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**REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE
COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE
COMMITTEE OF THE REGIONS**

**Interim Evaluation of the implementation of the Council Decision (Euratom) 2021/281
amending Decision 2007/198/Euratom establishing the European Joint Undertaking for
ITER and the Development of Fusion Energy and conferring advantages upon it**

{SWD(2026) 289 final}

I. INTRODUCTION

ITER is an international scientific collaboration project aiming to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes. The ITER Agreement, signed in 2006 between Euratom¹ (represented by the European Commission), the United States, Japan, Korea, China, Russia, and India, has set up the ITER Organisation (IO) as an international organisation for the construction, operation, exploitation, and deactivation of the ITER² facilities in Cadarache, France, and provide for its decommissioning. The ITER Agreement binds each Party to provide contributions in-kind (components necessary for the construction of the ITER device) and in-cash (financial funds for IO operations).

Each Party to the Agreement must set up a Domestic Agency (DA) as an entity for coordinated interaction with IO and supply of contributions on behalf of the Party. Euratom's Domestic Agency is the "European Joint Undertaking for ITER and the Development of Fusion Energy" (Fusion for Energy – F4E), which was established by Council Decision 2007/198/Euratom³ in March 2007. The Decision sets F4E's tasks as follows:

- to provide Euratom's contribution to the ITER Organisation⁴,
- to provide Euratom's contribution to Broader Approach activities with Japan⁵,
- to prepare and coordinate the preparation of the construction of a demonstration fusion reactor (DEMO) and related facilities.

F4E's members at present are Euratom (represented by the Commission), the EU Member States of Euratom⁶ and Switzerland. Third countries may become members of F4E under conditions specified in the Council Decision 2007/198/Euratom establishing F4E. The budget of F4E is 80% funded from the EU budget. France as the ITER host country funds almost 20%. The remainder is covered by membership fees of other F4E members.

The Council Decision (Euratom) 2021/281⁷ amending the Council Decision 2007/198/Euratom requires the Commission to carry out an interim evaluation of the implementation of the Decision. The Commission has prepared this interim evaluation with the support of an external contractor⁸ to assess Euratom's participation in ITER through F4E in line with Better Regulation principles. The evaluation is meant to:

1. inform on the status of the "ITER Programme".

¹ Euratom (the European Atomic Energy Community) is an entity legally distinct from the EU but with the same membership.

² ITER is an international scientific collaboration project aiming to demonstrate the scientific and technological feasibility of fusion energy for peaceful purposes.

³ [2007/198/Euratom: Council Decision of 27 March 2007 establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it](#)

⁴ During the construction phase, Euratom's contribution represents around 45% of the construction cost of ITER. The other ITER Members' shares are around 9% each.

⁵ In parallel to the ITER Agreement, Euratom entered into a separate bilateral agreement with Japan (the "Broader Approach" Agreement (BA)) to further facilitate and coordinate fusion-related activities with Japan.

⁶ This included the UK up the entry into force of the Withdrawal Agreement (31 January 2020),

⁷ [Council Decision \(Euratom\) 2021/281 of 22 February 2021](#) amending Decision 2007/198/Euratom establishing the European Joint Undertaking for ITER and the Development of Fusion Energy and conferring advantages upon it. (see in particular, Article 5c)

⁸ The Commission has published the report by the contractor selected to provide external input to the interim evaluation: https://op.europa.eu/en/publication-detail/-/publication/e8d31d19-f590-11ef-b7db-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=153343&WT.ria_f=8810&WT.ria_ev=search&WT.URL=https%3A%2F%2Fenergy.ec.europa.eu%2F

2. provide elements for the improvement of Euratom's ITER Programme and the working of F4E in the period 2025-2027.

The evaluation is primarily focused on the European participation in the ITER Project through Fusion for Energy during the first part of the current Multiannual Financial Framework (MFF), namely the period 2021-2024.

It assesses the performance of the ITER project and F4E against the project baseline (defining scope, schedule and budget) approved for the ITER project for that period (Baseline 2016) and F4E planning documents derived on its basis⁹. A new baseline was presented by the IO in June 2024 at the request of the ITER Council, and its execution is therefore out of the scope of the present evaluation.

II. WHAT WERE THE ACHIEVEMENTS OF EUROPEAN PARTICIPATION IN THE ITER PROJECT THROUGH F4E IN THE PERIOD REVIEWED?

a) Overview of F4E performance in a nutshell

The evaluation of Euratom's participation in the ITER project through F4E as required by Council Decision 2021/281 looks at the progress that F4E has been able to achieve on the three strategic objectives defined in that Decision. The members of the F4E Governing Board gave in a survey conducted in 2024 an overall positive assessment of F4E's performance. To the question **"to what extent are the original objectives of F4E met?"**, most considered **that F4E fulfilled its objectives and activities defined in the statutes of F4E (as per Art. 2 and Art. 3 of the Annex of Council Decision 2007/198/Euratom)**¹⁰.

A more thorough assessment of F4E performance needs to distinguish between the different areas of F4E activities as presented below.

For ITER: Over the period under review, F4E has delivered a significant part of its expected contributions to ITER. It has signed 24 major engineering and construction contracts representing a total committed value of EUR 3 bn¹¹. F4E has delivered a major part of the buildings on ITER's site in France and the European parts of the ITER magnet system (which is the largest and most integrated superconducting magnet system ever built). These major achievements were further complemented in October 2024 by the delivery of the first European sector of the Vacuum Vessel¹², to be followed by the other sectors until mid-2026.

While these achievements are undeniable, progress was not always in line with the 2016 Baseline. By the end of 2023, the budgetary execution and achievement of key milestones defined by the ITER Council (IC) and F4E Governing Board (GB) were below expectations:

⁹ Following the approval of the 2016 Baseline, F4E set a 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 projected for 2025. The EAC combines past actual costs and future estimated costs (including the likely impact of future risks) for the completion of F4E's ITER responsibilities until the end of 2035.

¹⁰ Figures provided in the supporting study available at : https://op.europa.eu/en/publication-detail/-/publication/e8d31d19-f590-11ef-b7db-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=153343&WT.ria_f=8810&WT.ria_ev=search&WT.URL=https%3A%2F%2Fenergy.ec.europa.eu%2F; see page 326 – question 1- sum of the answers "to a large extent" and "to a certain extent".

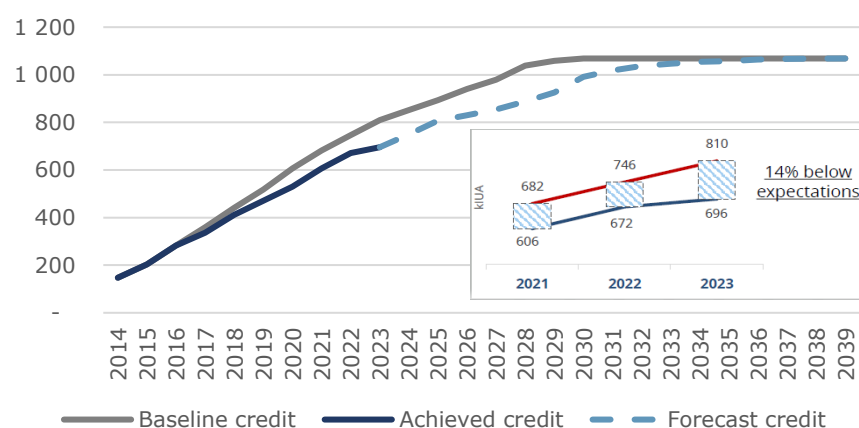
¹¹ <https://www.youtube.com/watch?v=gTc83Ql8djA&t=31s> (ITER Construction, October 2024)

<https://www.youtube.com/watch?v=NRaFSpd7cwA> (ITER Construction, October 2023)

¹² <https://fusionforenergy.europa.eu/news/europes-first-iter-vacuum-vessel-sector-ready/>

F4E had collected 65% of its ITER credits¹³, 14 percentage points lower than planned in the 2016 Baseline. The milestones, which are defined by IO governance (IC Milestones) and F4E governance (Governing Board milestones) to monitor progress of the ITER project, are also delayed by 32 months on average compared to the Baseline 2016.

Figure 1. ITER credits compared to 2016 Baseline in kIUA¹⁴



The EU budgetary authority allocated in MFF documents EUR 5.6 bn for the funding of F4E in the period 2021-2027. The slower execution of the project has generated significant underspending resulting in an accumulation of unused appropriations in F4E over the period 2021-2024. The Governing Board and the Commission have acted to adapt the annual budgets of F4E according to its needs. Based on the principle of sound financial management of EU resources, **EUR 1 bn out of EUR 5.6 bn** have been returned in the current MFF to the general EU budget to align the annual budgetary decisions on commitment appropriations to the actual needs of the project.

Table 1. Euratom commitments for ITER in the multiannual financial frameworks

	2007-2013	2014-2020	2021-2027
European contributions in commitment appropriations (MEUR)	3 273	2 915	4 562

For Broader Approach (BA): The BA programme consists of three major projects: i) Satellite Tokamak Programme (JT-60SA)¹⁵, ii) the Engineering Validation and Engineering Design Activities for the International Fusion Materials Irradiation Facility (IFMIF/EVEDA), and iii) the International Fusion Energy Research Centre (IFERC)¹⁶. Euratom’s contributions to BA activities have been delivered by F4E globally in line with the agreed timeline. Over the period

¹³ The ITER credits are the units used by ITER to define a value of in-kind components which DAs have to deliver and have agreed in Procurement Arrangements (PAs). Each of them represents specific work to be performed and delivered by the DAs to IO. Each PA specifies milestones agreed between IO and the DA concerned and used to mark the progress in the execution of the PA. The achievement of each milestone corresponds to a certain release of credits denominated in ITER unit of account (IUA). A similar system exists for the BA programme, whose unit of account is the BAUA.

¹⁴ The units used by ITER or BA. For the ITER project, the in-kind contributions to IO are organised through Procurement Arrangements (PAs) representing specific work to be performed and delivered to IO. When a PA is developed by IO, the milestones agreed to mark the execution of the project correspond to a certain release of credits denominated in ITER unit of account (IUA).

¹⁵ To build and operate the most powerful fusion machine in the world, JT-60SA, until the completion of ITER construction.

¹⁶ A project that carries out different sub-projects in fusion science using supercomputing equipment.

2021-2023, Euratom through F4E devoted EUR 72 million for the BA activities. Important achievements in the evaluation period include the inauguration of the JT-60 SA in late 2023. This inauguration was followed by a period of maintenance and repairs and will resume shortly with the start of the first experimental campaigns. JT-60SA is currently the largest and most advanced fusion research device in operation worldwide, and its performance will provide critical insights for the construction and operation of ITER.

To maximise the return on the EU's investment – and to ensure that Europe remains at the forefront of the global race to make fusion a viable energy source – it is essential that European scientists take the privileged opportunity to access JT-60SA, participating in, and learning from, the operation and exploitation activities.

For DEMO: F4E invested limited resources in the preparation for the construction of the DEMO reactor mainly because the delays and challenges encountered in ITER implementation required more F4E resources to address them. According to Council Decision 2007/198/Euratom, F4E is “to prepare and coordinate a programme of activities in preparation for the construction of a demonstration fusion reactor (DEMO)”. The overall delays in ITER also implied that the key fusion technologies have reached a lower level of maturity than would be needed for industrial activities in preparation for DEMO. F4E's involvement in DEMO activities was, therefore, primarily channelled through specific projects under the BA Agreement and collaborations with EUROfusion, which manages European fusion research activities funded through the Euratom Research and Training Programme.

b) Analysis of the cost overruns and delays in ITER construction

The ITER project has experienced major delays and cost overruns during the period under review mainly due to:

- i) **Overly ambitious Baseline 2016 adopted by the ITER Council.** The Baseline 2016 was based on the best technically achievable schedule and excluded any type of contingencies (in schedule and costs) which has deprived the project of the flexibility needed for coping with First-Of-A-Kind issues and added a degree of difficulty to its overall management.
- ii) **Design readiness and First-Of-A-Kind nature:** The programme faced significant cost overruns due to the numerous design changes and sometimes unnecessarily complex technical requirements. These repeated changes (particularly for buildings) led to claims lodged by the F4E contractors and contributed to cost increases. Several components that F4E had to deliver also posed technical challenges, often underestimated by the IO and F4E, and took longer to manufacture than agreed or expected. The Estimate Cost At Completion (EAC)¹⁷ for F4E increased by EUR 1 205 million between September 2020 and December 2024.
- iii) **Quality issues.** The IO detected in 2022 quality problems on key components (vacuum vessel sectors and cryostat thermal shields) delivered to the site¹⁸. These components had to be repaired. The repairs required two years to be executed. The IO optimised the machine assembly works to mitigate the impact of the repairs on the overall project schedule.

¹⁷ The EAC combines past actual costs and future estimated costs (including the likely impact of future risks) for the completion of F4E's ITER responsibilities until the end of 2035.

¹⁸ First, several thermal shields, designed to keep ITER's liquid helium refrigerant cold and protect the walls of the machine, corroded and cracked because of the way the welds interacted with an acid used to wash the metal. Secondly, certain components of the vacuum vessel, intended to interlock with extreme precision, were found to lack the required manufacturing accuracy. (Source: F4E (2023). Consolidated Annual Activity Report 2022).

- iv) **COVID-19 pandemic and the consequences of the War in Ukraine.** The COVID crisis added delays to the situation. The COVID-19 pandemic explained most of the delays in 2020 and 2021. The restrictions of circulation, travel and work attendance imposed during the pandemic slowed the manufacturing, shipping and installation of critical components.
The manufacturing cost increased significantly across all EU components due to the inflationary pressures triggered by the COVID-19 pandemic and subsequent geopolitical events, most notably Russia's invasion of Ukraine. These events drove up the prices of raw materials such as steel, which are integral to the construction of ITER components.
- v) **Regulatory challenges.** The technical documentation and answers provided by the IO on several licensing issues (such as neutronic fluence, radiation maps, seismic calculations and welding of the Vacuum Vessel) were not mature enough at the time of their initial submission to the Nuclear Safety Authority of France – currently referred to as the Nuclear Safety and Radiation Protection Authority (ASNR). In consequence, the ASNR informed the IO in January 2022 that the Tokamak Assembly Hold Point, a key regulatory milestone would not be lifted at the time assumed by IO. This led to the suspension of all “irreversible” assembly activities¹⁹ until IO provides information sufficient for the ASNR to proceed to the re-examination of these licensing files.

While not having been able to meet its commitments from one year to the next over the period of the interim evaluation, F4E has recently improved the preparation and execution of its work plans. Before 2023, F4E's milestone completion rate was in the 50-60% range, reflecting a lack of reliability in its own forecasts, resulting in cumulative delays year after year. In 2024, F4E reported a significant improvement, with 84% of the milestones achieved.

III. MEASURES TAKEN TO IMPROVE THE PERFORMANCE OF THE ITER PROJECT

At the level of the IO: Since taking up his post in September 2022, the new Director General of the ITER Organisation (IO DG) has worked on the re-baselining of the project and on a series of management reforms to get the project back on track. In particular, the IO DG thoroughly changed the organisation, putting a project matrix structure in place, and streamlined the decision-making process. In addition, he eliminated one layer of management and completely reorganised the management team in which he gradually introduced a system of delegations²⁰. The IO has also identified ways of repairing key components supplied by some Members (Vacuum Vessel sectors and thermal shields) and has improved the interaction with the French Nuclear Safety Regulatory Authority (ASNR). Although many challenges remain, a noticeable improvement was recognised by the ITER Council in 2024²¹.

At the level of F4E: F4E underwent a thorough reorganisation to implement the reforms deemed necessary by the F4E Governing Board after a suicide case, which occurred in May 2021 and led to a strike by F4E staff. The events revealed a culture of overwork, stress and unacceptable management practices. It led to the dismissal of the F4E Director in June 2022.

¹⁹ Irreversible activities include for instance the welding of Vacuum Vessel Sectors together.

²⁰ Source: IC-32/10 Director-General's Letter (DG/2023/OUT/0114 (94EGSL) – paragraph “reorganisation”.

²¹ Minutes of the Thirty-Fifth Meeting of the ITER Council (IC-35), November 2024

Necessary measures were taken to safeguard the psychological welfare of all staff members and improve the distribution of workload within the organisation.

A new Director was recruited in May 2023 and received the mandate i) to ensure a closer integration between F4E and the IO; ii) to create a modern, diverse, and flexible organisation; iii) to accelerate the delivery of the European contribution to ITER according to the agreed schedule, budget and quality; iv) to work collaboratively and transparently with the Governing Board; v) to implement a sound financial management and improve budget planning and reporting; and vi) to renew the engagement with scientific and industrial stakeholders and the long-term perspective of F4E. On 1 July 2024, a new matrix organisation chart came into effect in F4E to streamline its management and improve interaction with IO.

The Commission took the lead in F4E governance to ensure that F4E management put in place the urgent measures requested by the Governing Board to preserve the staff well-being, for the selection of the new Director and to ensure that F4E focuses on its core mission and delivers its key components to ITER, for instance the Vacuum Vessel sectors. Commission Services representing Euratom in F4E governance revised their Supervision Strategy to particularly strengthen i) the monitoring of the progress of critical projects and of the performance objectives, ii) the identification of risk and mitigation measures, and iii) the preservation of the EU interests in the way F4E implements its mission.

Integration of IO and F4E: IO identified the integration of its activities with those of the Domestic Agencies as an area for improving the efficiency of the project. As a result, IO and F4E have been exploring ways to better integrate their activities and exploit the potential synergies and complementarities between the two organisations. Since September 2023, a major effort has been undertaken by F4E and IO to identify the most relevant activities and functions to be integrated, as well as to set up integrated teams that share schedules, tools (IT, databases, indicators) and information in the medium term and work more efficiently towards common objectives.

The expected outcomes of the integration are efficiency gains and potential savings, as the IO and F4E could jointly identify optimisations in the way components are designed, procured and delivered. This will be particularly relevant for the early design of components and systems (Hot Cell Facility, diagnostics, heating, in-vessel) that are yet to be delivered by F4E. In addition, integration offers new career prospects for F4E staff and will allow the retention of qualified staff, even after the delivery of the components. The conditions for the secondment of the F4E staff to the IO (IO and F4E staff statutes are different) have been clarified in an administrative agreement signed in 2024.

Baseline revision: In June 2024, the ITER Organisation (IO) presented a revision of the project Baseline (scope, schedule and cost), to mitigate key assembly and commissioning risks, define contingencies for schedule and cost, while incorporating lessons learned from previous first-of-a-kind activities. The new schedule introduced significant changes in the sequencing of the assembly of the ITER machine. As a result, the revised timeline now foresees the “Start of Research Operation”, with the first nuclear deuterium-deuterium (DD) operation in 2035 for which there is no delay compared to the previous schedule. The start of fusion power in the deuterium-tritium (DT) phase is now expected in 2039. This new Baseline is underpinned by a phased licensing approach according to which IO will manage the safety demonstrations required by the French nuclear safety regulator (ASNR) by phases, building on previous phases to reduce risks in subsequent ones.

IV. WHAT WAS THE IMPACT OF THE EUROPEAN PARTICIPATION IN ITER THROUGH F4E?

EU participation in ITER through F4E has had an important economic, social and technological impact. Since its creation, F4E has awarded a total of EUR 7.6 bn in public procurements and EUR 114 million in grants. This expenditure has benefited a wide range of European companies which have been able to demonstrate their excellence, develop new skills and technologies, and sometimes export their know-how²².

The macro-economic impact analysis in the assessment covering the period 2018-2024²³ indicates that compared with a situation where F4E-related spending did not occur and funds were instead saved, the approximately EUR 5.62 billion (in 2024 prices) spent by F4E is estimated to have generated about EUR 5.95 billion in additional Gross Value Added and supported around 39,000 job-years.

Turning to firm-level impacts, companies that supplied goods or services to F4E between 2018 and 2024 reported significant learning effects, strengthening both technical and organisational capabilities. F4E collaboration has generated meaningful knowledge and innovation impacts. Around half of surveyed firms reported product or process improvements, often through technological adaptation, while more advanced outcomes such as patents, spin-offs, or cutting-edge technologies were concentrated among a smaller set of suppliers.

In the context of the present interim evaluation, a survey of F4E contractors conducted in 2024 confirmed that **contracts with F4E had significantly improved their technical and organisational expertise**. Working on ITER construction has also contributed to scientific innovation and the development of new technologies as demonstrated by the 39 concrete applications²⁴. These applications are concrete cases of successful transfers of know-how gained through F4E contracts to industrial activities either in the nuclear field or in other sectors (hydrogen, tire industry, mobile machinery, etc.). On the other hand, while underlining numerous advantages to participate in the procedures for ITER (e.g., knowledge, gain in credibility, international development of collaboration), companies mentioned that their participation was not always synonymous with profitability and benefits. Importantly, several contractors indicated the need **to capitalise on the knowledge developed, and ensure that projects complementary to ITER are pursued**. If not, companies run the risk of losing the skills they have acquired with these contracts.

Other studies²⁵ highlight the spin-off effects of ITER. For example, the development of superconducting electromagnets for ITER by ASG superconductors has advanced technologies applicable beyond fusion²⁶, including medical diagnostics, semiconductors, electronics, and defence.

The European participation in ITER has enabled the emergence of a domestic EU supply chain offering European high-tech industries and SMEs valuable opportunities to innovate and develop ‘spin-off’ products for exploitation outside fusion. F4E has placed

²² For an example of knowledge transfer see <https://www.axios.com/pro/climate-deals/2024/05/01/commonwealth-fusion-progress>

²³ 13th ANNUAL ASSESSMENT OF FUSION FOR ENERGY, Final study report, 2025.

²⁴ <https://fusion-technology-transfer.europa.eu/fusion-technology-portfolio/>

²⁵ Such as the LGI and IHS Markit study (2020): [Follow up study on the economic benefits of ITER and BA projects to EU industry - Publications Office of the EU \(europa.eu\)](#)

²⁶ [Follow up study on the economic benefits of ITER and BA projects to EU industry - Publications Office of the EU](#)

the development and the constitution of a European nuclear fusion supply chain at the heart of its industrial policy. Recent initiatives show that the sector is beginning to structure itself in Europe: several startup's have been created and received significant funding²⁷. In addition, three nuclear fusion trade associations have been set-up in Europe in 2024, with the aim of federating the interests of start-ups and industries in the sector (European Fusion Association, Fusion Europe, and an EU branch of the Fusion Industry Association). This is a new trend: before 2024, there were no such associations in Europe specifically devoted to industrial nuclear fusion and only one in the US, the Fusion Industry Association, which reported progress in fusion mainly in the US and in Europe.

European involvement in ITER is also expected to make a positive contribution to the EU climate objectives in the long-term. That is why the Commission considers that 100% of the ITER-related expenditure for the 2021-2027 period contributes to the climate effort of the EU budget. The financial amounts spent on European participation in ITER are expected to contribute to the Commission's long-term climate goals, in particular, to "become the first climate-neutral continent by becoming a modern, resource-efficient economy". Although ITER is not expected to produce electricity, it is a key project for developing fusion energy, which has the potential to provide a new source of emission-free energy in the future. Participation in ITER therefore contributes to the long-term effort of the European Union to "ensure access to affordable, reliable, sustainable and modern energy for all".

Finally, as an example of a global partnership involving seven international partners (Euratom, the United States, Japan, South Korea, China, Russia, and India) representing more than half of the world's population, **the ITER project contributes to the goal to "Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development"**²⁸.

V. IS EUROPEAN PARTICIPATION IN ITER THROUGH F4E STILL RELEVANT FOR THE FUTURE?

a) Should European involvement in ITER be further pursued despite the challenging context?

The ITER Agreement stipulates that the Host Party, i.e., Euratom, may not withdraw from the Agreement and thus the project. Euratom is, therefore, the Party with the greatest interest in making ITER a success. It is also necessary to ensure that ITER remains relevant to justify the need for continued EU intervention.

Several fusion initiatives in the world have recently reported significant breakthroughs²⁹ and the rhythm of announcements has increased since 2021³⁰. Some countries – such as the

²⁷ Global Investment in the fusion private sector, Report from the F4E Fusion Observatory, 2nd Edition, 2025.

²⁸ Sustainable Development Goal 17

²⁹ Foresight study on the worldwide developments in advancing fusion energy, including the small scale private initiatives: <https://op.europa.eu/en/publication-detail/-/publication/83bc3ecd-b19c-11ed-8912-01aa75ed71a1/language-en/format-PDF/source-292762830>

³⁰ 1) The National Ignition Facility (NIF) in the US is the largest Inertial Confinement Fusion (ICF) initiative globally and in 2021 NIF facility achieved a world first burning plasma state 'ignition' in which the plasma is predominantly self-heated by fusion reactions in the plasma. In December 2022, a new experiment at NIF achieved "target gain," producing more energy from nuclear fusion (3.15 MJ) than the amount of laser energy delivered to the fusion target (2.05 MJ)—a metric for achieving a robustly ignited fusion plasma. Four additional ignition shots

United States, China, Korea, Germany, and the United Kingdom – have also developed their own fusion programmes and increased their financial support to public laboratories and/or private companies. At least 45 companies around the world are working to commercialise fusion energy. Some of the recently created private companies – which have been able to attract a growing amount of private funding – have set extremely ambitious targets to demonstrate commercial fusion energy production (i.e., in the next decade).

Various parties, including some within the fusion community, have begun to suggest that the commercialization of fusion energy may be imminent. While this optimism provides motivation and attracts investment, it can also obscure the scale of the technical and financial challenges still lying ahead. Unrealistic expectations risk not only disappointment but also erosion of public and political confidence, which could in turn slow the very progress that ITER aims to accelerate. While extraordinary efforts have been made to incorporate within ITER as many reactor-relevant technologies as possible — including superconducting magnets, actively cooled plasma-facing components, tritium handling, and remote maintenance systems — its mission remains fundamentally experimental. ITER's objective is to explore and master the physics of long-pulse burning plasma operation, not to close all technological gaps required for a commercial fusion power plant. Several key technology gaps will remain beyond ITER's scope and will need to be addressed through complementary research and development. Cost remains one of the most significant barriers to fusion's long-term success. Public and political expectations should remain aligned with technical and physical reality, avoiding the risks posed by overpromising.

The Draghi report underlines that “Nuclear fusion is a disruptive technology that holds the potential to revolutionise the energy landscape in the second half of this century. [...]. It could play a pivotal role as a **low-carbon, climate-friendly, affordable and safe energy solution** based on an abundant and accessible supply of fuel material. The ITER project [...] has propelled the EU to the forefront of global fusion research, investing billions of euros in the industry's supply chain and research. Despite notable progress in global fusion research, its practical deployment remains several decades away, **necessitating further concerted effort and investment to bring this revolutionary energy source to market**”. Therefore, for the EU, the investment in ITER - and in fusion in general - continues to be fully aligned with its priorities,³¹ which are to build a prosperous Europe capable of bolstering its competitiveness and ensure its transition to a decarbonized economy.

Despite the emergence of public and private fusion initiatives that complement or pursue alternative paths than ITER, different stakeholders (including companies and laboratories) consider that **ITER is today a unique project capable of addressing all the technological**

followed the December experiment. The experiment made in February 2024 produced an estimated 5.2 MJ — more than doubling the input energy of 2.2 MJ. Fusion records in temperatures and sustained plasmas have also been set by the KSTAR (Korea) and EAST (China) tokamaks.

2) The JT-60SA tokamak in Japan, an EU-Japan collaboration under the Broader Approach agreement, reached first plasma late 2023.

3) Last 20 January 2025, China's Experimental Advanced Superconducting Tokamak (EAST), located in Hefei, has set a **new world record by sustaining steady-state, high-confinement plasma for 1,066 seconds**. That's nearly triple the previous world record of 403 seconds, which was also set by EAST, back in 2023. [Chinese "Artificial Sun" Achieves New Record in a Significant Milestone Toward Fusion Power Generation---Hefei Institutes of Physical Science, The Chinese Academy of Sciences](#)

³¹ https://european-union.europa.eu/priorities-and-actions/eu-priorities/european-union-priorities-2024-2029_en

challenges of fusion (including tritium breeding and plasma confinement) in an integrated manner.

ITER thus remains the single most important project currently underway to accelerate fusion development in the EU.

b) Should European involvement in ITER continue through F4E?

The views of the Members of F4E Governing Board (GB) collected during the preparation of this review also touched on the suitability of F4E for implementing Euratom's participation in ITER. In particular, over 90% considered that F4E delivered good quality components, equipment, materials, and other resources to the IO. However, the governance Members were less satisfied with F4E's capacity to coordinate its activities with IO (around 55% satisfaction).

The Members of the GB identified some factors that impaired the management of the project.³² Among these factors are: the lack of maturity of the design provided by and agreed with the IO, the overly ambitious baseline for First-of-A-Kind components, and the lack of flexibility to react to unforeseen circumstances. For them, the numerous F4E internal organisation changes, as well as the insufficient collaboration with IO, were detrimental to the ITER project. **They do not consider a revision of the mandate of F4E is necessary, but 51% think that some overlaps exist in the missions of F4E and IO.**

For its part, Euratom considers that a better integration between the IO and F4E is an indispensable improvement measure which has to be achieved for F4E to remain fit for its purpose, i.e., effective and efficient delivery of Euratom contributions to the ITER project, as well as other relevant programmes (notably BA and preparations for DEMO) in accordance with its mandate. Integration between IO and F4E must be achieved in particular on key upcoming technological projects (such as the Hot Cells). Actions are ongoing to this end, and their effectiveness will need to be monitored systematically.

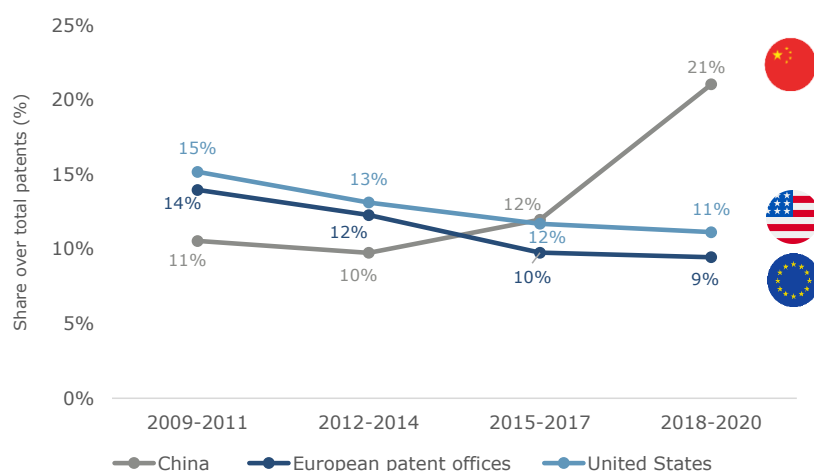
c) Can F4E deliveries of technologies and innovative components to ITER contribute to the EU's global competitiveness in key fusion technologies for future fusion power plants?

Despite the significant technological advantages associated with ITER in the EU, China and the US are moving fast, building on ITER progress and other initiatives, stimulated by an impressive increase in funding for start-ups and ambitious national programmes. Over the last decades, the EU share of patents has declined, and China, with its massive investments, has taken the lead in the race to the patents. China has recently stepped up its effort and could now "be spending \$1.5 bn each year on fusion, almost double what the US government allocated

³² Figures provided in the supporting study available at https://op.europa.eu/en/publication-detail/-/publication/e8d31d19-f590-11ef-b7db-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=153343&WT.ria_f=8810&WT.ria_ev=search&WT.URL=https%3A%2F%2Fenergy.ec.europa.eu%2F; see page 326 – question 6a and 6b - sum of the answers "neutral", "negative" and "not at all".

this year for this research”³³. China also launched a national consortium in January 2024 to build a nuclear fusion reactor by 2035³⁴.

Figure 2. Shares of nuclear fusion patents³⁵



F4E has already put some efforts into monitoring whether the components delivered generate patents and support the EU’s global lead in fusion technologies. This helps to assess whether the EU is strategically benefiting from its investments. As part of its mission³⁶, F4E GB adopted rules on industrial policy proposed by the F4E Director. This policy should serve the interests of European enterprises. By managing public procurement procedures, F4E is also building a network of companies that are likely to collaborate in the development of a commercialised fusion project. The need to create an efficient industry policy goes beyond its primary mission to deliver the components to ITER.

There is a growing risk that the benefits of ITER will be eroded by its ever-increasing cost and delayed implementation. The ongoing efforts by IO and F4E to optimise schedule and costs through re-baselining, reorganisation, and integration appear to be more important than ever. In parallel, efforts should be made to provide European high-tech industries and small and medium-sized enterprises with opportunities to innovate and develop components valuable and well suited to future commercial fusion reactors.

The EU should also support European enterprises to develop know-how and tackle the identified technological gaps in the path to achieving commercial fusion. In this respect, the Commission will consolidate of a strong EU supply chain and support a dynamic fusion start-up sector. It will encourage industry and research to collaborate to overcome technological

³³ Inside China’s race to lead the world in nuclear fusion (nature.com): https://www.nature.com/articles/d41586-024-02759-x?utm_campaign=nature&utm_medium=Social&utm_source=Twitter&mc_cid=fc9d5a2010#Echobox=172485496

³⁴ <https://www.ans.org/news/article-5668/china-launches-fusion-consortium-to-build-artificial-sun/>

³⁵ Note: "European patent offices" include the patent offices of individual Member States plus the European Patent Organisation, which includes all EU Member and other European countries such as Turkey, and the UK. The Patent Cooperation Treaty accounted for an average of 10% of patents. Japan and Korea also hold important shares (typically 8-12% each)

³⁶ <https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:02007D0198-20210101> – Annex – Articles 6 and 9

bottlenecks, enabling the construction of key enabling facilities for a first-of-a-kind fusion power plant.

The Commission is preparing a Public-Private Partnership in fusion in the form of a co-programmed partnership to involve the private sector not anymore as supplier, but as partners. The Commission will also enhance bottom-up support for the emergence and growth of fusion start-ups, by increasing Euratom co-funding under the Fusion EIC Challenge.

d) Can the EU participation in ITER through F4E be integrated more deeply in the wider fusion development?

The fierce global competition and the constantly evolving energy technologies environment require adjustments in policies and practices to guide the efforts of both the EU institutions and Member States. The contractor's support study points to the broad stakeholder consensus that European public policy intervention in fusion development should move away from a sequential approach to ITER and other initiatives (i.e., first build ITER, then other initiatives like DEMO) and that the EU should propose an overall strategy for the fusion sector.

The Draghi Report (2024) echoed this idea, calling for ***“an overarching EU innovation strategy for nuclear fusion energy and support the creation of a public-private partnership to promote its rapid, economically viable commercialisation. The partnership should aim to create a stable and predictable ecosystem for industrial innovation, leveraging the ITER project, while ensuring a clear technology development roadmap. The deployment of fusion energy will require public and private investment to act in synergy.”***

The Commission set up at the end of 2023 an expert group to assist in ensuring the coherence of Euratom activities on ITER and fusion research. This Fusion Expert Group (FEG), composed of 25 members nominated by EU Member States (Cyprus and Luxembourg not represented by their own decision) and observers coming from F4E and EUROfusion, formulated their views in a FEG Opinion Paper.

The Commission is currently developing a comprehensive strategy for further development of fusion in Europe, taking into account a wide range of inputs, including the FEG views as well as the results of further consultations of experts and of the public.

It is clear that public policy intervention at the EU level will be necessary beyond participation in ITER to help the development of fusion in Europe. This public intervention will be key for the construction of new research and technology infrastructures that will address remaining technology gaps in support of fusion. Such projects may offer opportunities for further involvement of F4E in wider fusion development.

The already ongoing construction of a European facility to test and qualify materials well-suited to fusion is a case in point. Following research projects carried out with EUROfusion, which demonstrated the relevance of the project, Spain and Croatia invested in IFMIF-DONES³⁷. Other countries, such as Italy and Japan, recently announced their contributions. In July 2025, the F4E GB decided on a contribution from Europe through F4E.

The experience gained through F4E is also highly relevant for further consideration of ways to strengthen and diversify the source of financing of fusion in Europe. While US companies have already attracted massive investments and other countries (notably China, UK) have significantly invested in fusion programmes, Europe too needs to develop instruments

³⁷ <https://ifmif-dones.es>

capable of financing innovative projects within the sector of fusion and seek to de-risk them by combining sources of funding coming from European, as well as national, sources.

VI. CONCLUSIONS

The evaluation focused on the European participation in the ITER Project through Fusion for Energy during the current Multiannual Financial Framework (MFF) for the period 2021-2024. The European intervention has generally achieved its objectives.

While external factors such as the COVID-19 pandemic and the inflationary context have had a serious impact on the project during the period under review, the main source of the difficulties has been structural: an overly ambitious Baseline 2016 with no contingency, frequent design changes, underestimation of project risks and complexity.

F4E and the IO did not meet all the objectives over the period of the interim evaluation. However, both organisations have recently improved the execution rate of the project.

Despite delays, ITER remains central to demonstrating the feasibility of fusion and to meeting the challenges of key enabling technologies. The project has created positive economic, industrial, and social impacts.

The macro-economic impact analysis in the assessment covering the period 2018-2024 indicates that compared with a situation where F4E-related spending did not occur and funds were instead saved, the approximately EUR 5.62 billion (in 2024 prices) spent by F4E is estimated to have generated about EUR 5.95 billion in additional Gross Value Added and supported around 39,000 job-years.

F4E has built a unique know-how in Europe in the development of components necessary for a fusion device. It has contributed to and developed a strong European fusion supply chain.

ITER's objective is to explore and master the physics of long-pulse burning plasma operation, not to close all technological gaps required for a commercial fusion power plant. Several key technology gaps will remain beyond ITER's scope and will need to be addressed through complementary research and development. A comprehensive strategy to advance fusion in the EU is under development. It will build on ITER and proposes measures to close the remaining gaps.