expanding the scope for use of the Reserve Fund. [333]
- Improved risk management[334]
- Enhanced oversight of Fusion for Energy. The Commission's oversight of Fusion for Energy relies on three different categories of supervision tools[335]:
  - Governance Bodies (Governing Board and Committees)
  - regular structured monitoring (using reporting as well as regular audit actions)
  - ad-hoc supervisory tools (mainly for tackling emergency situations).
- Milestones have been set by the ITER Council to allow close monitoring of the project progress[336]
- Improvement of project management
- The IO and the domestic agencies work towards the same overall milestones. ITER coordinate between the domestic agencies.

Indirect benefits

- The pace of construction is steadily increasing both on-site (primarily construction of the buildings), and off-site: industry in Europe and worldwide is in full production and the first big components are due to be delivered by the end of this year.[337]
- Easier overview of the milestones with the new monitor database
- Greater confidence in the project and the organisation
- Change in project management culture –increasing the number of milestones with short goals

Interviews with F4E

Interviews with F4E confirm that the IO and the domestic agencies work towards the same overall milestones with ITER as a coordinator between the domestic agencies. The interviewees unanimously state that the project management has been improved with the project reorganisation and new baseline. Interviewees stated that in between 2014 and 2016 the focus moved closer to compliance with the rules, and from 2016 moved further to the question of how to integrate the focus on compliance with a focus on efficiency. Interviewees acknowledged that there has been a lot of change to the project, particularly within the last two years with more focus on delivery than research. With the reorganisation, a project management department

[332] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[333] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[334] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[335] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[336] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[337] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"

was formed in F4E, and interviewees perceived a clear benefit from it, both in terms of confidence in their ability to deliver and actual performance in delivering on time and budget.

Interviewees reflected upon a positive change of project management culture based on shorter goals, which makes it easier to monitor and assess the results of the work and take corrective actions. For example, it was clearly stated that the overview of the milestones with the new monitoring database make it easier to follow the progress. Interviews related that now projects have their own milestones in the Primavera system. Progress and analysis of achieved milestones are presented during project management meeting once a month. Milestones are perceived easy to measure and easy to control among the interviewees. The Primavera system is also experienced as easy to use for scheduling and adding changes.

Interviewed mentioned significant improvement on the risk management. There is also a greater willingness to perform risk management in cooperation with IO. Risk management is carried out on several levels in the organization both at corporate level and project level. Risk assessment is shared with IO and updated on major changes. The contractors have to make their own risk assessments and share them with F4E. For most contracts there are weekly follow-up meetings where the risk management is a part of the agenda. Risk management is done through Primavera planning tool which offers Risk Register management features.

EQ10: How timely and efficient is the process for reporting and monitoring?

SHORT REPLY

This question focuses on evaluating the extent to which reporting, and monitoring deadlines are met, the extent to which reporting and monitoring results are available when needed, and finally whether the administrative burden related to the monitoring system is proportionate. This question is directly related to degree of fulfilment of the preconditions for Euratom's contribution dated 2015, such as active risk mitigation through careful monitoring and reporting activities focused on e.g. cost-containment measures.

The process for reporting and monitoring is largely supported by interactive IT systems available for most F4E staff. These systems are intimate elements of an Integrated Reporting System (IRS). The IRS, together with policies and strategies of monitoring and reporting, provides a reliable and familiar environment for on-time reporting activities. The IRS also allows availability of reports when needed since the system is on-line. Interviewees from F4E confirmed that usage of interactive systems in combination with F4E units' specific services enables them to meet deadlines and make reports available and the administrative burden was reported in interviews to be reasonable.

To give a more complete picture of this question, some interviews have been carried out with ITER staff. Results confirmed improvements in reporting since 2015.

The main project reporting system used at F4E is Primavera. The use of the system was tested and the results confirmed that it allows timely and efficient reporting.

In spite of very positive opinion presented by interviewees, respondents from IO pointed out that quality of coming data in reports is sometimes not satisfactory and difficult to analyse. They suggested that the reason might be in the fact that there IRS integrates different IT systems. Those systems might not be perfectly corresponding with each other.

INTRODUCTION

As mentioned in EQ5, weaknesses in F4E's organisation and management were first identified in 2009 in an internal management assessment of Fusion for Energy initiated by the Governing Board, which underlined in particular the lack of a project culture and industrial expertise. A series of changes in the structure of its governance followed in the period 2010-2015[338].

[338] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

FINDINGS

Desk research

As part of this effort, a set of reporting and monitoring systems e.g. DACC, and Prima Vera were implemented to better address potential costs increases and schedule delays and have been introduced for all F4E functions including e.g. Project Procurement Unit, Market Intelligence Unit and Process and Organisation Improvement Unit. The Integrated Reporting System was introduced in 2012.

The F4E Integrated Reporting System (IRS), first deployed in October 2012, allows users (all F4E staff) to access standard reports directly from the F4E intranet, providing high quality, consistent reports based on a controlled data set maintained in a central data warehouse. Most of these reports are interactive allowing the user to filter the data live within the system and to drill down to more detailed reports where more detailed investigations are required. In total there are currently about 250 standard reports available. In addition to the standard reports available, trained users are also allowed to create bespoke reports by directly creating queries on the data warehouse.[339]

The IT tool RAPID allows reporting and monitoring of the status of the implementation of audit action plans and can be directly used by the action owners in order to input progress made. RAPID is also integrated in IRS.[340]

The action plan presented by the acting Director of Fusion for Energy in Spring 2015 led to important changes in Fusion for Energy, including the creation of a Project Management Department to reinforce planning and control processes in the basis if the tools mentioned above.[341] Since then, project management systems and monitoring and control systems have been further developed and strengthened.

Interviews with F4E

The findings presented below are based mostly on open and in-depth interviews that have been carried out with managers of the following units: Project Management (PM), Market Intelligence (MI), Project Procurement Group (PPG), and Unit for Process and Organisation Improvement (POI). Since the character of activities at each unit is different, and that has an impact on reporting preconditions, as well as availability of reports when needed, findings are reported individually for each unit. Below, the most significant findings from the interviews are presented.

Interviews, in order to give a more complete picture, have also been carried out with managers of different units at ITER. The most important findings are also summarised in the presentation.

PM helps Technical Officers (ITER) of each major project in finding and defining milestones as well as scheduling of the project. Input data is placed into the Prima Vera system and daily updated from the ITER database. Results (KPIs) are automatically extracted and calculated, and easy to understand. Presentation of KPIs related to the progress or deviations of each major project takes place once per month and includes also explanation for deviations. Since all progress data is on-line and available freely, the systems is efficient and easily accessible. All other functions can download input data as well as analysis without hinder when needed. F4E concludes that degree of meeting deadlines as well as degree of accessibility is equal with 100%. The administrative load is identified by the F4E to be proportionate to the scope since system is on-line and automated.

MI communicates once per year with Technical Officers in order to recognise and register problems that appeared in contracts related to major projects. Data is downloaded into Supply Chain Management Database, and is easily accessible by any function when needed since system is interactive to all F4E staff. So far there has been no particular deadline for updating Supply Chain Management Database, except for when request for Market Survey appears, so it was concluded by the F4E manager that there is no problems in meeting deadlines or in making reports accessible when needed.

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[339] Progress reports by F4E to the Council of the EU (sent also to the EP), p. 37 n
[340] F4E Final consolidated Annual Activity Report 2016
[341] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

Prior to launching new procurement process the Market Survey is requested by PPG. Since the date of announcement of the new procurement, that defines dead-line for the Market Survey Report, is known long time in advance, there is no problem to meet the deadline with delivery of the Market Survey Report according to interviews. Lack of necessary resources at MI causes that the targeted (50 Reports/year) number of Market Surveys is not met.

The administrative load is found by F4E not to be proportionate to the scope since the Integrated Reporting System that will present MI's KPIs is fairly new, and the input data entered into the system is not always of good quality.

PPG visits sites if project activities take place there, or visits contractors if activities are running at contractor place. After signing the contract, PPG's role is to follow up contract implementation by controlling monthly measurements of estimate costs at completion. Input data enters DACC system, and by "push" system is available in e-mail for registered receivers. Monthly meetings with PM give opportunity to highlight the cost situation. If the contract costs are increasing over estimated budget, there is a possibility to negotiate the new budget. F4E opinion is that because project processes are generally stretching over long periods, the deadlines of monitoring and reporting are easy to meet. Since all data is in the DACC system, it is easily accessible on-line when needed. No particular disproportion in administrative burden in relation to the scope was mentioned.

POI is responsible for improvement of activities and processes, especially concerning organisation performance and contract management. POI uses integrated database and electronic tool for managing contract deviations. Functionality includes automatic reminders, e.g. when measures are close to optimum or close to exceeding maximum. Process design is monitored on an ongoing basis, and improvements are suggested where relevant. Improvements are typically introduced through projects. F4E Process Manual is fully electronically available on the F4E intranet, and directly linked to the document management system which includes templates, etc. Digitalisation of contract management helps to meet reporting deadlines according to F4E, however not all processes are fully digitalized. Monitored and reported data concerning contract management is saved in DAC and available when needed. The administrative burden has been described as reasonable to the scope.

Primavera System is a software for project intensive industries such as engineering and construction, aerospace and defence, utilities, oil and gas, chemicals, industrial manufacturing, automotive, financial services, communications, travel and transportation, healthcare, and government (). The field visit at F4E was an opportunity to observe the use if the system, which appeared to be very supportive to project managers in providing reporting tools and dashboardsfor monitoring and analysing performance data of each project.

Finally, it should be noted that interviews at F4E revealed that the quality of monitoring data could be improved.

Interviews with IO

Interviews carried out at IO confirmed that F4E was able to deliver reports on time. The reporting process experienced by ITER has increased in quality and credibility, as clearly stated during interviews. Common reporting system for project monitoring, between IO and F4E, provides input data on-line.

However, some disappointments regarding quality of documentation coming from F4E was expressed. One possible reason that was mentioned might be not fully corresponding IT systems for monitoring and reporting. There are different reporting platforms in use by different departments that are integrated in IRS, but probably are not fully compatible. Another aspect that has been highlighted as a possible reason is that input data might be not entered correctly because of lack of competence of person carrying this activity.

7.3 Relevance

EQ11: How well do the (original) objectives mentioned in F4E's Statutes (still) correspond to the needs and policies of the EU?

SHORT REPLY

The long-term goal of F4E is making fusion available as clean and secure energy source. The potential benefits from such an energy source are, and will continue to be, crucial for addressing worldwide problems such as pollution, climate change, and the finiteness of fossil fuels. Other

emerging energy sources can complement fusion energy, but at the current state-of-the-art of energy research it seems that none of them has the same potentials of fusion. Furthermore, fusion is expected to play an important role in European research and innovation, contributing also to EU industrial policy and competitiveness.

ITER represents a key step towards the generation of electricity from fusion energy, as highlighted in the European fusion roadmap[342] and the current project planning is overall still in line with the roadmap.

INTRODUCTION

The objectives of F4E are: (a) to provide Europe's contribution to ITER, (b) to support the BA, (c) and to contribute to DEMO[343].

The first objective, ITER, is purely a research project[344], and is not meant to produce electric energy and it will be decommissioned after its operational phase[345][346]. The insights gained from ITER will be used to pave the way for future demonstration fusion power reactors (the third objective, DEMO).

The second objective, BA, complements the other two objectives and consists of activities which aim to complement the ITER project and to accelerate the realisation of fusion energy through R&D towards DEMO.

As highlighted in the response to earlier questions, at this point in time the focus of F4E is predominantly on the first objective, less on the second and the least on the last one. In summary, the long-term goal of both, F4E and ITER is making fusion power available as energy source. The Council Decision that established F4E[347] highlights the "fundamental importance […] for harnessing fusion as a potentially limitless, safe, sustainable, environmentally responsible and economically competitive source of energy". The ITER project highlights the potential of fusion as "large-scale and carbon-free source of energy".

Findings

The long-term goal of both, F4E and ITER is making fusion power available as an energy source. The Strategic Energy Technology (SET) Plan[348] - the main aim of which is to accelerate the development and deployment of low-carbon technologies – integrates the European Union's 2050 vision of "a Europe with a thriving and sustainable economy, with world leadership in a diverse portfolio of clean, efficient and low/carbon energy technologies as a motor for prosperity and a key contributor to growth and jobs". F4E and the ITER project, as enlisted in the SET plan, are part of a broader new Research & Innovation approach designed to accelerate the transformation of the EU's energy system that addresses the whole innovation chain, from research to market uptake, stimulating EU industrial competitiveness[349].

Given the growing global energy demand at ever increasing rates, driven by population growth and energy-intensive lifestyles, and the urgency of climate change, the widespread commercial launch of fusion-generated electricity can bring a revolution in the world's energy landscape. The Council Decision that established F4E[350] highlights the "fundamental importance […] for harnessing fusion as a potentially limitless, safe, sustainable, environmentally responsible and economically competitive source of energy". The ITER project highlights the potential of fusion as "large-scale and carbon-free source of energy". Some key advantages of fusion as an energy source are[351][352][353]:

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[342] EFDA (2012) Fusion Electricity. A roadmap to the realization of fusion energy.
[343] As defined in Article 1(2) of F4E's Statutes
[344] Even though at the moment it is mostly concerned with construction of the research facilities.
[345] Such as e.g. the International Space Station (ISS).
[346] This is also reflected in the objective of ITER "to prove the feasibility of fusion as a large-scale and carbon-free source of energy".
[347] Council Decision 2007/198/Euratom establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it (OJ L90, 30.3.2007, p. 58–72)
[348] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[349] European Commission (2017). The Strategic Energy Technology (SET) Plan. Luxembourg: Publications Office of the European Union.
[350] Council Decision 2007/198/Euratom establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it (OJ L90, 30.3.2007, p. 58–72)
[351] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010

- It can be a large-scale energy source with basic fuels which are abundant and available everywhere. The main fusion fuel is deuterium, a form of hydrogen that is easily extracted from seawater. The second fuel is tritium, which is bred inside the fusion reactor from lithium. Unlike any other concentrated energy source, the fuel available for fusion is enough to supply industry and megacities for millions of years;
- It has low impact on the environment: no CO2 greenhouse gas emissions and no long-lasting radioactive waste are produced;
- Compared to nuclear fission operation is safe: the day-to-day operation of a fusion power station would not require the transport of radio-active materials and requires precise parameters. Therefore, power plants would be inherently safe, with no possibility of "meltdown";
- It has the potential to be more economic than other sources of energy: building and operating a fusion power plant will be comparable to the cost of building and operating power plants fuelled by coal, natural gas, oil, or nuclear fission. The forecasted marginal cost of supply of nuclear fusion energy is expected to be negligible compared to that of energy derived from fossil fuels[354]. But unlike fossil fuel plants, fusion plants will not have the global environmental impact of releasing CO2 and other pollutants into the atmosphere; and unlike nuclear fission plants, will not have the costs of high-activity, long-lived radioactive waste disposal.

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[355].This is also in line with European Commission's Energy Security Strategy[356] published in May 2014, which aims to ensure a stable and abundant supply of energy for European citizens and the economy. One of the five key areas addressed in the strategy to ensure long-term security of supply challenges focuses on diversifying EU supplier countries and routes. This includes further deployment of renewables and safe nuclear energy.

Renewable fuels and sources remains part of the wider EU energy and climate policies. In the EU, these renewable energies shall account for about 20% of the gross final energy consumption by 2020 and 60% by 2050[357]. According to the SET Plan, research and capital investment needs to focus on the efficient production of renewable fuels and sources (e.g. hydrogen, wind power, and solar panels) to support the transition to a low-carbon economy by 2050[358].

However, the supply of electricity from renewable energy sources, especially for wind and solar power, is currently highly cyclical.[359][360] This leads to deviations from the standard frequency in electricity grids, which can interfere with the operation of electronic devices. Due to this variability in the supply of energy from renewables, there is currently a debate on whether European countries can base their entire energy supply on renewable energy sources.[361][362] In

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[352] Sanchez, J. (2014). Nuclear fusion as a massive, clean, and inexhaustible energy source for the second half of the century: brief history, status, and perspective. Energy Science and Engineering. 2(4): 165–176

[353] Statement of Bernard Bigot, Director-General ITER International Fusion Energy Organization before the Subcommittee on Energy Committee on Science, Space and Technology U.S House of Representatives. *The ITER Project: Moving Forward* (April 20, 2016). p. 8

[354] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010

[355] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

[356] Communication from the Commission to the European Parliament and the Council. European Energy Security Strategy {SWD(2014) 330 final}

[357] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A policy framework for climate and energy in the period from 2020 to 2030. {COM(2014) 15 final}

[358] European Commission (2017). The Strategic Energy Technology (SET) Plan. Luxembourg: Publications Office of the European Union.

[359] Milan P, Wächter M and Peinke J (2013) Turbulent character of wind energy. Phys. Rev. Lett. 110 138701

[360] Woyte A, Belmans R and Nijs J (2007) Fluctuations in instantaneous clearness index: analysis and statistics. Sol. Energy 81 195

[361] B. P. Heard et al., 'Burden of Proof: A Comprehensive Review of the Feasibility of 100% Renewable-Electricity Systems', *Renewable and Sustainable Energy Reviews* 76 (September 2017): 1122–33, https://doi.org/10.1016/j.rser.2017.03.114.

contrast, the power supply from nuclear fusion is expected to be stable[363]. Thus, due to the relative stability of power supply from nuclear fusion to that of renewables, nuclear fusion may be a complementary source of energy in a fully-decarbonised economy post-2050. For this reason, ITER project can be seen to support the EU Energy Roadmap 2050[364] goal to further the nuclear safety and security framework.

EQ12: How has the development of the new project baseline contributed to sustaining the project's relevance?

SHORT REPLY

The 2016 baseline contributed significantly to the project's relevance by making its successful completion (i.e. reaching the operational phase) more realistic and by reinstating the trust in the ITER project of its stakeholders. However, the stipulated delay of the operational phase by 15 years potentially has impacts on the project's objectives regarding climate change and energy transformation. The focus on First Plasma is perceived as a potential risk by a number of stakeholders in F4E.

INTRODUCTION

The project baseline from 2010[365] foresaw construction to be finalised by 2020. The management assessment from 2013[366] preceding the 2015 IO turnaround identified, among others, the need to "develop a realistic ITER Project Schedule". A new baseline was developed during 2015 as part of the project turnaround, positively reviewed by independent experts in April 2016[367] and endorsed[368] by the ITER Council in June 2016.

Under the current planning First Plasma[369] is expected in 2025 and full operation is planned in 2035 and expected to last until 2037. Compared to the original baseline this means a delay of the fully operational phase by 15 years.

The aim of the staged approach is to better align the project implementation with the priorities and constraints of all ITER Members and it is expected to offer the possibility to better manage the project risks by progressively tackling the technical challenges and ensuring that the IO and the DAs[370] focus on what is most important to reach First Plasma in 2025.

RESULTS

Literature review

The 2016 project baseline foresees a significantly longer construction phase and increased costs for all members. Already before 2013 it had become increasingly clear that the 2010 schedule could not be met; however, until then insufficient action had been taken to address this issue[371]. Together with the stark delay the updated baseline also identified an increase of required resources from Euratom of EUR 3.9 billion (2008 value) until the end of the construction phase in 2025.

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[362] T. W. Brown et al., 'Response to "Burden of Proof: A Comprehensive Review of the Feasibility of 100% Renewable-Electricity Systems"', *Elsevier*, no. Preprint (15 March 2018), https://arxiv.org/pdf/1709.05716.pdf.
[363] NEA, IEA (2015). Technology Roadmap. Nuclear Energy. 2015 Edition.
[364] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Energy Roadmap 2050 {COM(2011) 885 final}
[365] The 2010 baseline was already an update to the original planning. Along this project update the Council of the EU capped the current budget for the European participation until 2020 at EUR 6.6 billion.
[366] Final report of the 2013 ITER Management Assessment, 18 October 2013.
[367] Report of ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources (ICRG)
[368] Approval was *ad referendum* because it is still subject to a final decision by the Budgetary Authorities of the ITER Members.
[369] I.e. the end of the main construction phase.
[370] It should be noted that not all DAs deviated from the 2010 baseline
[371] The 2013 ITER Management Assessment stated that "because the IO staff has not been allowed to openly challenge the schedule, numerous examples of detrimental behaviors, demotivated staff and cynicism were observed".

However, those updated estimations were crucial for the project's success since they supported reinstatement of trust[372] into the project of funding parties, staff and other stakeholders. An independent assessment of the capacity of F4E to deliver the European contribution to the new ITER baseline[373] confirmed the capacity of F4E to deliver the Euratom contribution to the new ITER schedule on time and coherently with the staged approach and within the current available budget until 2020. The resolutions of the European Parliament accompanying the discharge for F4E's budget for the financial years 2014[374] and 2015[375] state that the EP welcomes the progress "in a way that will allow for a sound, realistic and detailed proposal for schedule and associated cost up to First Plasma" and notes that the ITER Council adopted "the new schedule and resources for the ITER project (a new "Baseline" accompanied by a staged approach towards reaching First Plasma) that were considered to be realistic", respectively. The 2015 assessment from the U.S. Department of Energy also stated that the updated baseline will allow IO to "1) present the ULTS to Ministers for approval, 2) operate under a set cost and schedule baseline, and 3) permit the IO to begin benchmarking milestones beyond the current two-year window" to further enable confidence.

As explained in more detail in EQs 17 and 18 below the new schedule potentially has implications for the project relevance with regard to policies and international obligations with regard to energy and climate change. While the timeline for the widespread commercialisation of fusion power after DEMO is largely undefined in can be expected that the early delays in the project have also postponed this step which needs to be considered problematic in light of the urgency of climate change as well as the need to increase energy security. However, those objectives will remain to be of uttermost importance and fusion power, even though potentially delays, has enormous potential in addressing them as highlighted in EQ 12 above.

Interviews F4E

Some interviewees in F4E saw potential risks for the long-term performance of F4E stemming from the focus on FP as defined in the staged approach. While this approach on the one hand entails several benefits (see EQ 9) it is seen by stakeholders also as a potential risk since it deviates resources away from most activities that do not directly contribute to reaching FP. This is perceived by some stakeholders as a risk, e.g. when fewer staff and financial resources are made available for activities than sought or than having been available in the past. Even though there is indeed a potential for such risks they are difficult to pinpoint and will, if at all, manifest slowly over time.

EQ13: What improvements to the relevance of the project have been brought through the turnaround in IO and F4E since 2015?

SHORT REPLY

For ITER to fulfil its objective "to prove the feasibility of fusion as a large-scale and carbon-free source of energy" F4E and IO needed to address management and organisational shortcomings. The progress in addressing the shortcomings touches on many aspects identified in the questions above, which suggest that significant progress has been made. Post-2015 assessments of both F4E and IO point to major improvements of the project's management and progress and thus also to their relevance. Stakeholders generally agree that the turnarounds in both organisations had significant and ongoing positive impacts; most importantly, trust has been regained on the capacity to carry out the ITER project to the demonstration stage and prove the feasibility of fusion as a source of energy.

[372] Together with the changes brought by the management turnaround.
[373] Fusion for Energy (F4E) Assessment and Review – The F4E Review Group (RG), 31 October 2016
[374] European Parliament resolution of 27 October 2016 with observations forming an integral part of the decision 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 2014 (2015/2196(DEC))
[375] European Parliament resolution of 27 April 2017 with observations forming an integral part of the decision on discharge in respect of the implementation of the budget for the European Joint Undertaking for ITER and the Development of Fusion Energy (Fusion for Energy) for the financial year 2015 (2016/2194(DEC))

The survey revealed a mixed picture regarding the stakeholders' opinion about changes in the relevance of the project since the management reorganisations in F4E and IO. While 75 % of the GB members strongly agreed and agreed that the management reorganisations had a positive impact on the relevance of the project no survey participant from the ILOs agreed with the statement while 57 % neither agreed nor disagreed.

INTRODUCTION

To recapitulate, relevance looks at the relationship between the needs and problems in society and the objectives of the intervention. The overall objective of the ITER project is "to prove the feasibility of fusion as a large-scale and carbon-free source of energy"[376] by achieving a range of technical milestones. For the project to be able to fulfil its objective it needs to progress and to advance through the project stages until the full performance operation estimated in 2035. The experienced project delays and cost overruns of the project were, among other reasons, due to weaknesses in its management and governance[377]. In 2015, IO and F4E both presented Action Plans preceded by critical assessments that identified managerial shortcomings in both organisations. In 2013, the "ITER Management Assessment" report by William Madia & Associates[378] revealed several problems in the management and organisation of the ITER project and identified 11 recommendations for urgent action, including among others the need to create a project culture, install a strong Nuclear Safety Culture and to develop a realistic ITER Project Schedule[379]. In 2015 an Action Plan[380] was proposed by IO and since then implemented to correct the deficiencies identified by the Management Assessment.

Also in 2013, the European Parliament's Budgetary Control Committee published a report by Ernst & Young which revealed some shortcomings in the organisation of F4E. Following this, but mainly in support of the ITER Action Plan F4E presented an own F4E Action Plan[381] that identified measures in order to address supplementary issues to those planned under the ITER Action Plan. Planned actions under the F4E 2015 Action Plan include the establishment of an appropriate level of risk-appetite (acknowledging that "a risk-averse approach at local level is often generating high risks at global level"); the improvement of the uptake of project and contract management tools (e.g. earned value reporting using the ITER Credit Allocation System milestones, better integration of Primavera and a Contract Tracker tool); working towards full coherence between F4E and IO annual work- and project plans; the need to increase F4E presence at supplier premises and the ITER site; and investigation of the possibilities to benefit of an increased level of flexibility within the implementing regulations.

While a comparison of all activities in the Action Plans against their actual execution is outside the scope of the present study some general observations can be made based on the insights from other evaluation questions.

RESULTS

Literature review

The 2016 assessment of the ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources[382] concluded that the turnaround in IO led to "substantial improvement in project performance, a high degree of motivation, and considerable progress".

The latest annual independent assessment of F4E[383] stated that "F4E has made significant progress in management and performance over the past 2-3 years towards its objective of delivering the European in-kind contribution to ITER"[384].

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[376] https://www.iter.org/proj/inafewlines
[377] Commission Staff Working Document SWD(2017)232 "The ITER Project Status"
[378] Final report of the 2013 ITER Management Assessment, 18 October 2013.
[379] The outcome of this exercise, the new baseline, is assessed in the next question.
[380] Action Plan 2015 – Foundations for a new phase of ITER
[381] 2015 F4E Action Plan
[382] Report of ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources (ICRG)
[383] 6th Annual Assessment of F4E - Report to the Governing Board
[384] The second and third objective of F4E, i.e. the Broader Approach and work towards DEMO are not covered by this assessment.

In May 2016 the United States Department of Energy published a report[385] discussing the considerations that led to the recommendation that the U.S. remain a partner in the ITER project through FY 2018, at which time the U.S. will reassess the project. One major factor that played into the decision was a significant improvement in project management since early 2015.

Survey

The survey revealed a mixed picture regarding the stakeholders' opinion about changes in the relevance of the project since the management reorganisations in F4E and IO. While 75 % of the GB members strongly agreed and agreed that the management reorganisations had a positive impact on the relevance of the project no survey participant from the ILOs agreed with the statement while 57 % neither agreed nor disagreed. The results should be seen against the background of the interfaces of the two groups with the F4E and IO. The GB group is closely involved in the development of F4E and has direct contacts with IO. The ILOs, on the other hand, are predominantly receiver of information about upcoming procurements[386]. As explained in EQ4 above the effects of the turnaround on procurements and projects is a slow process and improvements are indirect in nature (as compared to direct improvements in internal processes etc.). It can be expected that this delay, the indirect nature of changes and the limited interface of ILOs with F4E led to a large extend to the results and differences in perception.

EQ14: To what extent are the objectives of ITER relevant to the needs of EU and its policies?

SHORT REPLY

In general, the objectives of ITER are mainly research-oriented. Therefore, ITER objectives are in line with wider EU agenda on industrial growth and a 'Global-EU' partnership on R&I, but not relevant with regard to the short-term EU vision towards complete decarbonisation by 2050[387].

INTRODUCTION

This question seeks to highlight the extent to which the objectives of the IO ("to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes"[388]) are relevant to EU's needs and policies.

Findings

The objectives of ITER are research-oriented and ITER is not meant to produce electricity. However, the insights and technical advancements that the ITER project is expected to deliver will set the scene for future electricity production from nuclear fusion[389].

The radical transformation process addresses the way energy is produced, aiming at the production of a clean, safe, and accessible energy. As mentioned above, nuclear fusion energy may satisfy these requirements and ITER's activities constitute essential input to the fusion roadmap. However, since ITER is estimated to operate until 2037, the objectives of ITER are not relevant to the current European Union's current needs and policies towards a 2050 transition to a low-carbon competitive economy[390].

At the same time, ITER project can be seen to support EU needs and policies, in context of two other key features of the Energy Roadmap 2050[391].

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[385] U.S. Department of Energy – U.S. Participation in the ITER Project, May 2016
[386] In addition, they also work with F4E on the improvement of procurement procedures.
[387] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Roadmap for moving to a competitive low carbon economy in 2050 {COM(2011) 112 final}
[388] Information Circular (IAEA) INFCIRC/702 Date: 25 April 2007 Agreement on the Establishment of the ITER International Fusion Energy Organization for the Joint Implementation of the ITER Project
[389] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"
[390] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, the Committee of the Regions, and the European Investment Bank. Accelerating Clean Energy Innovation {COM(2016) 763 final}
[391] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Energy Roadmap 2050 {COM(2011) 885 final}

First, boosting EU technological development and growth. ITER is a positive investment for the EU as it brings important benefits to European industries and R&D institutions. Around 300 companies from about 20 different EU Member States and Switzerland, as well as some 60 research organisations[392] have benefited from this investment on ITER activities[393].

Second, a shift towards a 'Global-EU' research and innovation policy[394]. Euratom is part of the global ITER project, which has an international outlook and a broad scope, involving six other global partners: United States, Russia, Japan, China, South Korea, and India.

Literature review

Since 2007, the EU need for "a potentially limitless, safe, sustainable, environmentally responsible and economically competitive" as well as "large-scale and carbon-free" source of energy has not changed[395]. The European Union's objectives set out in the Strategic Energy Technology (SET) Plan[396] are of "a Europe with a thriving and sustainable economy, with world leadership in a diverse portfolio of clean, efficient and low/carbon energy technologies as a motor for prosperity and a key contributor to growth and jobs".

ITER can support these needs through its contributions to the development of commercially viable electricity supply from nuclear fusion.

Nuclear energy is enlisted in the SET Plan as part of a new generation of technologies necessary to meet the 2050 vision towards to reduction of EU greenhouse gas emissions by 80 - 95%[397].

At the same time, nuclear energy can have an impact on the social and economic dimension of the energy roadmap. The transition to low-carbon options will affect employment and jobs, "requiring education and training and a more vigorous social dialogue"[398]. Finally, nuclear energy may also foster EU growth. There is a shared belief concerning the need to encourage R&I activities which may affect the wider European economy, ultimately creating new business opportunities, jobs and growth[399][400].

EQ15: Does the European contribution to ITER adapt adequately to technological or scientific advances?

SHORT REPLY

The European contribution to ITER is perceived to adapt adequately to technological and scientific advances, taking into account the restrictions coming from a long-term project with a multitude of stakeholders. No major technological or scientific advances have been identified that should have been considered by the European contribution to ITER.

[392] Organisations engaged in cutting-edge R&D, technology, design and manufacture work for ITER components

[393] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

[394] European Commission (Ed.). (2012). Global Europe 2050. Luxembourg: Publ. Off. of the Europ. Union.

[395] Statement of Bernard Bigot, Director-General ITER International Fusion Energy Organization before the Subcommittee on Energy Committee on Science, Space and Technology U.S House of Representatives. The ITER Project: Moving Forward (April 20, 2016).

[396] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.

[397] https://setis.ec.europa.eu/about-setis/set-plan-governance

[398] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Energy Roadmap 2050 {COM(2011) 885 final}

[399] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A European Strategic Energy Technology Plan (SET-Plan) "Towards a low carbon future" {COM(2007) 723 final}

[400] ""The economic benefits and opportunities for cross-border trade extend well beyond fusion applications to other fields in which superconductors are essential, such as medical imaging and energy transportation" Statement of Bernard Bigot, Director-General ITER International Fusion Energy Organization before the Subcommittee on Energy Committee on Science, Space and Technology (U.S House of Representatives) The ITER Project: Moving Forward. April 20, 2016

INTRODUCTION

Fusion research started in the second half of the 20th century and the first tokamak began operation in 1958. Stakeholders in IO stated that today technological evolution in the field of fusion research is linear and is not moving at a critical speed. However, ITER is a long-term project with a design and construction phase of almost 20 years that has started in 2007 and even though the overall design of the in-kind contributions, as defined in the PAs, needs to be followed in order to be interfaced with the ITER project, technical details are subject to industrial advances during this timeframe.

FINDINGS

Interviews with IO and external stakeholders

The general opinion of interviewees at IO and external stakeholders is that the European contribution to ITER adapts adequately to technological and scientific advances.

No interviewee pointed out a major scientific or technological advancement that should have been considered by F4E.

Stakeholders at IO agreed that it is IOs task to deliver stability in the project and that the core of the project cannot be changed. This is for two reasons: The governance structure of ITER as agreed on in the IA does not allow for major changes since allocation of machineries and costs have been agreed on in this agreement. Additionally, the nature of the project with the interfaced in-kind contributions from different actors requires a steady design.

Within this framework F4E has limited space to adapt for example in the design of smaller components. Other interviewees consistently stated the impression that F4E shows interest in new developments and uses this limited space adequately. On the other hand, concerns have been raised that the procurement processes might rely too heavily on selection criteria such as references, numbers of years of experience and financial strength for innovative SMEs to be able to join the procedures.

Survey

Stakeholders of both surveyed groups mainly agree that F4E adapts adequately to technological and scientific advances. 14% of respondents from ILO disagree with the statement (0% from GB members).

7.4 Coherence

EQ16: To what extent is the European contribution to ITER coherent with other Commission initiatives?

SHORT REPLY

In general, the European contribution to ITER is coherent with other Commission initiatives. It is line with the Europe 2020 flagship initiative for a resource-efficient Europe[401] and outlines milestones in the transition to a competitive low carbon EU economy. Finally, ITER supports the first objective of the Commission's political agenda, that is, 'boosting jobs, growth and investment in future high potential technologies'[402]. From a European Commission's perspective, many EC initiatives support – through direct or indirect support – the ITER project.

Findings

This question aims at determining the degree of coherence between the European contribution to ITER with other initiatives proposed by the EC.

[401] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A resource-efficient Europe – Flagship initiative under the Europe 2020 Strategy {COM(2011) 21 final}

[402] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

Since the commercialisation of fusion energy is not expected until after 2050, most of the financial support to ITER currently comes from public funds[403]. The F4E main contribution to ITER comes from Horizon 2020. At this moment, the Commission has proposed and financed different initiatives whose goals are, to different extents, coherent with ITER objectives. However, there is still a belief that renewable energies must continue to play a fundamental role in the transition towards a more competitive, secure and sustainable energy system[404]. At the same time, the EC is of the view that the first priority in climate change policy is the adoption of the Commission proposal for a market stability reserve to improve the functioning of the EU ETS as the main instrument of EU climate policy[405].
An overview of present Commission initiatives connected to EU contribution to ITER is presented inTable 7.

Table 8 Overview of Commission initiatives connected to the European contribution to ITER

Initiative	Relevant goals	Comments
European Commission 10 Political Priorities	(1) boosting jobs, growth, and investment in future high potential technologies (3) making energy more secure, affordable, and sustainable	Jobs created through F4E and investment in high potential technologies. Long-term goal of ITER: safe, affordable, inexhaustible and sustainable source of energy.
Roadmap to Fusion Electricity	The roadmap addresses three separate periods with distinct main objectives: First period - Horizon 2020 (2014-2020) with five overarching objectives: (1) Construct ITER within scope, schedule and cost; (2) Secure the success of future ITER operation; (3) Prepare the ITER generation of scientists, engineers and operators; (4) Lay the foundation of the fusion power plant; *(5) Promote innovation and EU industry competitiveness.* Second period (2021-2030) - Exploit ITER up to its maximum performance and prepare DEMO construction. Third period (2031-2050) - Complete the ITER exploitation; construct and operate DEMO.	(1) The ITER project as the "essential step towards energy production in a fast track", as the key facility of the roadmap; (2) A single step (DEMO) between ITER and the commercial fusion power plant designed "as a credible prototype for a power-producing fusion reactor, although in itself not fully technically or economically optimised"; Delays in timeline of ITER project have to be taken into consideration when assessing its coherence with the roadmap. The 2016 project baseline has led to longer construction phase and increased costs[406].
EUROfusion and the Joint European Tours[407]	JET is a fusion research facility operated by the EUROfusion consortium, in which 30 research organisations and universities from 26 EU Member States plus Switzerland	ITER is anticipated and supported by Europe's other major fusion experiment, the Joint European Torus (JET). The mid-term review of EUROfusion activities 2014-18, and the associated roadmap must

[403] Report from the Commission to the European Parliament, the Council and the European Economic and Social Committee. Interim evaluation of the Euratom Research and Training Programme 2014-2018 {COM(2017) 697 final}
[404] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A policy framework for climate and energy in the period from 2020 to 2030. {COM(2014) 15 final}
[405] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Roadmap for moving to a competitive low carbon economy in 2050 {COM(2011) 112 final}
[406] U.S. Department of Energy – U.S. Participation in the ITER Project, May 2016; European Parliament resolution of 27 April 2017 with observations forming an integral part of the decision on discharge in respect of the implementation of the budget for the European Joint Undertaking for ITER and the Development of Fusion Energy (Fusion for Energy) for the financial year 2015 (2016/2194(DEC))
[407] European Parliament Research Service (EPRS) (2017) Briefing How the EU budget is spent.

Initiative	Relevant goals	Comments
	and Ukraine collaborate on research that will ultimately make possible fusion electricity. In general, EUROfusion aims at: (1) preparing for ITER experiments and (2) developing concepts for the fusion power demonstration plant DEMO.	take into account the revised ITER baseline[408].The objective of EUROfusion to supply fusion electricity to the grid by 2050 by supporting ITER experiments and DEMO operations, in line with Roadmap 2050 missions, is relevant to the scope of and coherent to ITER objectives
Euratom Research and Training Programme	The Euratom Research and Training Programme (RTP) supports research in three areas: nuclear safety and security; nuclear fission; and nuclear fusion, of which the ITER project is an example. The RTP is	Policy objectives are focused towards ITER development and exploitation.
Strategic Energy Technology (SET) Plan	Main objectives relate to research and innovation in different fields, including: • Development of energy-efficient energy system • Increase safety in the use of nuclear energy	Within SET plan, fusion technology (therefore ITER project) is considered as a high potential attractive long-term low-carbon energy solution. However, the SET Plan also places renewable technologies at the heart of the new energy system, addressing the important role that they have in meeting short-term GHG reduction targets
Framework Strategy for the Energy Union[409]	The Framework Strategy for the Energy Union sets the vision for the future and integrates a series of policy areas into one cohesive strategy. The Energy Union is based on the three long-established objectives of EU energy policy: security of supply, sustainability and competitiveness.	/ Energy security; energy efficiency; decarbonisation of the economy; and research, innovation and competitiveness are objectives that are tackled by ITER project (from a long-term research-oriented perspective)

EQ17: To what extent is European participation in ITER coherent with the wider EU policy (Energy, Research, Climate, Environment)?

SHORT REPLY

Overall, he EU participation in ITER is coherent with the wider EU policy. Other energy sources, such as renewable energy, which are supported by EU policy are complementary.

FINDINGS

In line with international commitments[410], the European Council reconfirmed in February 2011 the EU objective of reducing greenhouse gas emissions by 80-95% by 2050 compared to 1990[411]. The Europe 2020 Strategy sets out the guidelines for a transition to a low carbon economy. Total emission for GHG[412] are expected to decrease by 40-44% in 2030 and by 79-82% in 2050, while sectoral reduction with regard to the power sector is expected to be around 54-68% in 2030 and 93-99% in 2050

In order to achieve such objectives, Roadmap 2050 EU policy can lock in carbon intensive investments, resulting in higher carbon prices later on and significantly higher overall costs over

[408] Interim evaluation of the Euratom Research and Training Programme 2014-2018
[409] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[410] To keep climate change below 2ºC
[411] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Roadmap for moving to a competitive low carbon economy in 2050 {COM(2011) 112 final} p.5
[412] Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. A Roadmap for moving to a competitive low carbon economy in 2050 {COM(2011) 112 final} p.6

the entire period. At the same time, a wide range of technologies will need to be deployed, including more advanced and complex technologies, such as nuclear fusion energy.

However, nuclear fusion energy development is not the only solution to the problem: the 2030 climate and energy framework, which forms an integral part of the Energy Union and contributes to the transition to a low carbon economy, sees the adoption of the Commission proposal for a market stability reserve to improve the functioning of the EU ETS as the main instrument of EU climate policy. A

In addition to that, Cohesion Policy will play a strong role in delivering the 2020 Energy Strategy on the ground. With the significant funding available for investments in the shift to a low-carbon economy, Cohesion Policy will help Member States, regions, local government and cities implement much needed investments in energy efficiency in buildings, renewable energy, smart grids or sustainable urban transport[413].

Table 9 Overview of wider EU policy connected to the European contribution to ITER

Policy	Relevant goals	Comments
Europe 2020 Energy Strategy	Implementation of the Strategic Energy Technology Plan	ITER project is a research-oriented project which aims at demonstrating fusion power as a future reliable source of energy. However, the ITER project will not provide any factual support in achieving the objective of reducing greenhouse gas emissions (GHG) by 20% by 2050; moreover, the SET Plan advocates an increase of the share of renewables in the EU's energy mix to 20% by 2050.
	3% of the EU's GDP to be invested in R&D	Resources put into R&D projects
	Collaborating internationally: (…) Europe should continue to be open for access to its R&D programmes, while ensuring comparable conditions abroad. (…)	The ITER Project is 45% of the total. In return, the EU has access to 100% of the scientific and technological advancements resulting from the project
2050 low-carbon economy	By 2050, the EU should cut greenhouse gas emissions to 80% below 1990 levels; the low carbon transition should be feasible and affordable	The timeline after operational phase of ITER is unclear – this might create uncertainty with regard to the contribution of ITER to achieving a carbon-free economy. Moreover, the downwards trend in costs of renewables may put into question whether ITER facilitates a cost-effective transition to a low-carbon economy (Bloomberg[414])

EQ18: To what extent is the European contribution to ITER coherent with international obligations?

SHORT REPLY

In general, the European contribution to ITER is relevant to the EU international obligations under the Paris Agreement and the Sustainable Development Goals. The European Contribution to ITER does not directly support the Paris Agreement goal of limiting global warming to below 2°C above pre-industrial levels by the end of this century due to the late expected realisation of commercially viable fusion power. The European Contribution to ITER can be seen as coherent with the Sustainable Development Goals.

[413] MEMO/10/165 (European Commission) ITER & Fusion Research. 5th May 2010.
[414]https://www.bloomberg.com/news/features/2017-10-20/renewable-energy-threatens-the-world-s-biggest-science-project

FINDINGS

Literature review

This question focuses on evaluating the coherence between the European contribution to ITER and the international obligations of the EU. Specifically, the relevant EU international obligations include the Paris Agreement, and the Sustainable Development Goals.

The Paris Agreement sets out a global action plan and aims, by the end of this century, to:[415]

- "Holding the increase in the global average temperature to well below 2°C above pre-industrial levels and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels (…);
- Increasing the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development (…);
- Making finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development."

To achieve the Paris Agreement goal (a), regarding climate change mitigation, it is necessary for the worldwide energy mix to phase out fossil fuels.[416] By furthering the viability for electricity generation by fusion power, and its commercialisation, the European Commission sees potential for fusion to replace fossil fuels in the energy mix towards the end of this century[417]. Due to the long-term potential for fusion to replace fossil fuels in the energy mix, the European Contribution to ITER and Paris Agreement goal (a).

However, according to the High-Level Panel of the European Decarbonisation Pathways Initiative, the Paris Agreement's goal of limiting increases in global temperatures to 2°C requires the world economy to be fully decarbonised (i.e. climate neutral) by 2050[418]. Nevertheless, ITER is estimated to run until 2037, and the subsequent timeline for the penetration of commercial generation of electricity from fusion is estimated to take place after 2050[419]. Fusion power is therefore unable to address climate change within the timeline of the Paris Agreement.[420] Thus, the European Contribution to ITER does not directly support Paris Agreement aim (a) to keep global warming to below 2°C above pre-industrial levels by the end of the century.

With respect to the UN Sustainable Development Goals[421], the European Contribution to ITER can be seen to support targets under the goals 7 and 13 as it is shown in Table 9.

Table 10 UN Sustainable Development Goals in line with European contribution to ITER

Goal	Target	Link to European Contribution to ITER
7	7.A	By 2030, enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology
13	13.A	Implement the commitment undertaken by developed-country parties to the United Nations Framework Convention on Climate Change to a goal of mobilizing jointly $100 billion annually by 2020 from all sources to address the needs of developing countries

[415] Adoption of the Paris Agreement (United Nations Framework Convention on Climate Change, 2015), 22.
[416]
[417] 'COM (2017) 319 - EU Contribution to a Reformed ITER Project' (European Commission, 14 June 2017), 2, https://ec.europa.eu/energy/sites/ener/files/documents/eu_contribution_to_a_reformed_iter_project_en.pdf.
[418] 'Interim Recommendations' (High-Level Panel of the European Decarbonisation Pathways Initiative, n.d.), 1, http://ec.europa.eu/transparency/regexpert/index.cfm?do=groupDetail.groupDetailDoc&id=36435&no=1.
[419] NEA, IEA (2015). Technology Roadmap. Nuclear Energy. 2015 Edition.
[420] T. W. Brown et al., 'Response to "Burden of Proof: A Comprehensive Review of the Feasibility of 100% Renewable-Electricity Systems"'.
[421] The Sustainable Development Goals framework is valid until 2030 and thus only commitment targets and no outcome targets are considered.

Goal	Target	Link to European Contribution to ITER
		in the context of meaningful mitigation actions and transparency on implementation and fully operationalize the Green Climate Fund through its capitalization as soon as possible

7.5 EU Added Value

EQ19: What is the additional value of EU intervention (Euratom participation in ITER) compared to what could have been achieved by Members States at national level?

SHORT REPLY

The data presented below suggests that an intervention at Euratom level is crucial in terms of resource availability and project complexity. Also, it is generally perceived to bring added value as compared to participation at MS level in terms of influence, cohesion in terms of access to research findings, political stability as well as to limit governance complexity of IO. At the same time, the nature of F4E, being subject to EU regulation, potentially decreases or slows down the achievement of full benefits as shown in previous question.

The findings are summarised in the table below.

Table 11 Overview of findings for EU added value

	Positive	Negative
EU intervention	• Political stability • Higher influence of European stakeholders • Contributes to cohesion in terms of access to research findings in Europe • Economies of scale • Coordination gains	• Potential effects on F4Es performance due to its nature as EU institution and connected regulations
MS intervention	• Potentially more flexible DAs at MS level	• More complex governance structure of ITER project • Potentially decreased influence of European stakeholders • High financial burden on MSs (assuming that the European share is maintained) • Decreased cohesion in terms of access to research findings in Europe

INTRODUCTION

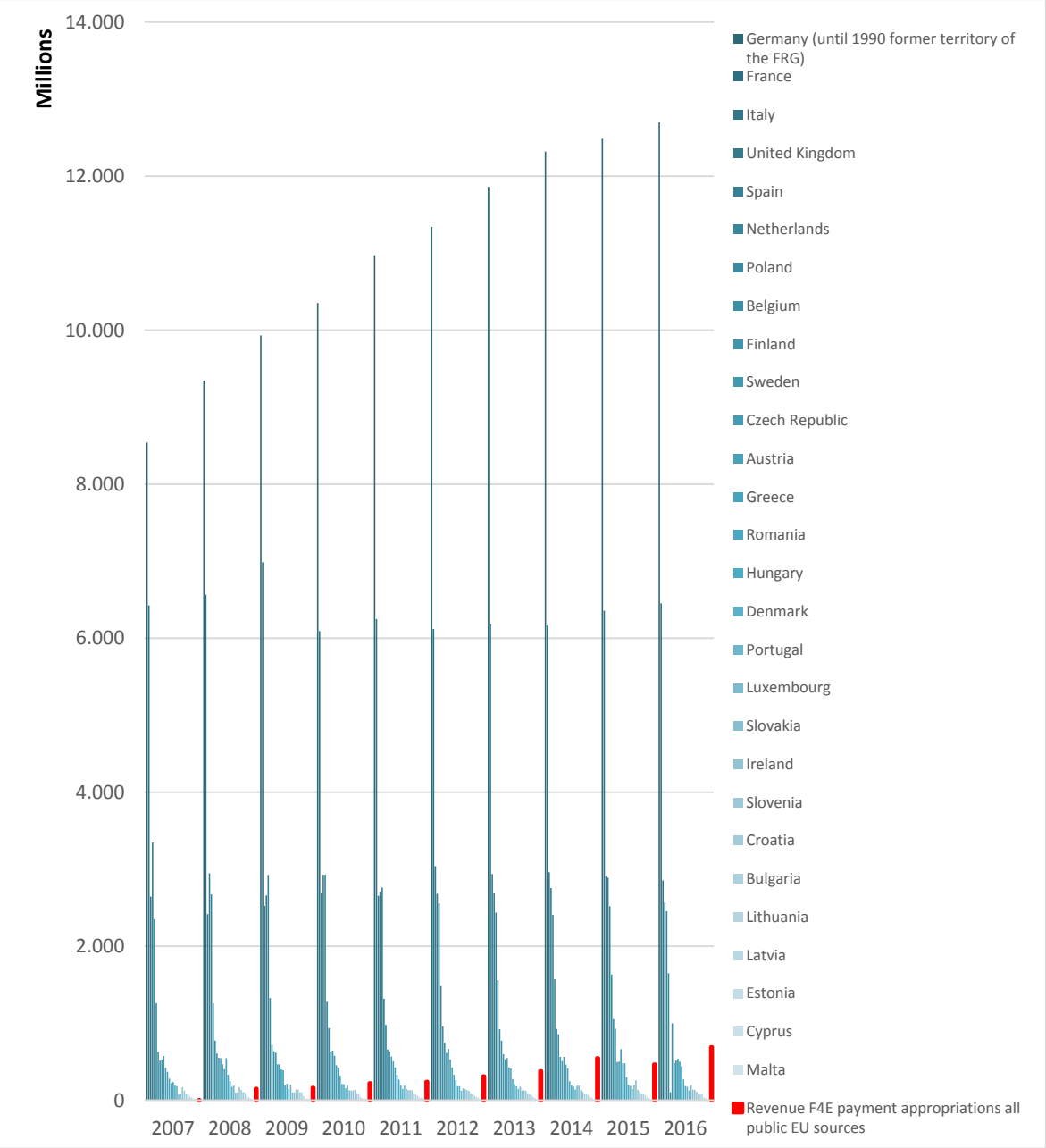
Euratom's contribution, consisting of the EU budget (80 %) and France (20 %), is with 45 % share of costs during the construction phase by far the largest compared to other stakeholders on the ITER project. The overall budget from F4E's establishment until 2020 is capped at EUR 6.6 billion (2008 values). After the construction phase, for operation, deactivation and decommissioning of the facility as well as preparing the site the obligations of Euratom amount to 34 % of the costs. The question considers economies of scale from the pooling of resources to address those obligations as well as the evidence of Member States engaging individually in such a project. This question also must be seen in light of above-mentioned perceptions that the nature of F4E, being an EU institution and thus being subject to certain regulation (including for procurement and for hiring of staff), potentially has adverse effects on the effectiveness and efficiency of the European participation on ITER.

FINDINGS

Literature review

The figure below summarises the respective R&D budget coming from public sources in the 28 MS of the EU. It can be seen that the costs to be covered by Euratom under the IA would represent a considerable challenge for one or more MS. The EC emphasises this point by stating that achieving a future fusion power plant requires sustained scientific, managerial and financial commitment on a scale that no single country can provide[422].

Figure 53 Revenue of F4E in payment appropriations from all EU sources compared to R&D expenditure (GERD) of the government sector in all EU MS



Source: Revenue F4E in payment appropriations from F4E; R&D expenditure (GERD) from Eurostat [rd_e_gerdtot]

[422] Commission Communication COM(2017)319 to the European Parliament and the Council on "the EU Contribution to a Reformed ITER Project"

It can be assumed that economies of scale exist from an EU intervention as compared to MS interventions; this is for example implied as being generally the case for EU agencies such as F4E[423] but also stated by the EC[424].

As explained earlier, the nature of F4E as an EU organisation is considered by stakeholders in IO to be potentially detrimental to the performance (effectiveness and efficiency) of F4E. This can be seen as an argument against an intervention at EU level; however, the counterfactual (i.e. the efficiency and effectiveness of MS DAs) is not certain. The dependence of F4E on EU regulation such as the financial regulation stems from its legal form as a joint undertaking. The recent Impact Assessment study (2018) assessed options of using other legal instruments of delivery mechanisms including as a public-private partnership, joint undertaking (the current legal form), EU agency, intergovernmental organisation, private company and as a European Research Infrastructure Consortium with the results of the impacts though the different legal forms still pending during the time of writing.

The ITER project is highly sequenced; for example, due to the staged approach as mentioned above and on a more detailed level, the sequence and duration of future activities are fully mapped in the ITER master schedule[425]. Interviews at IO suggest that this has the effect that the delay in contribution of one party has the potential to significantly disrupt the overall construction process. The governance structure of the ITER project and the system of in-kind contributions are a significant challenge for the management of the project. Based on those findings, on one hand it can be assumed that a more complex governance structure with several MS being direct stakeholders instead of F4E instead could increase the risk of delays in the project due to the required coordination of more stakeholders. On the other hand, given the perceived restrictions coming from the nature of F4E as an EU organisation, the contribution from a number of (more flexible) national organisations could potentially have advantageous effects; as stated before, the nature of this counterfactual is uncertain.

Survey

The survey results show a clear agreement that there is an added value from an intervention at EU level as compared to what could be achieved at national level. More than 90% of both surveyed groups agree or strongly agree that the Euratom participation in ITER provides a higher value compared to what could be achieved at national level with minor difference between the groups (Q16a). Overall agreement has also been stated for the statement that the intervention at EU level provides efficiency gains (e.g. lower administrative and operating costs) compared to what could have been achieved at national level. All respondents from the ILO agree or strongly agree with this statement while 15% of the GB members disagree with this statement and another 15% neither disagree nor agree (Q16b).

Interviews with external stakeholders

Interviewees of the other stakeholder group in general recognise an added value coming from the intervention at EU level compared to what could achieved by all or selected EU Member States. Interviewees stated that an intervention at EU level overall brings added value to Europe in terms of influence and widespread access to high-tech R&D. Likewise, interviewees stated that the ITER project profits from an EU intervention by increasing political stability. At the same time, it is generally acknowledged that the governance structure of a European undertaking is complex and that such partnerships are challenging.

[423] EU Agencies Network (2016) The EU Agencies working for you. Luxembourg: Publications Office of the European Union, 2016 See https://euagencies.eu/sites/default/files/eu_agencies_brochure_2017.pdf

[424] MEMO/11/938 Brussels (European Commission) European Commission proposes Supplementary Research Programme for ITER. 21st December 2011. See MEMO/11/938

[425] 2016 Report of the ITER Council Working Group on the Independent Review of the Updated Long-Term Schedule and Human Resources (ICRG)

EQ20: To what extent do the issues addressed by Euratom's participation in ITER project continue to require action at EU level?

SHORT REPLY

The IA does not grant Euratom, being the Host Party of the ITER project, the right to withdraw from it. Other parties are allowed to join the IA and thus EU Member States could potentially join the agreement and take on all or selected responsibilities from Euratom. However, such a change is likely to be very disruptive and bears risks of delays given the complexity of the ITER project. The resources still required under the new baseline are considerable and unlikely to be affordable by one EU Member State. Should more than one Member State join the IA as distinct parties this would lead to an even more complex governance structure of ITER project.

INTRODUCTION

Euratom is party to the IA and is Host Party of the ITER Project. As such it is subject to special conditions as defined in the IA. Euratom's contribution is delivered through F4E as defined in the F4E statutes and the contribution to ITER is F4E's first objective.

FINDINGS

Literature review

As stated in Article 26 of the IA[426], Euratom, being the host party of ITER, cannot withdraw from the agreement whereas the other parties have the right to withdraw after it has been in force for ten years (i.e. from October 2017 on). However, in case a party withdraws, they are bound by the agreement to continue providing its contribution for the construction phase but cannot participate in the operational phase. If a party withdraws during the period of operation of ITER, it shall also contribute its agreed share of the cost of decommissioning the ITER facilities.

The IA was ratified in 2007 with an initial duration of 35 years and is thus expected to expire in 2042[427]. Following the operational phase, the IO will hand over a decommissioning fund, which is generated during the operational phase by IO, to the Host State the Fund and the ITER facilities for their decommissioning.

Article 23 of the IA states that any State or international organization may accede to and become a Party to this Agreement following a unanimous decision of the ITER Council. Theoretically it EU Member States could thus become partners to the agreement; however, the legal situation is unclear if Euratom's contribution were to be reorganised and resumed by one or more EU Member States. A situation is supposable in which one or more EU Member States become discrete parties to the IA and take on all or selected responsibilities of Euratom. However, such a change is likely to be very disruptive. As stated in the recent Impact Assessment study of the EU participation in ITER[428] it appears that such a change would add significant risk of delay, because of the complexity of the required change.

With regard to resource need the project continues to require considerable funding also after the current MFF. It is estimated that a total of EUR 7.1 billion[429] is needed until 2035 (i.e. until the beginning of high fusion power operation). This amount is unlikely to be covered by one EU Member State and would probably require the involvement of two or more states.

As stated in EQ19 above a participation of EU Member States as parties in the IA would lead to an even more complex governance structure of ITER project, decreased cohesion in terms of access to research findings in Europe and it would decrease the European influence on the project.

[426] Council Decision 2007/198/Euratom establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it (OJ L90, 30.3.2007, p. 58–72)
[427] According to Article 24 of the IA the duration could be extended having regard to the progress of the ITER project. The maximum extension of the period is 10 years.
[428] Supporting Analysis for an Impact Assessment on the Future Funding of the EU Participation in ITER Project and Broader Approach (BA) Activities under the next Multi-Annual Financial Framework.
[429] In 2008 values.

Survey

Survey respondents of both groups unanimously agreed or strongly agreed that the objectives addressed by Euratom's participation in ITER continues to require resources and action at EU level (Q16c). When asked the respondents if they agreed that EU Member States would not continue contributing to ITER in the absence of EU coordination via F4E the opinion between the two groups differ. In the group of the ILOs 57% strongly agreed with this statement while at the same time 29% strongly disagreed with the statement and 14% disagreed (Q16d). On the other hand, 70% of respondents from the GB strongly agreed or agreed with this this statement

Interviews with external stakeholders

As mentioned above interviewees consistently stated that an EU intervention currently brings added value. However, some interviewees stated that this might change after the construction phase, i.e. in the operational phase of ITER as well as for DEMO[430]. However, the respondents also stated that those assumptions are purely theoretical since they are subject to a very high level of uncertainty in the future development of the project.

7.6 Acceptability

EQ21: To what extent can we observe changes in the perception of Euratom's participation in ITER (positive or negative) by the targeted stakeholders and by the general public?

SHORT REPLY

Acceptability is interpreted at two levels, reputation and awareness. The findings presented below suggest that the awareness of both ITER and Euratom's participation in it is high among their stakeholders but low among the general public. The reputation of both the ITER project and the nature of Euratom's participation in it has improved over time among their targeted stakeholders (industry, research community and funders). Following from the low awareness of F4E in the general public interviewees perceived the outreach and dissemination work of F4E to be not effective and stakeholders from IO perceived F4E's communication to be too focused on F4E and not sufficiently on the ITER project itself.

INTRODUCTION

The following table demonstrates the two dimensions of the question.

	Awareness	Reputation (including for resource spending)
Euratom's contribution (predominantly F4E)		
ITER		

FINDINGS AWARENESS

Literature review

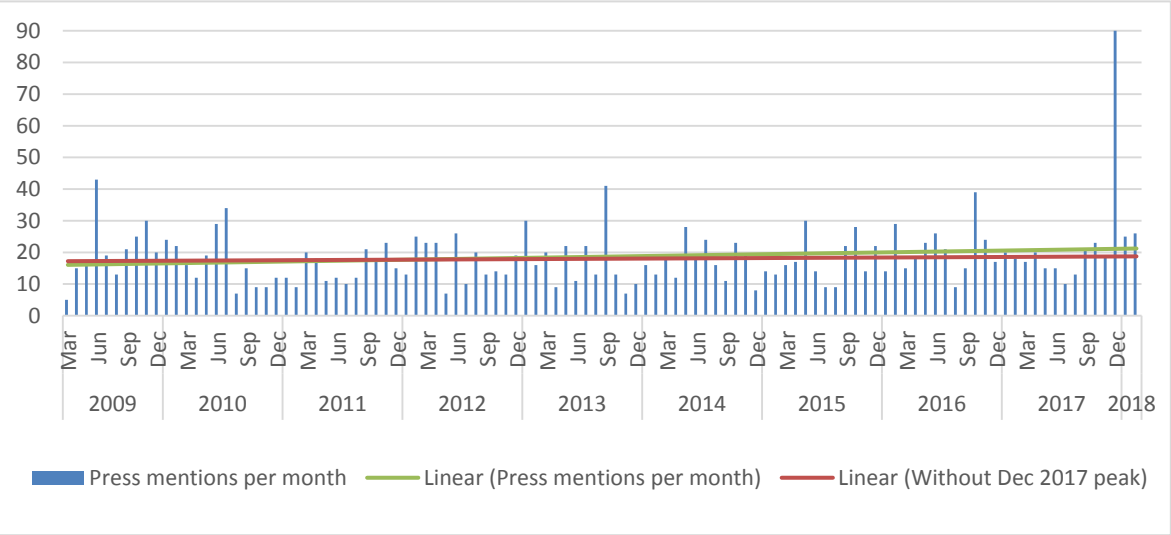
The "Industry and Fusion Laboratories Portal"[431] is F4E's central interface with potential suppliers and partners (industry and research community) who can register in order to "give them a greater visibility at F4E", to look for partners, and for networking[432]. F4E has confirmed that interest in registering and interacting in the platform is consistently high.

Since 2009, IO systematically tracks press mentions around the world concerning the ITER project which can be used as a proxy for the interest of the general public; the publications per

[430] For DEMO there is no detailed timeframe or agreement on how it will be governed yet. The assessment of an involvement of Euratom or EU Member States in DEMO is out of scope of this project. However, it should be pointed out that F4E was set up for a period of 35 years, i.e. until 2042. Given the delays in the ITE project it is probable that the results from its operational phase will only become fully available at a point in time where the feasibility of construction of DEMO is without the scope of those 35 years.
[431] https://industryportal.f4e.europa.eu/IP_PAGES/ehome.aspx
[432] Those goals are stated at http://fusionforenergy.europa.eu/procurementsgrants/industryportal.aspx

month are plotted in the graph below. In terms of long-term trends[433], the figure shows that media coverage has been relatively constant. A significant peak is shown in December 2017. This spike follows a press release by IO about 50 % completion of the ITER project[434].

Figure 54 Press mentioning of ITER



The table below shows the followers[435] of IO and its DAs as well as CERN[436] on LinkedIn, Facebook and Twitter. The numbers show that F4E has a good outreach on those platforms compared to other DAs[437].

Table 12 Followers of IO and its DAs as well as CERN on LinkedIn, Facebook and Twitter

	IO	F4E	China	India	Japan	Korea	Rusia	USA	CERN
LinkedIn followers	12 912	6 183	/	733	/	/	/	/	72 704
Facebook followers	22 350	1 515	/	301	323	17 774	/	/	647 395
Twitter followers	7 644	4 970	/	/	308	9 516	/	841	2.6 million

However, the comparison with another major nuclear research project, CERN, shows that interest on social media platforms of F4E and ITER is comparably low. Likewise, several interviewees in F4E stated that they feel that F4E is not well known by the general public and that this should be improved.

Interviews with IO

Interviewees at IO have highlighted the perception that F4E's communication efforts are in times focussed too much on F4E and not on the overall project, also in comparison with the communication efforts of other DAs. However, it also was also acknowledged that since the DAs are not only about ITER (e.g. F4E also works on the BA) they should be able to market

[433] A second trendline is plotted that does not take the December 2017 peak into account.
[434] ITER Organisation (2017). World's most complex machine is 50 percent completed. Press release.
[435] On 09 March 2018
[436] European Organization for Nuclear Research
[437] This comparison should be interpreted carefully since the platforms don't have the same penetration rate or are not available in all member countries.

themselves beyond ITER too while focusing on the message that ITER is a group project. IO stakeholders also stated the perception that the communication of F4E seems to be too much focused on engineering and procurement progress instead of the unique nature of the ITER project.

Interviews with other stakeholders

In interviewees with other stakeholders this point has been advanced with frequent mentioning of F4E's and IO's shortcomings in explaining and highlighting the differences between fission and fusion.

FINDINGS REPUTATION

Literature review

Concerning the abovementioned December 2017 peak in press visibility, according to interviews with IO staff, a non-systematic assessment of the press following this press showed that the general tenor of the articles is that ITER has run into problems[438] in the past, but that it currently shows positive trends while often linking the positive trends to Mr Bigot, the DG of IO.

Interviews with F4E

Interviews show that most stakeholders think that F4Es performance has increased over the last few years.

Interviews with IO

As shown above, interviewees at IO perceive F4E to have some systemic issues that have adverse effects on its performance. However, at the same time interviewees at IO consistently state that F4E's reliability as a partner has increased since the 2015 turnaround.

Interviews with external stakeholders

In interviews with other stakeholders the largest share of interviewees states that F4E's work has become more effective, results-oriented and reliable after the turnaround in the organisation.

Survey

The survey asked the participants two questions concerning acceptability; a question about the development of the respondents' perception of Euratom's participation to ITER over time (Q18a) and their opinion about the development of the general public's perception of Euratom's participation in ITER over time (Q18b)[439]. In general respondents don't seem to have strong opinions about this; in the ILO group for both questions 43% of respondents did neither agree nor disagree; in the GB group, those shares were 24% and 36% respectively. The results for the first question (43% agreement and 14% disagreement from ILOs and 72% agreement or strong agreement from GB members) are overall more positive than for the second question. In the second question the ILO group is discordant with 14% agreeing, disagreeing, strongly disagreeing and not knowing, respectively. The picture is similar for GB members even though slightly more positive with 28% agreeing, 12% disagreeing and 24% not being sure. Those results could point to a lack of definition of the question. As stated above interviewees generally pointed out that there seems to be a very limited awareness of the general public about the ITER project and even less so of F4E. It is likely that against this background respondents of the survey were unsure on how to reply to this question since if there is no awareness the reputation cannot improve.

[438] Problems have not been mentioned in the press statement published by IO.

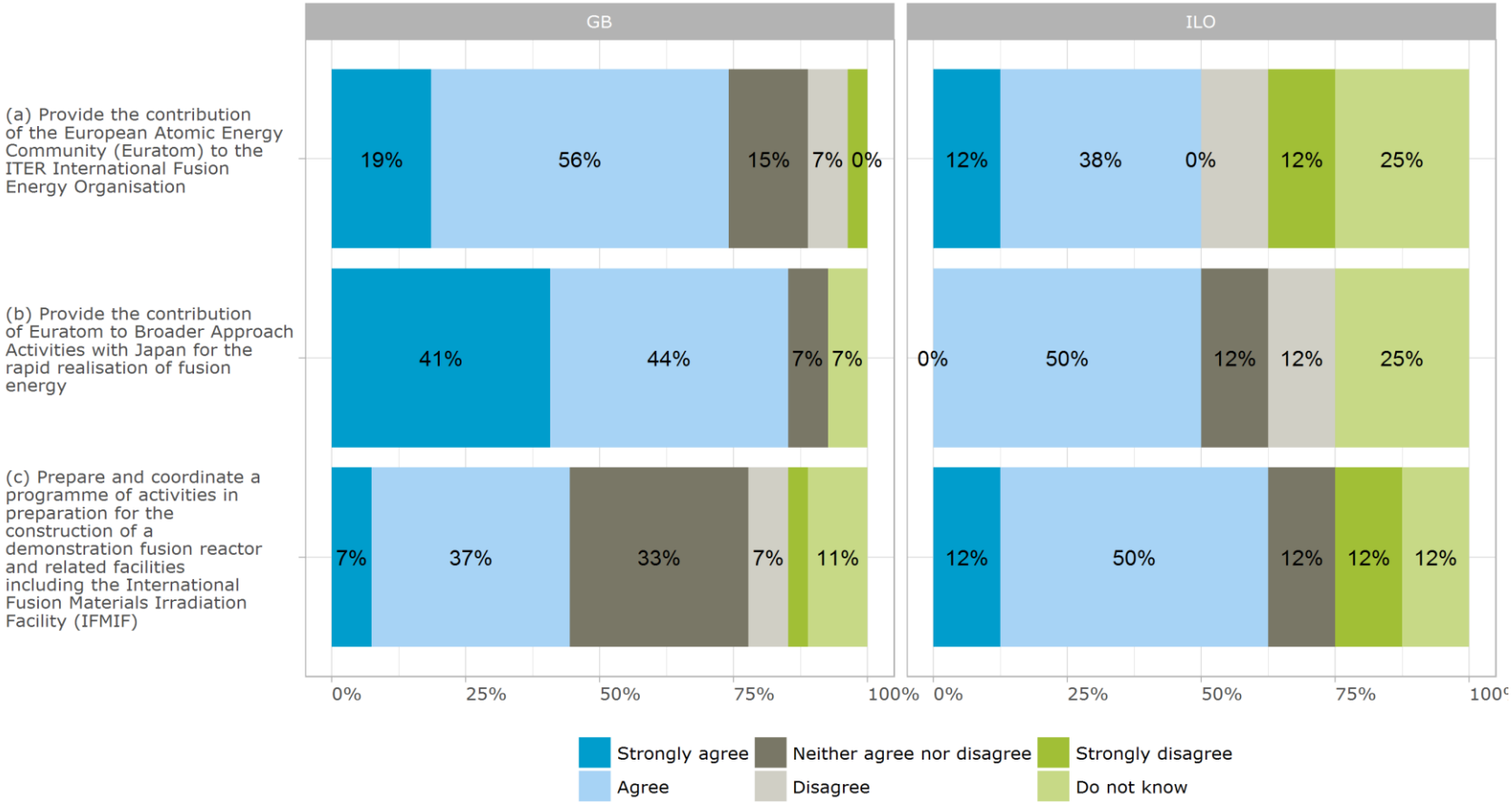
[439] The results need to be interpreted with care since the questions only referred to developments "over time" without specifically referring to the time since the management turnaround. Even though referral was made to this specific timeframe in the introduction of the survey it is possible that respondents did not recall this referral when replying to this question.

8. Annex 3 – List of interviewees

Name	Date of Interview	Organisation
Gyung-Su Lee	6th March 2018	IO
Bernard Bigot	6th March 2018	IO
Tim Luce	6th March 2018	IO
Masanori Onozuka	6th March 2018	IO
Eisuke Tada	6th March 2018	IO
Hans-Henrich Altfeld	9th March 2018	IO
Roberto Lanza	27th March 2018	IO
Francoise Flament	7th March 2018	IO
Shira Tabachnikoff	6th March 2018	IO
Anne-Kathrin Preiss	15th February 2018	F4E
Esther Barbero Soto	15th February 2018	F4E
Patrick Lorenzetto	9th March 2018	F4E
Jean José Lopez	16th February 2018	F4E
Kristel Tans	15th February 2018	F4E
Leonardo Biagioni	15th February 2018	F4E
Teresa Jover	16th February 2018	F4E
Tzeitel Schuster	16th February 2018	F4E
Victor Saez	15th February 2018	F4E
Vincenzo Esposito	15th February 2018	F4E
Walther Schuster	16th February 2018	F4E
Prof. Francesco Romanelli	28th February 2018	BA
Elena Righi Steele	15th February 2018	EU
Ingeborg Graessle	14th February 2018	EU
Clare Moody	28th February 2018	EU
Roger Jaspers	9th February 2018	Research
Tony Donne	8th February 2018	Research
Klaus Hesch	22th February 2018	Research
Christian Dierick	15th February 2018	ILO
Sabine Portier	12th February 2018	ILO
Ana Belen del Cerro	13th February 2018	ILO
James Drake	21st March 2018	Public sector
Jane Nicholson	9th February 2018	Public sector
Xavier Reymond	26th February 2018	Public sector
Joaquín Sánchez Sans	21st March 2018	Public sector

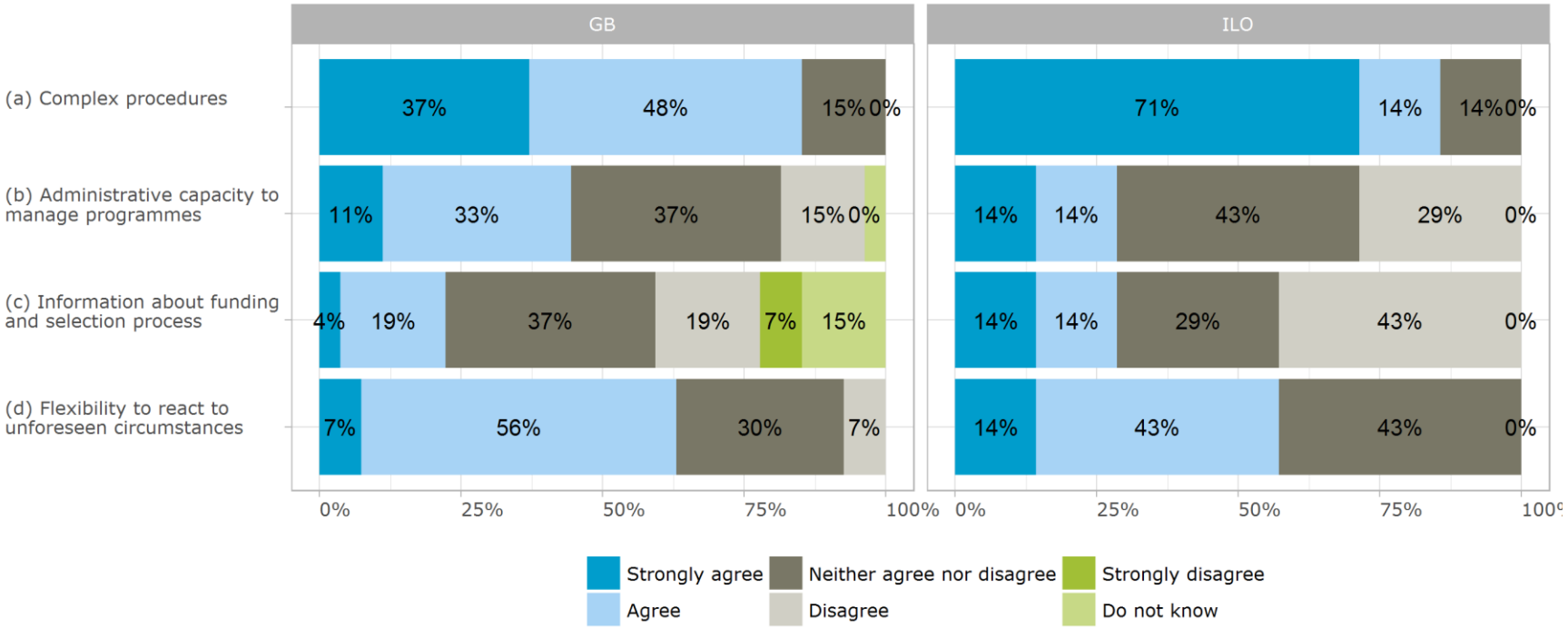
9. Annex 4 – Analysis of survey results

Q1. Please indicate the extent to which you agree with the following statements in context of the European Contribution to ITER and F4E since 2015, i.e. after the last major management reorganisation. F4E has successfully fulfilled the following objectives: (ILO=8, GB=27) [Displayed to: All, Mandatory, Matrix - Single answer, Effectiveness EQ1]



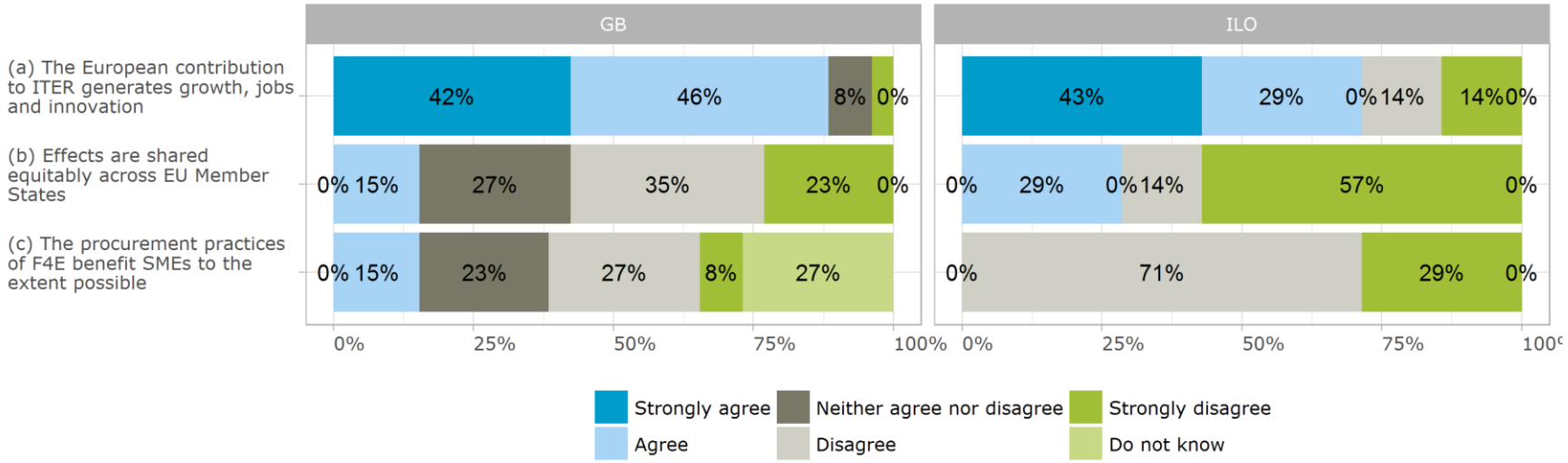
Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q3. Please indicate the extent to which you agree that the following points prevent the European Contribution to ITER (via F4E) from more successfully achieving their objectives? (ILO=7, GB=27) [Displayed to: All, Mandatory, Matrix - Single answer, Effectiveness EQ1]



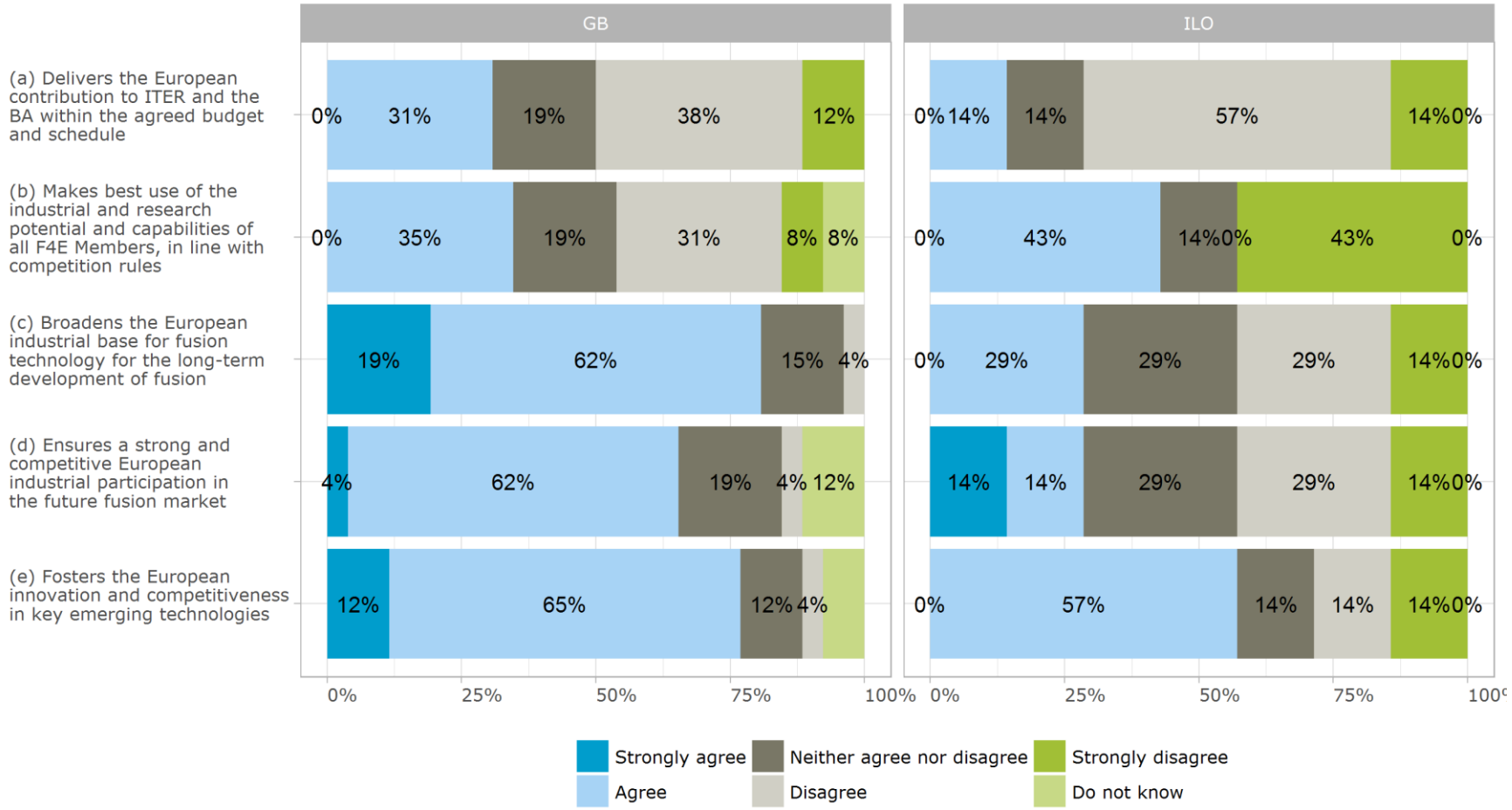
Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q5. Please indicate the extent to which you agree with the following statements concerning the impacts of the European Contribution to ITER (via F4E) (ILO=7, GB=26) [Displayed to: All, Mandatory, Matrix - Single answer, Effectiveness EQ2]



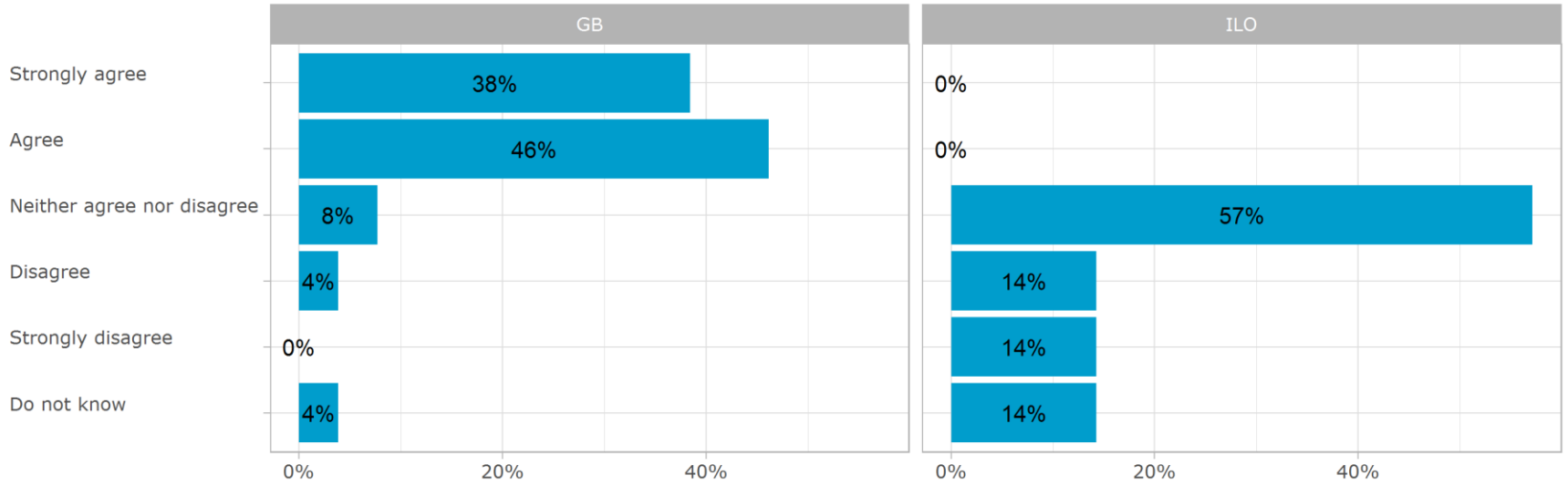
Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q6. Please indicate the extent to which you agree with the following statements concerning the industrial policy of the European Contribution to ITER. The European contribution to ITER… (ILO=7, GB=26) [Displayed to: All, Mandatory, Matrix - Single answer, Effectiveness EQ3]



Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q8. Please indicate the extent to which you agree with the following statement concerning the effects of the recent management reorganisation at F4E. The management reorganisation at F4E since 2015 had a positive impact on the effectiveness of the European contribution to ITER (ILO=7, GB=26) [Displayed to: All, Mandatory, Single answer, Effectiveness EQ3]

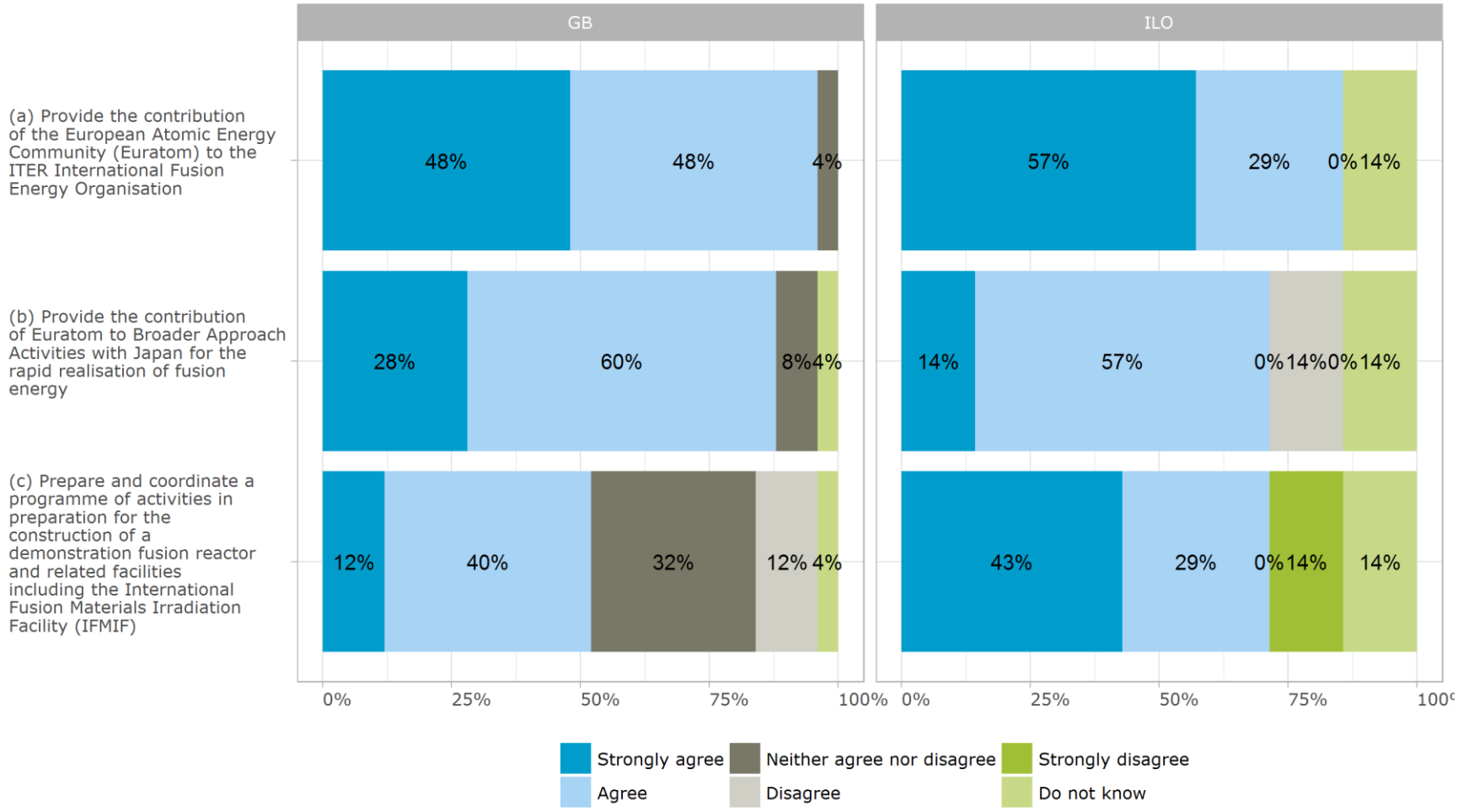


Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q10. Please indicate the extent to which you agree with the following statements concerning the efficiency of the European Contribution to ITER. (ILO=7, GB=25) [Displayed to: All, Mandatory, Matrix - Single answer, Efficiency EQ6-9]

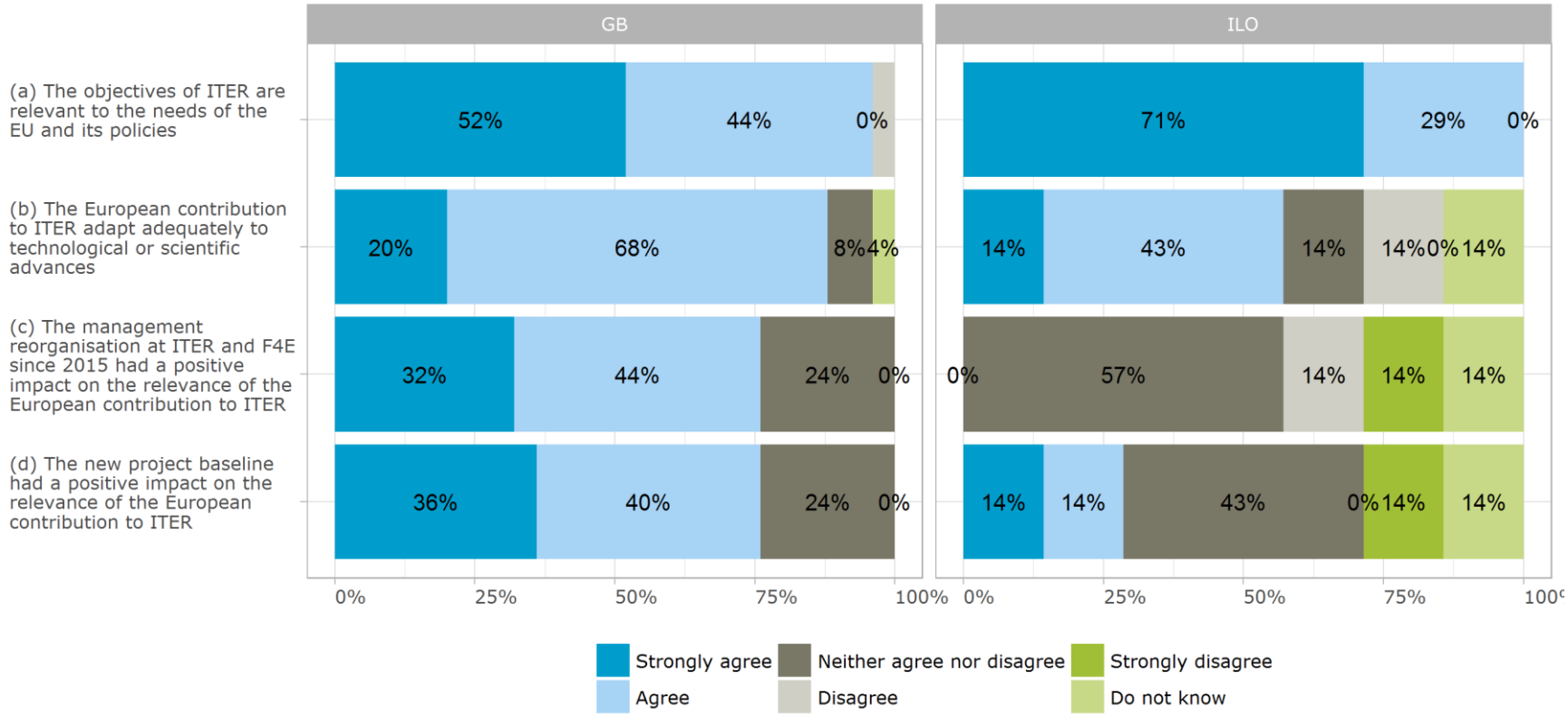
Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q12. Please indicate the extent to which you agree with the following statements concerning the relevance of the European Contribution to ITER. The following objectives of F4E correspond to needs and policies of the EU, and should continue to: (ILO=7, GB=25) [Displayed to: All, Mandatory, Matrix - Single answer, Relevance EQ11]



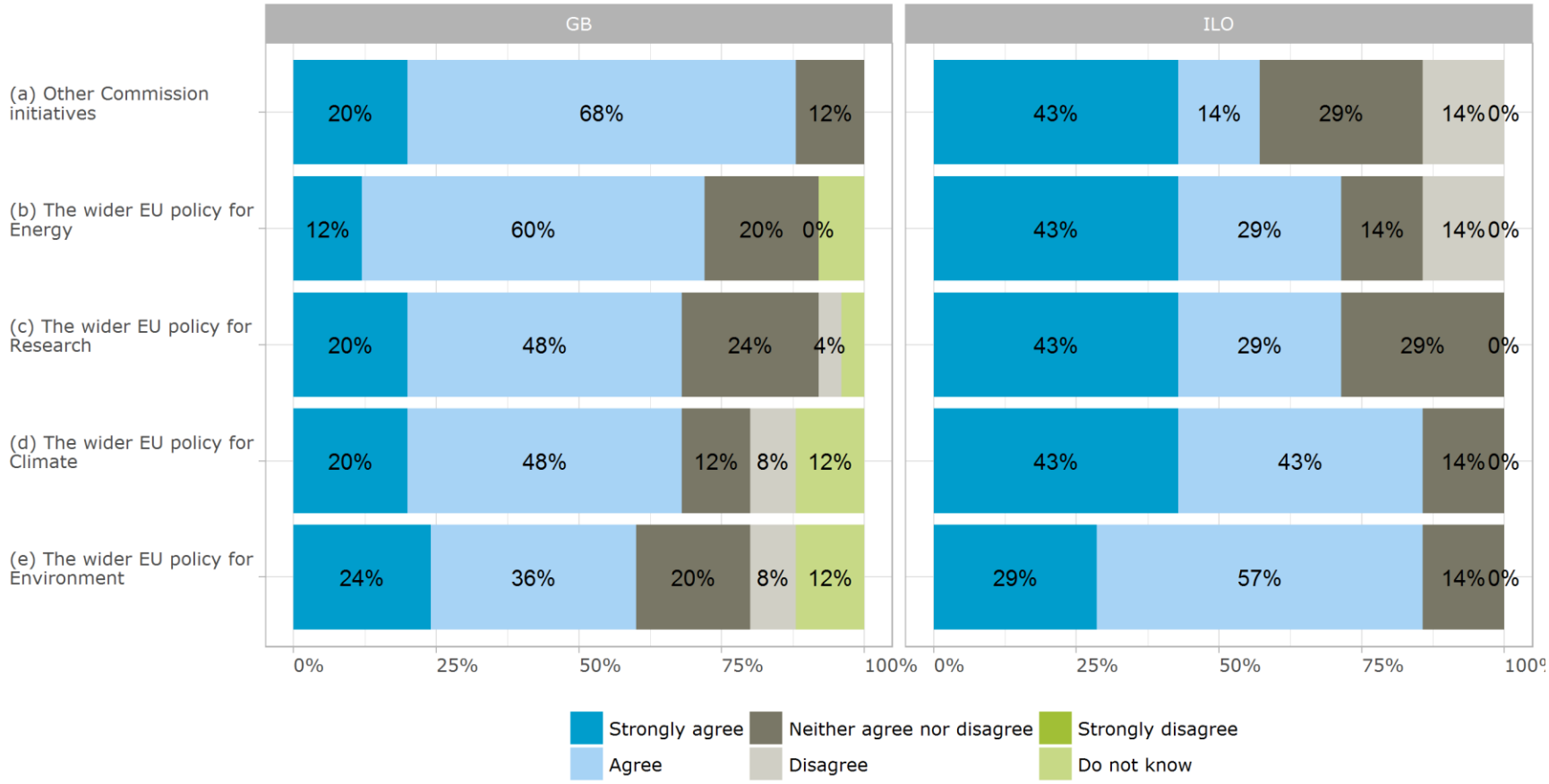
Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q13. Please indicate the extent to which you agree with the following statements concerning the relevance of ITER. (ILO=7, GB=25) [Displayed to: All, Mandatory, Matrix - Single answer, Relevance EQ12-15]



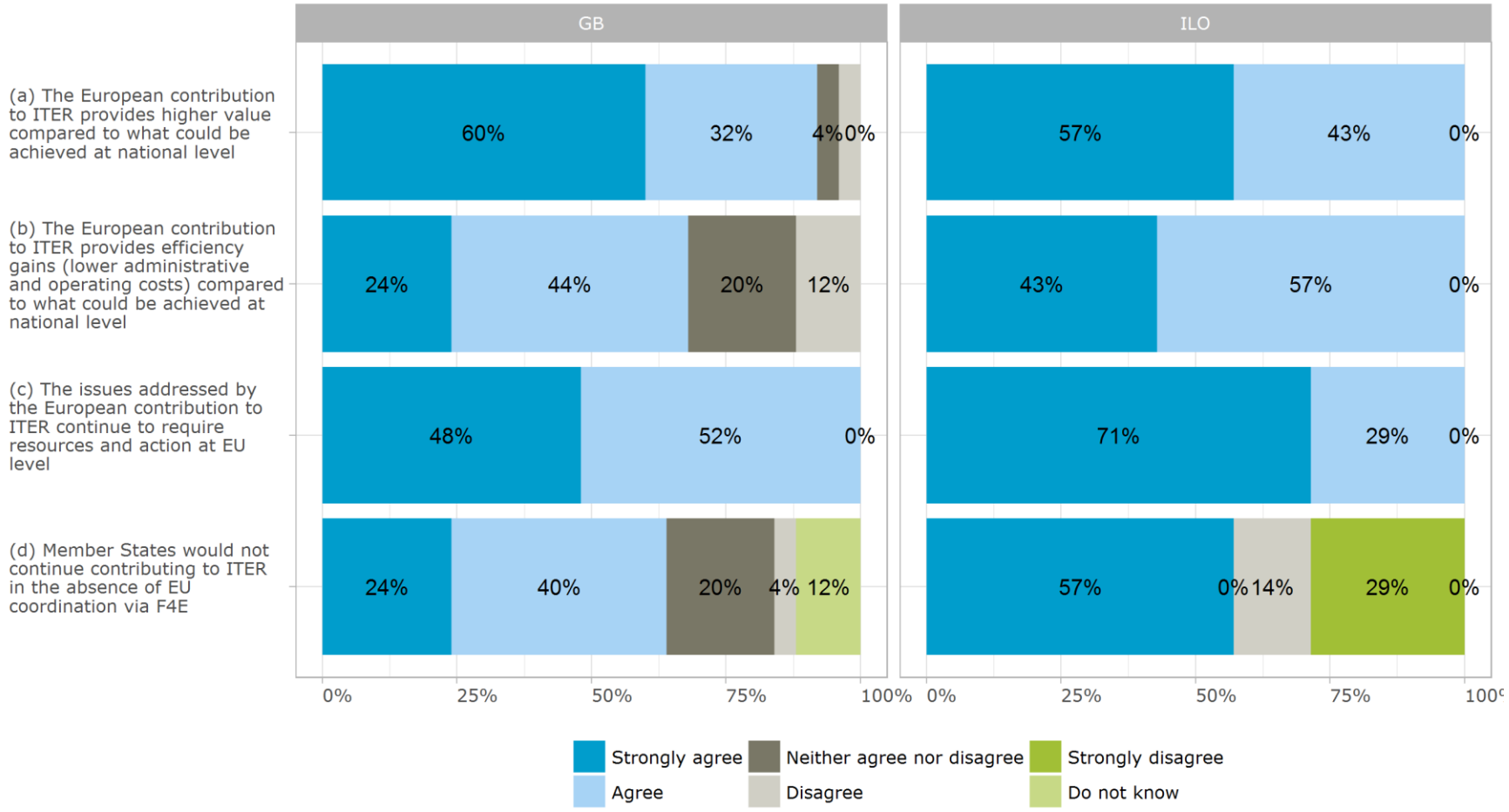
Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q14. Please indicate the extent to which you agree with the following statements concerning the coherence of the European Contribution to ITER. The European contribution to ITER is coherent with: (ILO=7, GB=25) [Displayed to: All, Mandatory, Matrix - Single answer, Coherence EQ16-18]



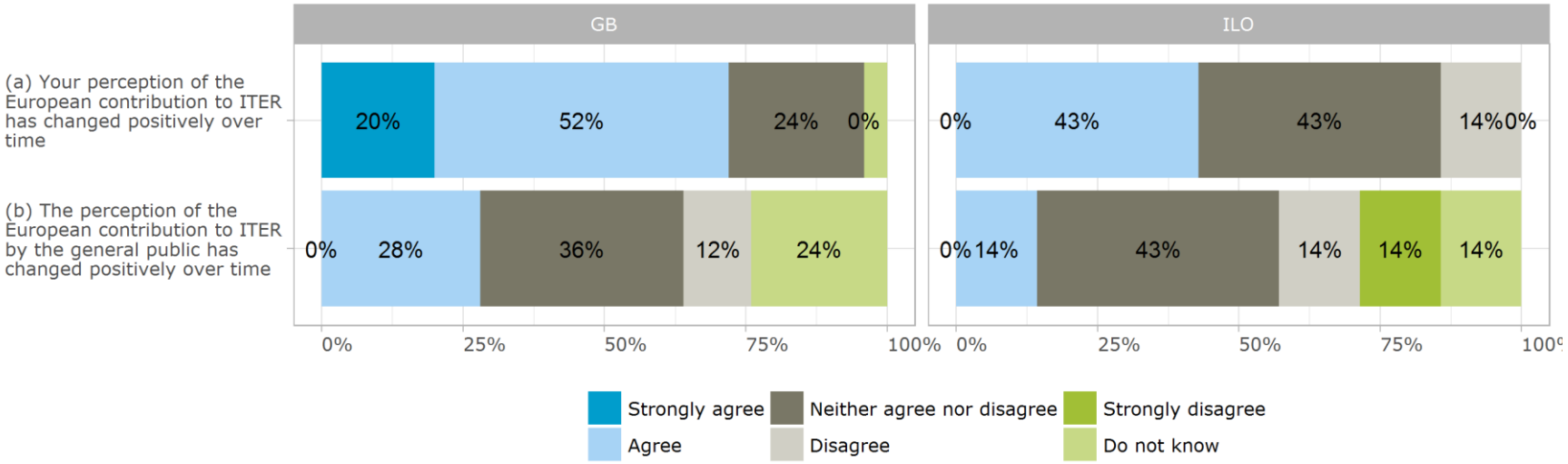
Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q16. Please indicate the extent to which you agree with the following statements concerning the added value of the European Contribution to ITER. (ILO=7, GB=25) [Displayed to: All, Mandatory, Matrix - Single answer, Added Value EQ19-20]



Source: Ramboll on the basis of European contribution to ITER survey results 2018.

Q18. Please indicate the extent to which you agree with the following statements concerning the acceptability of the European Contribution to ITER. (ILO=7, GB=25) [Displayed to: All, Mandatory, Matrix - Single answer, Acceptability EQ21]



Source: Ramboll on the basis of European contribution to ITER survey results 2018.

10. Annex 5 – Synopsis report of stakeholder consultations

This document supports the final report of the study "The European contribution to ITER: Achievements and challenges".

It summarises the methodology and main findings from the stakeholder consultations used to feed into the evaluation.

Besides the literature review, two main methods have been used to consult stakeholders: semi-structured interviews with three different groups of stakeholders (F4E staff, IO (IO) staff and other external stakeholders), and a survey among all members of the F4E Governing Board (GB) and the Industrial Liaison Officers (ILO)[440].In the analysis, the data sources have been triangulated to generate findings.

Interviews

A total of 34 in-depth interviews were conducted with different types of stakeholders, as summarised in the table below. Each interview lasted for about one hour and was of a semi-structured nature. The interviews followed an interview guide, adapted for the type of stakeholder[441], yet allowed for exploration of topics outside the guide if considered relevant.

Table 13 Number of interviewees per stakeholder group

Stakeholder group	Conducted interviews
IO	9
F4E	12
Other	13
Total	**34**

The semi-structured nature of the interviews and the time-limit of one hour meant that the interviewer prioritised questions most relevant to the knowledge of the interviewee. As a result, the extent of the responses to the questions in the interview-guide varies between the interviewees.

Relying on different groups of stakeholders allows to uncover institutional biases and the triangulation of the interview notes has been done in the analysis by comparing results from the different groups.

The evaluation team interviewed staff at Fusion for Energy (F4E) in Barcelona, Spain on 15 and 16 February 2018, and IO (IO) in Saint Paul-les-Durance on 06 March 2018, France, to increase understanding of the Euratom contribution to ITER, fill data gaps and gather feedback on latest developments and progress. A list of interviewees is in Annex 3.

Due to the small number of stakeholders having knowledge on the European contribution to ITER, but also in order to avoid overlap with other studies conducted in parallel, the stakeholder consultation focus on a restricted number of semi-structured phone interviews. A list of interviewees is in Annex 3.

Semi-structured survey among ILOs and GB members

A survey was conducted among member of the F4E Industrial Liaison Officer (ILO) network and the members of the F4E Governing Board. The survey results are in Annex 4.

The response rate to the online survey was 45% for the Governing Board (GB) members and 36% for the for Industrial Liaison Officers (ILO), which is not very high considering their small

[440] Industrial Liaison Officers (ILOs) are a network of representatives from different European countries that together with F4E to raise awareness regarding funding schemes and ways to get involved in the ITER project.

[441] That is, an adapted interview guide was created for representatives from: IO, F4E, ILO, GB, BA, Scientific Community, and the European Parliament.

populations (60 and 22, respectively) and the high commitment that could be expected from then. This implies that there may be self-selection biases in the sample. For example, it may be that more committed GB members and ILOs responded to the survey, and that more these members are more likely to respond in a certain way.

The results of the survey can therefore not be statistically generalised to the GB and ILO populations[442]. That is, the results do not lend themselves to the identification of their associated margin of error. Thus, as calculating the margin of error could be misleading, it was not calculated for the responses to the survey.

Notably, the biases outlined above do not impact on the value of the results of the survey. Although they should be kept in mind upon interpretation of the survey results, the results still give an indication of the opinion of GB members and ILOs on the European contribution to ITER.

Summary of findings

This paragraph presents the findings of the evaluation. It is structured according to the evaluation criteria as listed above: **effectiveness, efficiency, relevance, coherence, EU added value and acceptability**. A summary of findings is included at the level of each evaluation question, whereas findings for each data source can be found in the report.

Effectiveness

EQ1 To what extent have the objectives of European participation to ITER as stated in Article 1(2) of F4E's Statutes been achieved so far?

Interviews with F4E
Interviews with F4E staff show that the changes made in the past two years had a positive impact on F4E to achieve the objectives of the European Contribution to ITER. To illustrate such progress, interviewees from F4E mentioned the number of Procurement Arrangements that have been signed with ITER, as well as the number of contracts and progress delivered by the contractors. However, interviewees acknowledge that while much progress is being made for the first objective (a) and the second objective (b), the Staged Approach may result in postponing the construction of a demonstration fusion reactor.
Overall, interviewees from F4E have great confidence in their ability to achieve their objectives.

Interviews with IO
ITER organisation considered the contribution from EU critical because of the fact that they are the largest contributors and in charge of most critical components. The interviews confirm that there have been problems with delays in EU´s contribution but after the new baseline and the reorganisation the confidence have increased. There is also a perception of the interviewees is that F4E are delivering according to the objectives. There is also a general perception of the interviewees that F4E is delivering according to its objectives even though there are some reservations about efficiency.

Interviews with external stakeholders
External stakeholders are generally aware that the ITER project and European Contribution to ITER encountered serious delays, which where explained either by organisational or political issues. That said, stakeholders generally agree that the reorganisation of the project, as well as the appointment of the new directors at ITER and F4E, have put ITER back on track. This is noticeable by the deadlines and deliverables that are met. It is a commonly shared opinion among interviewees that trust in the project and project organisations has been regained.
The perception of the interviewees is that the projects under the BA are progressing very well. For the DEMO, the perception is that the original timeline was very optimistic and that it is not a focus anymore. Some slow progress of DEMO is however being made under the BA

Survey
In the survey, the two groups of respondents show similar opinion on F4E's fulfilment of its objectives. Concerning providing F4E contribution to ITER, almost 2/3 of respondents from ILO and half of the respondents from the GB expressed that they strongly agree or agree with the

[442] Louis M. Rea and Richard A. Parker, *Designing and Conducting Survey Research: A Comprehensive Guide*, Fourth edition (San Francisco, CA: Jossey-Bass, a Wiley brand, 2014), 198.

statement that F4E fulfils its objectives. Concerning F4E contribution to BA, we could recognise that app. 86% of GBs respondents strongly agreed or agreed that F4E successfully fulfils objectives, and app 50 percent of ILOs respondents agreed with the statement. Concerning F4E contribution related to the objective c), app. 62% of ILOs respondents agreed that F4E is successful in fulfilment of the objective, and app. 48% of GBs respondents represented the same opinion. Survey with members of GBs and ILOs gave a clear indication concerning which elements are mostly experienced as obstacles in achieving objectives of F4E contribution to ITER. Over 87% of respondents strongly agree or agree that complex procedures prevent achievement. Approx. 57% of respondents expressed that lack of flexibility at F4E to react to unforeseen circumstances is hinder for achieving objectives.

EQ2 What have been the quantitative and qualitative effects on growth, jobs, innovation, enterprises and SMEs linked to the European contribution to ITER?

Interviews with IO
Some particular effects related to F4E contribution to ITER in the host region have been mentioned, such as creation of work for local people working on-site, increasing industry capacity, especially in the region. Also, different side effects have been mentioned such as creation of new schools in the region, economic development by renting houses, establishing agencies and connected to this logistic and infrastructure.

Interviews with other stakeholders
Interviewees have highlighted the complementarity of ITER and BA in terms of procurements. Most of the companies working with BA have already worked with ITER before and are thus able to consolidate their gathered expertise. This consolidation aspect is very important because it makes sure that European industries stay leaders in this field and that knowledge does not get lost again. For this it is important to have a continuity in investment.

Survey
Concerning aspect of F4E contribution to ITER making best use of the industrial and research potential in line with competition rules, we found that 41% of respondents agree with the statement while at the same time 39% disagree. Approx. 29% of ILO respondents agree that F4E contribution to ITER broadens the European industrial base for fusion technology for the long-terms, but over 43 % disagree with the statement. The opposite result has been found among GB respondents, where 82 % agree with statement, but only 14 % disagree. Generally, we found opinion differences between ILO and GB respondents, but also within ILO and within GB. This indicates that perception of aspects is not homogenous, and the reason should be investigated further

EQ3 Do the observed effects address the objectives of the European contribution to ITER?

Interviews with F4E
Interviews with F4E staff shed light on the importance of the purchasing strategy of F4E to ensure it is in line with competition rules, while encouraging the participation of the European industry and guaranteeing that the best use of the industrial and research potential and capabilities are met.
F4E does not make any positive discrimination to favour, for example, the geographical spread or SMEs. F4E operates under EU procurement rules and complies with competition law, and interviews with F4E staff have shown a high level of awareness of, and commitment to, these rules.
Against this backdrop, interviews with F4E staff have identified various activities that contribute to address the objectives of F4E's industrial policy:

- F4E tries to un-bundle procurement packages where they can, in order to get more competition in their tenders; also not to force large consortiums, which would not be cost-effective. This leads to a fairly large number of contracts per year, with a budget typically in the tens of millions rather than hundreds of millions, which generates more competition and facilitates participation of SMEs. It was noted that large projects such as the construction of buildings are coming to an end, while small scale projects are in their start up phase. This should lead to a situation where more SMEs will be interested in taking part in the ITER project.
- F4E provides grants to involve the research and innovation community. However, grants are very small part of the European contribution to ITER. Also, they were interesting for research organisations in the early stages of projects, during the design phase, but interest has decreased as entering into the manufacturing phase.

- F4E keep the industry informed about progress, needs and upcoming opportunities. This includes market related activities, B2B meetings, and conferences with industry and member states representatives
- The role of the F4E Industry Portal to maintain a pipeline of potential suppliers has been mentioned. According to interviewees, the portal receives a lot of interest.

Interviews with F4E staff shed light on the importance of the purchasing strategy of F4E to ensure

The clear majority of companies registered in the Portal are European, which is consistent with the fact that F4E can normally only procure from economic operators established in Euratom countries (EU and Switzerland), unless there are specific justifications. There are no such geographical constraints on subcontractors, but certain criteria must be met to allow subcontracting from outside Euratom countries – and for certain core activities subcontracting is not possible.

It was mentioned by interviewees that during and shortly after the 2008 financial crisis, there was high interest in participating in F4E procurements. However, since the economic recovery, companies have become less interested and prefer focusing more on their core activities. According to interviewees, this however indicates that the European contribution to ITER reinforces the resilience of the European economy. It was mentioned that the job contribution of ITER amounts to 28 000, which is a significantly positive contribution to the European economy.

Interviews with external stakeholders

Interviews with stakeholders focused on contribution in terms of innovation and technology development. Stakeholders insisted on the fact that ITER is a research-driven process that makes ITER a unique project but also contributes positively to research excellence and competitiveness. While the end goal of ITER is to contribute to the EU energy policy in terms of reduction of CO2 emissions and security of supply, the research and innovation benefits justify the project in itself already. One example provided by an interviewee was the fact that dealing with such high levels of temperatures and reactions requires the development of new, cutting-edge materials, which is a goal that could be pursued in its own. A common view from the interviews with stakeholders is that F4E and ITER have a large impact on research and innovation in Europe.

This remark actually does not only apply to grant, but to contracts as well. When taking part in ITER projects, companies have to push their innovation to a higher level, which in turn gives them access to new markets and clients. According to interviewees, companies get involved not only because of the revenue of the contracts, but also for getting access to European technology networks and increase their knowledge and visibility.

Concerning the geographical spread of contracts and grants, stakeholders share the perception that the value is not equally shared across Europe. However, this does not appear to be an issue for the industry: F4E projects are technically very challenging and require the best of technological capabilities to be successful.

However, it was mentioned that contracts and grants are complex and time consuming, which hampers competition. According to interviewees, in some cases, there is limited competition, due to a lack of competences and resources to take part in procurement processes. Some interviewees also raised the question of differences in labour costs across the EU, which might be an obstacle for competition.

Survey

Survey with members of GBs and ILOs gave a clear indication regarding opinion on following aspects:[443]

- The European contribution to ITER generates growth, jobs and innovations
- Effects are shared equitably across EU Member States
- The procurement practices of F4E benefit SMEs to the extent possible.

83% of all respondents throughout GB members and the ILOs strongly agreed or agreed with the statement 1.

71% of ILO respondents and 58% of GB respondents strongly disagree or disagree with statement 2; on the other hand, 29% of ILO respondents and 15% of GB respondents agree with the statement. The two groups of respondents had very different views on if the procurement practices of F4E benefits SMEs the extent possible. Not a single ILOs respondent

[443] Q5 of Ramboll on the basis of European contribution to ITER survey results 2018

agreed with this perception. App. 19% of GBs respondents reply that procurement practices benefit SMEs.

EQ4 To what extent did the recent management reorganisations at ITER and F4E impact the performance of the European contribution to ITER?

Interviews with F4E

Interviews with F4E staff confirmed the importance of the progress mentioned in the literature, and provided updated information on recent activities. According to the interviewees, several internal activities have been carried out in order to improve F4E's ability to support the efficient execution of the contribution to ITER, through addressing issues addressed in the Action Plan and improving the organization's general performance. This includes:

- Projects to streamline the internal organization and procedures, e.g. by reducing the number of separate actors necessary to take decisions, while simultaneously clarifying the responsibilities of the individual actors. In the area of procurement, this includes a project to reduce the lead time (from identified need to completed contract), which led to the reduction of reviewers of tender materials. In the area of contract management, this includes the introduction of the Commercial Officer function – implying that each project team will now have a single commercial representative, rather than three people, involved in verification of each contract deviation.
- There are described processes for every major recurring activity of F4E, through an F4E Process Manual. There is an awareness that process descriptions have currently reached different levels of maturity, and that the less mature processes should be developed further.
- Improvement of risk management activities, including heightened focus on risk management from senior executives. This includes the use of contract-specific risk assessments.
- Implementation of the Integrated Reporting System. Data quality in the system was mentioned as an issue, but this was not perceived as a performance problem with the system, but rather as due to inconsistent quality of data inputs.
- Expansion of contract management software to the DAC system, which has been used to manage all contract deviations since 2016. Additional contract management functionality is due to be implemented in 2018.

Many F4E interviewees had a perception that organizational performance has improved over the past 2 to 3 years, citing factors such as a more professional approach to risk and contract management.

In terms of in-cash contributions to ITER, F4E interviewees clarified that IO has the full decision competence as to how these contributions are spent, and therefore F4E does not perform any form of follow-up on the use of these contributions. F4E's control processes are therefore limited to follow-up on planning and executing the payments, including checking that the requested cash transfers are within the total limit for the European contribution, before payments are executed.

Interviews with IO

Interviews with ITER IO staff confirmed that there had been positive progress since the 2015 Action Plans, but also highlighted that there is still room for further improvement:

- An improvement in the cooperation between the IO and F4E, and an increased team spirit, was definitely perceived to have taken place in recent years, further to the Action Plans. However, it was also mentioned that there was still room for further improvement in this regard, particularly on the technical levels of the co-operation.
- Communication from F4E was considered to have improved – though F4E could still improve communication in relation to performance issues in areas within F4E's responsibilities.
- It was mentioned that the IO and F4E tend to have different priorities, which may at times have a negative impact on performance. The IO priorities were perceived as quality and adherence to schedule, while cost was perceived as a main priority for F4E. This could lead to issues which did not benefit the ITER project as a whole.
- Several IO interviewees indicated that there was still scope for improvement of the focus and efficiency of the F4E organisation, which was viewed as too focused on administration, while lacking sufficient resources with technical and project management competences. Over-reliance on lawyers was specifically mentioned as a source of problems.
- F4E's approach to procurement was perceived as very similar to that of EU institutions such as the European Commission, due to very similar regulations, as well as a lot of

staff drawn from EU institutions. This was not considered to provide a suitable procurement framework for a project with the characteristics of ITER. The use of F4E of a high number of separate contracts was also viewed as a cause of deviations and delays.
- In terms of contract management, F4E was perceived as behaving in a very restrictive way, compared with the other DAs, often citing limitations in their regulations, which provided difficulties for realizing the needs of the project. Some (not all) interviewees did note that improvements had been made in recent years.
- The increased F4E on-site presence in Cadarache was considered to have positive effects, but it was also noted that additional co-location would provide an opportunity for further improvement.

The 10-month delay for the Tokamak building – which is within F4E's responsibility – was noted several times. This was announced shortly after the new baseline. Work is ongoing to find ways to avoid this delay having an impact on First Plasma by 2025.

Survey
The survey indicated that:[444]
- The two groups of respondents had very different views on the impact of the management reorganisations. More than 80% of GB respondents replied that the management reorganisations had a positive impact on the performance of the European contribution to ITER. Not a single ILO respondent agreed with this perception, and a minority of respondents even disagreed.
- When asked whether certain factors prevented the European Contribution to ITER from more successfully achieving its objectives, "complex procedures" was mentioned by more than 80% respondents, and "flexibility to react to unforeseen circumstances" was mentioned by 60% of all respondents (with fairly similar results for the two groups of respondents).
- A majority of respondents indicated disagreement with the statement that the "procurement practices of F4E benefit SMEs to the extent possible". All ILO respondents disagreed with this statement, whereas 37% of GB respondents disagreed.

It should be noted that the survey was directed to a small group of people, and that the response rate of ILOs to the survey was quite low; this may affect the validity of the results.

Other external stakeholders
While a positive development in the European Contribution was indicated, potential for further improvement was also noted:
- Although some relevant derogations had been obtained already, the Regulations applying to F4E could be adapted even further to the needs of a project such as ITER. Staff regulations were mentioned as a potential hindrance for adapting the F4E staffing fast enough to accommodate the changing needs of the project.
- It was mentioned that F4E contracts tend to place a high degree of risk on contractors. However, it was considered an improvement that new contracts include liability caps for contractors, since unlimited liability could distort the tender participation towards companies with high risk tolerance.
- ILOs indicated specifically that there was still scope for reducing the barriers for SME participation in tenders.
- In telephone interviews with other external stakeholders, it was perceived that in previous years, bids taking due account of risks and eventualities were at a disadvantage in F4E procurement procedures due to their higher prices. However, an improvement in evaluation criteria in recent years was noted.

EQ5 Analysis of the Performance Framework

Interviews with F4E
Interviews with F4E staff using the IMS (KPIs and Milestones) on a daily basis have been carried out. Interviews contributed to the evaluator's understanding and assessment of the tool:
The top-level milestones are the "ITER Council milestones", which are those pertaining to the ITER project as a whole; the next level milestones are "Governing Board milestones", focusing

[444] Ramboll on the basis of European contribution to ITER survey results 2018; responses to questions 3, 5c, 8 and 10c

only on the EU contribution; below this, there are thousands of "working-level milestones", which are intermediate milestones used internally by the F4E management for monitoring. Since the implementation of the Prima Vera on-line system, each project has the possibility to create and follow (online) its own milestones. According to F4E interviewees, milestones are easy to measure and easy to control; also, the system is easy to use for scheduling and making adjustments.
ITER has two core KPIs: SPI and CPI. Schedule Performance Indicator (SPI) is based on the working-level milestones; it is monitored in terms of how many of the planned milestones are achieved by the planned dates. Cost Performance Index (CPI) is used at corporate level; it is monitored in terms of how close it is to the budget ceiling agreed by the ITER Council.
Besides the overall KPIs, almost all Services of F4E have their own KPIs for internal F4E uses. An example from the Procurement unit is the number of contracts signed per man-month.
F4E staff's opinion regarding the two core KPIs is divided. The two major KPIs measure what they are intended to, but are not a sufficient indication of F4E's own performance – they are more focused on project performance as a whole, and as such they are very relevant on a corporate level, but they can still be used as an indication of whether there is something that needs to be changed.
F4E staff's opinion concerning the working level KPIs is generally positive. Indicators are adequate to monitor progress towards milestones, and identify cost deviations at contract level. However, some of them would need to be adjusted to current needs, which can be different from 2014. One example mentioned particularly is KPI on working level is *number of contracts signed/man-month*. Respondents expressed opinion that it is not a critical issue to have a contact signed quickly, since there is a clearly developed framework presenting minimum and maxim of time for contract signing.

Efficiency

EQ6 To what extent has the European contribution to ITER (in kind and in cash) been cost effective?

Interviews with F4E
Interviews with F4E's project managers indicate that under the given framework and existing pre-conditions the European contribution to ITER is managed efficiently. However, the framework is intrinsically expensive in itself.
Regarding the main contracts the experience is that civil works such as the construction of buildings and foundations are primarily cost effective and are produced with the agreed costs including variation orders. The contracts for large components such as vacuum vessel, toroidal field coils and poloidal field coils are new technology deliverables and as such difficult to evaluate if designed cost effectively. In the new baseline focus is on achieving First Plasma 2025 and these contracts are scrutinised and very cost effective according to the project managers.
During the procurement a minimum of 2-4 tenders are required per contract. If there are too few tenders the Project Procurement Group have the possibility to go outside the Euratom agreement and have international tendering to avoid technical monopoly and achieve more competitive tenders. The split of production of coils for the Tokamak between different countries is not cost effective, but has other advantages such as knowledge transfer and economic effect shared between multiple economic actors.
A general remark from the interviews is that the European contribution to ITER is a political co-operation in a global research and development project of a future new source of energy that has never been done before. To evaluate the cost effectiveness in a traditional sense is very difficult. The ITER project cover over 25 years and this evaluation is for the period of 2014-2017. It is very difficult to evaluate the cost effectiveness over a very short time in a mega project like ITER. During this period a new organisation has been put in place with a new F4E director in charge. The results from all interviews are that it has been a very positive change in project culture and more efficient cooperation in the F4E organisation and with the ITER organisation. However, the long-term results are too early to recognize.

Interviews with IO
Interviews with ITER staff confirmed that there is a much better cooperation and improvement in communication on all levels in the organisations between F4E and IO management. A general comment is that F4E is a joint undertaking and that all member states are stakeholders and it is necessary to assure a proper communication between F4E and IO management because all of the countries are contributing to the European budget. After the reorganisation and the actions introduced by the new director it have been much better progress and collaboration. The interviews reflected that it has resulted in a more efficient project organisation and collaboration between F4E and ITER but the long-term effects remain to be seen.

EQ7 To what extent are the costs of the European contribution to ITER (administrative and operational) justified?

Interviews with F4E and IO
From the interviews of representatives from F4E and ITER organisation there are different opinions regarding the administrative expenditure. The F4E organisation is built on the framework for F4E and the co-operation between the member states which imposes a larger administration. Due to the EU procurement regulations and legal framework in the EU there is a need for larger administration compared to the other Domestic Agencies which have their own independent organisations. One reflection is also that F4E are responsible for the procurement and contract management which also requires more administration.
The results from the interviews from the ITER organisation reflect an opinion that the administrative organisation in F4E is too large. Requests to the F4E organisation take a lot of time due to complex administration and high involvement of legal administration.

Survey
The survey indicated that a majority of GB and ILO respondents (67%) believe the European contribution to ITER (In-kind) delivers value for money but only a minority disagree (10%). A small majority (52%) believe the Administrative and operating costs of F4E are justified and a minority (24%) disagree. When it comes to the new management a majority (81%) believes the new management reorganisation at F4E since 2015 had a positive impact on the efficiency of the European contribution to ITER and its ability to deliver on time and within budget. Regarding the new project baseline, a majority (86%) believe it had a positive impact on the efficiency of the European contribution to ITER, and its ability to deliver on time and within budget.

EQ8 What factors influenced the efficiency with which the achievements observed were attained?

Interviews with F4E
Several of the interviewees have commented on improvement in organisation cooperation and project culture after the management reorganisation and actions introduced by the new Director Johannes Schwemmer. These improvements had to be done to change the project culture from a R&D oriented organisation and into a more construction oriented project organisation.
One major factor influencing the efficiency of the European contribution is the large number of collaborating countries in F4E and the legal framework around F4E that is not adapted for a very large international construction project.
The interviews also confirmed that strengthened nuclear safety regulations have been imposed since the Fukushima accident which has led to stronger requirements and improved training in the project in order to have a stronger nuclear safety culture.
There were also some concerns regarding the development in Great Britain and Brexit and that it could affect the cooperation in the future, but no effect has been seen so far.

Interviews with IO
Interviews with ITER staff confirmed that there have been much better progress and collaboration since the management reorganisation and the actions introduced by the new director Mr. Schwemmer. The interviews reflected that it has resulted in a more efficient project organisation and collaboration between F4E and ITER but the long-term effects remain to be seen.
There is difference between the IO and F4E organisation with regards to organisational efficiency in terms of legal framework and regulations for procurement and contracting. There is a lack of flexibility for this large one-of-a-kind project which has an impact on efficiency.
Also, the interviews confirmed the perception that F4E has to follow EC regulations that are not adapted for large first-of-a kind project like ITER. This imposes a higher level of administrative burden which leads to delays and cost impact. There has to be more flexibility for project procurement and contract management in these large projects.

EQ9 To what extent are the costs associated with the European contribution to ITER under the new baseline proportionate to the benefits (direct and indirect ones) generated?

Interviews with F4E
Interviews with F4E confirm that the ITER organization and the domestic agencies work towards the same overall milestones with ITER as a coordinator between the domestic agencies. The interviewees unanimously state that the project management has been improved with the project reorganisation and new baseline. In 2014/2016 focus became on compliance with the

rules, and from 2016 how to get results cheaper and more efficient. Interviewees acknowledged that there has been a lot of change to the project, particularly within the last two years with more focus on delivery than research. With the reorganisation, a project management department was formed in F4E, and interviewees perceived a clear benefit from it, both in terms of confidence in their ability to deliver and actual performance in delivering on time and budget.
Interviewees reflected upon a positive change of project management culture based on shorter goals, which makes it easier to monitor and assess the results of the work and take corrective actions. For example, it was clearly stated that the overview of the milestones with the new monitoring database make it easier to follow the progress. Interviews related that now projects have their own milestones in the Prima Vera system. Progress and analysis of achieved milestones are presented during project management meeting once a month with the Technical group. Milestones are perceived easy to measure and easy to control among the interviewees. The Prima Vera system is also experienced as easy to use for scheduling and adding changes. Anytime there is a deviation the Finance Department keeps track of deviations to cost, registering them in ABAK and updating the commitment to pay. The Finance Department also checks the invoices and asks the technical team whether the milestone deliveries have been sufficiently completed before proceeding to payment.
Interviewed mentioned significant improvement on the risk management. There is also a greater willingness to perform risk management in cooperation with IO. Risk management is carried out on several levels in the organization both at corporate level and project level. Risk assessment is shared with IO and updated on major changes. The contractors have to make their own risk assessments and share them with F4E. For most contracts there are weekly follow-up meetings where the risk management is a part of the agenda. Risk management is done through Primavera planning tool which offers Risk Register management features.

EQ10 How timely and efficient is the process for reporting and monitoring?

Interviews with F4E
The findings presented below are based mostly on open and in-depth interviews that have been carried out with managers of the following units: Project Management (PM), Market Intelligence (MI), Project Procurement Group (PPG), and Unit for Process and Organisation Improvement (POI). Since the character of activities at each unit is different, and that has an impact on reporting preconditions, as well as availability of reports when needed, findings are reported individually for each unit. Below, the most significant findings from the interviews are presented.
Interviews, in order to give a more complete picture, have also been carried out with managers of different units at ITER. The most important findings are also summarised in the presentation.
PM helps Technical Officers (ITER) of each major project in finding and defining milestones as well as scheduling of the project. Input data is placed into the Prima Vera system and daily updated from the ITER database. Results (KPIs) are automatically extracted and calculated, and easy to understand. Presentation of KPIs related to the progress or deviations of each major project takes place once per month and includes also explanation for deviations. Since all progress data is on-line and available freely, there are no obstacles for meeting deadlines or to have access to relevant report. All other functions can download input data as well as analysis without hinder when needed. F4E concludes that degree of meeting deadlines as well as degree of accessibility is equal with 100%. The administrative load is identified by the F4E to be proportionate to the scope since system is on-line and automated.
MI communicates once per year with Technical Officers in order to recognise and register problems that appeared in contracts related to major projects. Data is downloaded into Supply Chain Management Database, and is easily accessible by any function when needed since system is interactive to all F4E staff. So far there has been no particular deadline for updating Supply Chain Management Database, except for when request for Market Survey appears, so it was concluded by the F4E manager that there is no deviation in meeting deadlines or in making reports accessible when needed.
Prior to launching new procurement process the Market Survey is requested by PPG. Since the date of announcement of the new procurement, that defines dead-line for the Market Survey Report, is known long time in advance, there is no problem to meet the deadline with delivery of the Market Survey Report according to interviews. Lack of necessary resources at MI causes that the targeted (50 Reports/year) number of Market Surveys is not met.
The administrative load is found by F4E not to be proportionate to the scope since the Integrated Reporting System that will present MI's KPIs is fairly new, and the input data entered into the system is not always of good quality.
PPG visits sites if project activities take place there, or visits contractors if activities are running at contractor place. After signing the contract, PPG's role is to follow up contract implementation by controlling monthly measurements of estimate costs at completion. Input data enters DAC

system, and by "push" system is available in e-mail for registered receivers. Monthly meetings with PM give opportunity to highlight the cost situation. If the contract costs are increasing over estimated budget, there is a possibility to inform Cost Centre in order to negotiate the new budget. F4E opinion is that because all projects are slow, the deadlines of monitoring and reporting are easy to meet. Since all data is in the DAC system, it is easily accessible on-line when needed. No particular disproportion in administrative burden in relation to the scope was mentioned.

POI is responsible for improvement of activities and processes, especially concerning organisation performance and contract management. POI uses DAC, integrated database and electronic tool for managing contract deviations. Functionality includes automatic reminders, e.g. when measures are close to optimum or close to exceeding maximum. Process design is monitored on an ongoing basis, and improvements are suggested where relevant. Improvements are typically introduced through projects. F4E Process Manual is fully electronically available on the F4E intranet, and directly linked to the document management system which includes templates, etc. Digitalisation of contract management helps to meet reporting deadlines according to F4E, however not all processes are fully digitalized. Monitored and reported data concerning contract management is saved in DAC and available when needed. The administrative burden has been described as reasonable to the scope.

Prima Vera System is a software for project intensive industries such as engineering and construction, aerospace and defence, utilities, oil and gas, chemicals, industrial manufacturing, automotive, financial services, communications, travel and transportation, healthcare, and government (Oracle). The field visit at F4E was an opportunity to observe the use if the system, which appeared to be very supportive to project managers in providing reporting tools and dashboards for monitoring and analysing performance data of each project.

Finally, it should be noted that interviews at F4E revealed that the quality of monitoring data could be improved.

Interviews with ITER Organisation

Interviews carried out at ITER Organisation confirmed that F4E was able to deliver reports on time. The reporting process experienced by ITER has increased in quality and credibility, as clearly stated during interviews. Common reporting system for project monitoring, between IO and F4E, provides input data on-line.

However, some disappointments regarding quality of documentation coming from F4E was expressed. One possible reason that was mentioned might be not fully corresponding IT systems for monitoring and reporting. There are different reporting platforms in use by different departments that are integrated in IRS, but probably are not fully compatible. Another aspect that has been highlighted as a possible reason is that input data might be not entered correctly because of lack of competence of person carrying this activity.

Relevance

EQ11 How well do the (original) objectives mentioned in F4E's Statutes (still) correspond to the needs and policies of the EU?

No interview or survey has been carried out for this evaluation question.

EQ12 How has the development of the new project baseline contributed to sustaining the project's relevance?

Interviews F4E

Some interviewees in F4E saw potential risks for the long-term performance of F4E stemming from the focus on FP as defined in the staged approach. While this approach on the one hand entails several benefits (see EQ 9) it is seen by stakeholders also as a potential risk since it deviates resources away from most activities that do not directly contribute to reaching FP. This is perceived by some stakeholders as a risk, e.g. when fewer staff and financial resources are made available for activities than sought or than having been available in the past. Even though there is indeed a potential for such risks they are difficult to pinpoint and will, if at all, manifest slowly over time.

EQ13 What improvements to the relevance of the project have been brought through the turnaround in ITER Organisation and F4E since 2015?

Survey

The survey revealed a mixed picture regarding the stakeholders' opinion about changes in the relevance of the project since the management reorganisations in F4E and IO. While 75 % of the GB members strongly agreed and agreed that the management reorganisations had a

positive impact on the relevance of the project no survey participant from the ILOs agreed with the statement while 57 % neither agreed nor disagreed. The results should be seen against the background of the interfaces of the two groups with the F4E and IO. The GB group is closely involved in the development of F4E and has direct contacts with IO. The ILOs, on the other hand, are predominantly receiver of information about upcoming procurements[445]. As explained in EQ4 above the effects of the turnaround on procurements and projects is a slow process and improvements are indirect in nature (as compared to direct improvements in internal processes etc.). It can be expected that this delay, the indirect nature of changes and the limited interface of ILOs with F4E led to a large extend to the results and differences in perception.

EQ14 To what extent are the objectives of ITER relevant to the needs of EU and its policies?

No interview or survey has been carried out for this evaluation question.

EQ15 Does the European contribution to ITER adapt adequately to technological or scientific advances?

Interviews with IO and external stakeholders
The general opinion of interviewees at IO and external stakeholders is that the European contribution to ITER adapts adequately to technological and scientific advances.
No interviewee pointed out a major scientific or technological advancement that should have been considered by F4E.
Stakeholders at IO agreed that it is IOs task to deliver stability in the project and that the core of the project cannot be changed. This is for two reasons: The governance structure of ITER as agreed on in the IA does not allow for major changes since allocation of machineries and costs have been agreed on in this agreement. Additionally, the nature of the project with the interfaced in-kind contributions from different actors requires a steady design.
Within this framework F4E has limited space to adapt for example in the design of smaller components. Other interviewees consistently stated the impression that F4E shows interest in new developments and uses this limited space adequately. On the other hand, concerns have been raised that the procurement processes might rely too heavily on selection criteria such as references, numbers of years of experience and financial strength for innovative SMEs to be able to join the procedures.

Survey
Stakeholders of both surveyed groups mainly agree that F4E adapts adequately to technological and scientific advances. 14% of respondents from ILO disagree with the statement (0% from GB members).

Coherence

EQ16 To what extent is the European contribution to ITER coherent with other Commission initiatives?

No interview or survey has been carried out for this evaluation question

EQ17 To what extent is European participation in ITER coherent with the wider EU policy (Energy, Research, Climate, Environment)?

No interview or survey has been carried out for this evaluation question

EQ18 To what extent is the European contribution to ITER coherent with international obligations?

No interview or survey has been carried out for this evaluation question

EU added value

EQ19 What is the additional value of EU intervention (Euratom participation in ITER) compared to what could have been achieved by Members States at national level?

Survey

[445] In addition they also work with F4E on the improvement of procurement procedures.

The survey results show a clear agreement that there is an added value from an intervention at EU level as compared to what could be achieved at national level. More than 90% of both surveyed groups agree or strongly agree that the Euratom participation in ITER provides a higher value compared to what could be achieved at national level with minor difference between the groups (Q16a). Overall agreement has also been stated for the statement that the intervention at EU level provides efficiency gains (e.g. lower administrative and operating costs) compared to what could have been achieved at national level. All respondents from the ILO agree or strongly agree with this statement while 15% of the GB members disagree with this statement and another 15% neither disagree nor agree (Q16b).

Interviews with external stakeholders
Interviewees of the other stakeholder group in general recognise an added value coming from the intervention at EU level compared to what could achieved by all or selected EU Member States. Interviewees stated that an intervention at EU level overall brings added value to Europe in terms of influence and widespread access to high-tech R&D. Likewise, interviewees stated that the ITER project profits from an EU intervention by increasing political stability. At the same time, it is generally acknowledged that the governance structure of a European undertaking is complex and that such partnerships are challenging.

EQ20 To what extent do the issues addressed by Euratom's participation in ITER project continue to require action at EU level?

Survey
Survey respondents of both groups unanimously agreed or strongly agreed that the objectives addressed by Euratom's participation in ITER continues to require resources and action at EU level (Q16c). When asked the respondents if they agreed that EU Member States would not continue contributing to ITER in the absence of EU coordination via F4E the opinion between the two groups differ. In the group of the ILOs 57% strongly agreed with this statement while at the same time 29% strongly disagreed with the statement and 14% disagreed (Q16d). On the other hand, 70% of respondents from the GB strongly agreed or agreed with this this statement

Interviews with external stakeholders
As mentioned above interviewees consistently stated that an EU intervention currently brings added value. However, some interviewees stated that this might change after the construction phase, i.e. in the operational phase of ITER as well as for DEMO[446]. However, the respondents also stated that those assumptions are purely theoretical since they are subject to a very high level of uncertainty in the future development of the project.

Acceptability

EQ21 To what extent can we observe changes in the perception of Euratom's participation in ITER (positive or negative) by the targeted stakeholders and by the general public?

Interviews with F4E
Interviews show that most stakeholders think that F4Es performance has increased over the last few years.

Interviews with IO
Interviewees at IO have highlighted the perception that F4E's communication efforts are in times focussed too much on F4E and not on the overall project, also in comparison with the communication efforts of other DAs. However, it also was also acknowledged that since the DAs are not only about ITER (e.g. F4E also works on the BA) they should be able to market themselves beyond ITER too while focusing on the message that ITER is a group project. IO stakeholders also stated the perception that the communication of F4E seems to be too much focused on engineering and procurement progress instead of the unique nature of the ITER project.

[446] For DEMO there is no detailed timeframe or agreement on how it will be governed yet. The assessment of an involvement of Euratom or EU Member States in DEMO is out of scope of this project. However, it should be pointed out that F4E was set up for a period of 35 years, i.e. until 2042. Given the delays in the ITE project it is probable that the results from its operational phase will only become fully available at a point in time where the feasibility of construction of DEMO is without the scope of those 35 years.

Interviews with external stakeholders
In interviews with other stakeholders the largest share of interviewees states that F4E's work has become more effective, results-oriented and reliable after the turnaround in the organisation.

Interviews with other stakeholders
In interviewees with other stakeholders this point has been advanced with frequent mentioning of F4E's and IO's shortcomings in explaining and highlighting the differences between fission and fusion.

Survey
The survey asked the participants two questions concerning acceptability; a question about the development of the respondents' perception of Euratom's participation to ITER over time (Q18a) and their opinion about the development of the general public's perception of Euratom's participation in ITER over time (Q18b)[447]. In general respondents don't seem to have strong opinions about this; in the ILO group for both questions 43% of respondents did neither agree nor disagree; in the GB group, those shares were 24% and 36% respectively. The results for the first question (43% agreement and 14% disagreement from ILOs and 72% agreement or strong agreement from GB members) are overall more positive than for the second question. In the second question the ILO group is discordant with 14% agreeing, disagreeing, strongly disagreeing and not knowing, respectively. The picture is similar for GB members even though slightly more positive with 28% agreeing, 12% disagreeing and 24% not being sure. Those results could point to a lack of definition of the question. As stated above interviewees generally pointed out that there seems to be a very limited awareness of the general public about the ITER project and even less so of F4E. It is likely that against this background respondents of the survey were unsure on how to reply to this question since if there is no awareness the reputation cannot improve.

[447] The results need to be interpreted with care since the questions only referred to developments "over time" without specifically referring to the time since the management turnaround. Even though referral was made to this specific timeframe in the introduction of the survey it is possible that respondents did not recall this referral when replying to this question.

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