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
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Thank you Chairman Weber, Ranking Member Grayson, and distinguished members of the Committee. I am grateful for this opportunity to present to you the status of progress on the ITER Project.

Introduction

Today we are at a critical time in the history of the ITER Project and the ITER Organization. Since I accepted the position of Director-General, 13 months ago, I do believe we have been moving at a rapid pace in accordance with the ITER Members' expectation. For the project to move forward, it was essential for us to accomplish two objectives at once: first, to execute sweeping organizational reform, fully addressing and correcting the problems identified in the 2013 Management Assessment report; and second, while in the midst of this reform, to shift from design and early construction activities to full-paced construction and manufacturing, making tangible progress to demonstrate we had the capacity, with reliability, to actually build the machine.

I am pleased to say, looking back, that we have done both. Today is no time for relaxation or self-congratulation, but it is worth reflecting on how we have gotten ITER back on track, because we must understand how to sustain this pace, keep our momentum, while continuing to improve in several specific areas. Who would have expected that every point of the concerns of ITER Members in 2013-2014 would be fixed within one year of new management?

It is particularly gratifying for me to report that, as of last week, we have received new external validation of our progress, based on the report of the independent Review Group appointed by the ITER Council. Although that report is not being made publicly available until the meeting of the Extraordinary ITER Council in Paris one week from now, I will discuss it with you in detail in agreement with the ITER Council Chair, Professor Won Namkung.

Fundamentally, I hope to answer three questions in this hearing that I believe are of relevance to you, as responsible leaders and decision-makers:

- Why should the United States and other ITER members have confidence that the ITER Project is back on track?
- Why should we consider ITER and its global partnership a sound investment for its Members, and for the U.S. in particular?
- Why should there be a greater global sense of urgency about the importance of fusion to our future?

1. The ITER Project: A Basis for Renewed Confidence

Fusion is the mass-to-energy conversion that occurs in the core of the Sun and all the stars. It is the most powerful source of energy in the universe. Every second, our Sun fuses 600 million tons of hydrogen into helium. It is this fusion reaction that gives the Earth light and warmth.

The ITER International Fusion Energy Organization, a collaboration of seven members representing 35 countries and more than half the world's population, is on its way to recreating the energy source of the Sun here on Earth. In Southern France, ITER is constructing the largest and most powerful controlled fusion device ever built. When finished, it will allow us to demonstrate the scientific and technological basis for large scale fusion energy.

By its fundamental nature, ITER is a challenging project, due to its size, technological complexity, long timeline and consequent high cost. It is even more challenging because the ITER Agreement required a unique multinational structure: the ITER Organization serves as owner and coordinator of the whole ITER program as well as the nuclear operator; and seven domestic agencies are in charge of 90% of the value in the form of procuring the components of the ITER installation. Thus ITER is both a first-of-a-kind machine and a first-of-a-kind organization.

This international approach has many desirable elements. It allows us to pool the best fusion science and engineering minds from around the globe. It lowers the financial and other risks for any one member. And it enables the joint creation and acquisition of intellectual property. The constant spin-off technologies that emerge from ITER – based on ground-breaking science and technological innovation – will be applicable to other industries and will open significant opportunities for multinational trade.

Clearly, this organizational complexity requires top-notch management performance and execution. Each of the ITER Members has been successful in high-tech enterprises. But each one has a different approach to project management. Cultural and national differences lend complexities to other areas: communication, political decision-making, budgetary processes, labour practices, and other aspects. These complexities must be intelligently managed.

The October 2013 Management Assessment, led by Bill Madia, identified 11 recommendations for urgent action. These recommendations were accepted and endorsed by the ITER Organization and its oversight body, the ITER Council:

1. Create a Project Culture
2. Accelerate the Director-General transition
3. Hold the Director-General accountable for resolving conflicts
4. Reduce the number of senior managers in the ITER Organization
5. Strengthen Systems Engineering
6. Instill a strong Nuclear Safety Culture
7. Develop a realistic ITER Project Schedule
8. Align the interests of the ITER Organization and the Domestic Agencies
9. Simplify and reduce the ITER Organization bureaucracy
10. Use Human Resources systems and tools as a strategic asset
11. Improve Advisory Assessment responsiveness

In July 2014, when this Subcommittee held its most recent ITER management hearing, these deficiencies were understood and steps were being taken to address them. The chairmanship of the ITER Council had been assumed by Dr. Robert Iotti, based on a U.S. recommendation. Bob Iotti's exceptional leadership skills, a combination of vision and pragmatism, commanded the respect of the ITER Organization and all the ITER members. Positive changes were made, but it was clear that neither the scope nor the pace was yet sufficient.

In March 2015, after extensive consultation, I agreed to assume the role of ITER Director-General, based on the acceptance, by all ITER Members, of an Action Plan I proposed to get the project back on track. The Action Plan was designed to correct fully the deficiencies identified by the Management Assessment, while accomplishing several specific objectives: a structure for effective, efficient technological decision-making; profound integration of the work of the ITER Organization Central Team (IO-CT) with that of the Domestic Agencies; a comprehensive technological understanding of all aspects of the ITER machine; finalization of design for ITER's critical path components; an updated, reliable schedule before the end of 2015; and a project culture.

The positive impacts of the Action Plan were rapidly evident. The ITER reorganization that followed created a structure and modes of interaction more suited to this complex, first-of-a-kind project. The Executive Project Board, made up of myself, my two deputies, and the heads of each Domestic Agency, has proven effective in resolving the technical questions that arise naturally at the interface of the ITER systems and components contributed by each Member. The Reserve Fund we set up is an efficient mechanism for financing timely adjustments to the design where necessary. The design finalization for critical path components has been a vital step to prevent further delays and cost overruns. And Project Teams, including all relevant actors in a single entity, are now guiding progress on the most critical project elements (Buildings, Cryogenics and Vacuum Vessel).

Perhaps most significantly, after eight months of exhaustive technical analysis and consultation with DAs and suppliers, we successfully compiled a fully integrated schedule and resource assessment. This result – reflecting comprehensive understanding of a machine that will have more than 1 million components, with manufacturing, construction and assembly constituting more than 200,000 activities – is the essential foundation to give confidence that the ITER Project can progress from this point forward on a realistic and reliable basis. It offers the fastest possible technical path to ITER full functionality: First Plasma and later Deuterium-Tritium operation.

In November 2015 – on time and as promised – I presented this "Best Technically Achievable Schedule" to the ITER Council.

The Council acknowledged the much-improved understanding of project scope, sequencing, risks, and costs achieved by this systematic review. It expressed appreciation for the tangible progress in construction and manufacturing. And it took three broad decisions to consolidate and build on the ITER Organization and Domestic Agency efforts.

First, on the technical front, the Council approved the proposed schedule for 2016-17 – using our submitted schedule as a reference – to ensure the ITER Project would keep its momentum. The Council approved a set of 29 well-defined technical and organizational milestones, referenced to this schedule, which can be used to monitor our ongoing reliability and progress on the critical issues. If achieved successfully and on time, these milestones will demonstrate that the ITER Project is staying on pace. The Council also approved the allocation of additional staff, and the re-allocation of existing funding, to ensure the ITER Organization has the needed resources to meet these milestones over this two-year period.

I am pleased to report that, to date, 8 of the 29 milestones have been achieved, on time and as promised. While we have experienced challenges and minor delays with individual milestones, we have in each case mitigated the challenges, offset the delays and gotten back on track. Overall there has been no slippage whatsoever in the reference schedule.

Secondly, the ITER Council called for an independent review of the overall proposed schedule and associated resources, to validate our methodology and analysis, to suggest adjustments and improvements where warranted, and if possible to identify additional measures for consolidating and expediting the schedule and reducing costs.

Thirdly, and in parallel, the ITER Members are engaged in a series of discussions, as anticipated, regarding the proposed "Best Technically Achievable Schedule" and associated resource assessment. The focus of this effort is to consider the priorities and resource constraints of ITER Member governments, including manufacturing schedules and the interfaces of each Member's in-kind contributions. Through a series of iterations, the Council is committed to reach an agreed Updated Schedule and corresponding Baseline through First Plasma by the next regular ITER Council meeting in June 2016.

Findings of the Independent ITER Council Review Group

Regardless of the renewed commitment, accountability and performance of the ITER Organization and its Domestic Agencies, and our belief that we can reliably deliver the ITER Project as promised, it is gratifying to receive external validation. In that regard, I would like to summarize in some detail the findings of the ITER Council Review Group. The group consisted of 14 international experts, chosen by the ITER Council. Given the broad charter of the group and the intensive nature of their review, I am especially pleased that we were able to support every request for information, every drill-down into the project details, so that they could successfully deliver their report last Friday, 15 April, on time and as promised.

In its general overview, the Review Group found that the major restructuring we have undertaken, "with highly experienced senior managers leading the ITER Organization Central Team," has resulted in "substantial improvement in project performance, a high degree of motivation, and considerable progress during the past 12 months."

The Review Group took note that the ITER Organization is in the process of employing an "Earned Value Management System" as a means of tracking performance and progress, in terms of both cost and schedule. The current "overall value-weighted estimate for construction project completion" through First Plasma – when accounting for all design work, ITER Organization Central Team contributions, and Domestic Agency in-kind contributions – is reported as approximately 40%.

A primary focus of the Review Group's work was to evaluate the reliability of our efforts to develop a realistic project schedule and associated ITER Organization resource estimate. After extensive consideration, the Review Group reached several key observations and conclusions in this area:

- Schedule Approach: The proposed schedule was considered successful in "fully and logically" mapping the "sequence and duration" of the activities of the ITER Project through completion. The methods employed were found to be "rigorous and … applied systematically from the bottom up," giving confidence that the inventory of activities in the schedule is "complete, with no significant omission." Regarding the possibility of schedule consolidation, the Review Group concluded that "there seems to be no possibility to accelerate the delivery date of [First Plasma]."
- Resource Estimate: Similarly, the associated resource estimate for the ITER Organization was found to be complete, including elements that had not previously been accounted for, thus providing "a credible estimate of cost and human resources." It is worth noticing that the resource estimate does not include Domestic Agency activities – since each DA controls its own costs for in-kind contributions – but these DA activities are tracked with milestones that ensure appropriate integration into the overall schedule. The group conducted sample "drill-down" reviews in greater detail for seven major aspects of the resource estimates, and concluded that "resource estimates for [ITER Organization Central Team] costs were within a reasonable range for this stage of the project (i.e., not significantly over- or under-estimated)."
- Risk Management: As proposed, the schedule and resource estimate do not include any contingency, and thus "cannot yet be considered to be reliable given that some risks will inevitably materialise." The Review Group noted that, under the new Director-General, senior management is giving attention to the management of risk, characterized by "project-wide systematic identification of risks and opportunities, development of response strategies and specific mitigation plans, and estimation of the pre- and post-mitigation probabilities of occurrence." As a result, the "IO's risk management approach, organization, and processes are maturing at a good pace."
- Critical Path: The primary critical path elements for the project are the Vacuum Vessel, the Tokamak Building, and Assembly and Commissioning of the machine itself. The Review Group recommended that the First Plasma target date, in the new baseline, should incorporate "a reasonable contingency once an initial quantitative risk analysis is performed."
- Iteration Modelling: Following its meeting in November 2015, the ITER Council asked the ITER Organization to develop a revised schedule that would reflect the annual financial constraints of ITER Members. The ITER Organization has been working on this in a process referred to by the Review Group as "Iteration Modelling," building on the work already invested in developing the "Best Technically Achievable Schedule."

  This Iteration Modelling is intended to form the basis for agreement, by all ITER Members, on an Updated Schedule and Baseline by June 2016. Recognizing that this activity "is still a work in progress," the Review Group nonetheless took a close look at the methodology involved, and specifically at the "staged approach" to the schedule that appears to be emerging. The Review Group observed that, "although the staged approach delays the crucial burning plasma experiments by a few years, it has a number of benefits" when compared to the "Best Technically Achievable Schedule." These benefits, as outlined by the Review Group, would include:

  - Enabling all ITER Members to "better focus on the successful achievement of [First Plasma]";
  - Lowering the project risk overall "by addressing the technical challenges step by step";
  - Decreasing the 2017–2019 funding requirements, during a period "when some [Domestic Agencies] face budgetary constraints";

- Providing greater “flexibility for accommodating delivery constraints” for both the ITER Organization and the Domestic Agencies;
- Allowing more time “to accommodate a longer research program between [First Plasma] and the start of [Deuterium-Tritium] Operation,” in turn enabling more thorough preparation for these crucial experiments.

The Extraordinary Meeting of the ITER Council next week, on 27 April, will give us final direction and guidance regarding this proposed schedule.

In addition to these specific technical points, the Review Group made a number of general recommendations:

- Project Culture: The Review Group recognized the benefits of the considerable efforts made to date, including the establishment of Project Teams and other specific measures, and concluded that “The DG and his team are working successfully to create a project management culture at ITER.” However, they also saw this as an ongoing effort, calling for “a continued strengthening of the project management culture at all levels of the organisation.”
- Reserve Fund: The guidelines governing the use of the Reserve Fund were found to be too narrow. Broadening these rules of use would enable the ITER Director-General “to use the Reserve Fund more effectively for the benefit of the project, for example to mitigate risks.”
- Human Resources: In accordance with its charter, the Review Group specifically examined the effectiveness of ITER’s Human Resources function. They made specific recommendations related to: restricting ITER staff assignments to not more than two terms, with exceptions where needed; using contractors rather than employed staff “to address peak or more conventional requirements”; and developing a “skills/competency inventory” and a systematic approach to knowledge management. And they called for adjustments as needed to improve the diversity, flexibility, and supportive nature of the Human Resources function.
- IO-CT and DA Integration: The Review Group noted that collaboration between the ITER Organization and the Domestic Agencies had improved markedly under the new leadership, but called for “further strengthening” of these relationships in a “culture of collaboration.” They stated, further:
  - “ITER must become the common project of all Members, and all priorities must be adjusted to meet the common goal: to make ITER and fusion a success.”
  - “Joint operation experience by personnel from all ITER Members in the coming years, using available Tokamak facilities, would be an important step in that direction, especially by providing a training ground for ITER scientists and engineers.”

While it is evident that complete organizational reform cannot be instantaneous, I believe it is also clear that the ITER Project has undergone significant positive change over the past 13 months, largely addressing the recommendations of the Madia Report and the corresponding elements of the Action Plan I proposed when taking office. Remaining corrective actions are well underway, with the focus and commitment to continue the reform until it is complete in all respects, and to instill a culture of continuous improvement. The tangible project achievements during this period add further credibility to the capacity of the ITER Organization and the Domestic Agencies to meet their commitments with reliability.

2. ITER: A Sound Investment

The accomplishment of truly transformative science at a massive scale requires sustained and significant investment – of time, funding, and human capital – to succeed. The unique multinational structure of the ITER Project, while admittedly challenging to manage, leverages the costs and risks effectively across a global partnership. In sharing costs, the investment of each ITER member is leveraged, and the risks correspondingly reduced.

The U.S. contribution to the ITER Project is 9.1% of the total. In return, the U.S. has access to 100% of the scientific and technological advancements resulting from the project. This leverages the U.S. investment by a factor of more than 10: a solid investment by any measure.

A key point regarding the value of ITER lies in the importance of achieving and studying a "burning plasma," the core of a fusion reactor. A burning plasma is self-heating or nearly self-heating, because the power from the fusion of hydrogen into helium keeps the plasma at its ultra-high temperature – much like in the fusion that occurs in the Sun. After six decades of research on magnetic confinement fusion, this is the essential, unavoidable final step if we are to commercialize fusion energy. And a burning plasma can only be created and studied at full-scale. That is one of the primary reasons why ITER is necessary, and why the ground-breaking science of ITER will be of such value to all who participate.

Other examples of science projects at ITER's scale include the Large Hadron Collider, CERN, and the International Space Station. Each of these projects has demonstrated the benefits of collaboration across national boundaries. By bringing leading subject matter experts together and providing shared intellectual access, the most effective solutions to science and technology challenges emerge.

The return on investment from such projects often comes in the form of technological spin-offs. Many spin-off benefits have already resulted from investments in fusion energy research; these benefits range from improvements in modern lighting, manufacturing, and medical applications to energy efficiency and the mitigation of environmental hazards. The September 2015 report by FESAC, the Fusion Energy Sciences Advisory Committee of the U.S. Department of Energy, provides a thorough analysis of the far-ranging social and economic benefits of this science.

At ITER specifically, we already are seeing these types of spin-off benefits, in areas such as remote handling robotics, power electronics, explosive metal forming, terahertz signal transmission, superconductors, and other technologies.

Consider the ITER-related advancements in just one of these areas: superconductors. Superconductors are essential to the commercial viability of the Tokamak design. They consume less power and are cheaper to operate than conventional counterparts, while carrying higher current and producing stronger magnetic fields. ITER's extraordinary technical requirements and the sheer amount of material required – 200 kilometres of cable-in-conduit, equivalent to 2,800 metric tons – resulted in a worldwide collaborative procurement effort involving nearly every ITER Member.

Before the ITER Project began, worldwide production of Niobium-Tin (Nb_3Sn) superconductor cable was 20 metric tons per year. Now, two U.S. companies alone – Luvata Waterbury, Inc. in Connecticut, and Oxford Superconducting Technology in New Jersey – each are producing 5 metric tons per month. This collaborative global effort prompted advancements in superconductor materials science. In addition, the successful multinational collaboration on superconductor design attributes, production standards, quality assurance measures and testing protocols for a project of this technical complexity is a remarkable achievement. 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.

At this point in the project, based on data received from the U.S. ITER Domestic Agency, more than 500 contracts have been awarded in 43 states. More than 80% of the U.S. ITER Project funding to date has remained in the U.S. The value of contracts awarded to U.S. industry and universities plus obligations to DOE national laboratories exceeds $800 million. Examples of major active contracts include General Atomics of California for central solenoid modules, New England Wire Technologies of New Hampshire for toroidal field conductor cabling, and Major Tool & Machine, Inc. of Indiana and Petersen, Inc. of Utah for central solenoid structures. In addition, other ITER Domestic Agencies have placed contracts with U.S. industry for more than $55 million.

Fusion energy can be an important component of a long-term shift away from fossil fuels, and as such offers the potential for the development of a new and economically massive field of industry. Clearly, the timeline to such a return on investment is measured in decades. But along the way, the ground-breaking science and technological innovation emerging from the global partnership in ITER constitutes, in and of itself, a solid investment.

3. Fusion: A Renewed Sense of Urgency

The uniqueness of fusion as an energy source is best considered in the context of increasing global energy demand and the gradual diminishment of other sources of baseload electricity.

It is no secret that global energy demand is growing at ever increasing rates, driven by population growth, energy-intensive lifestyles and the desire to raise the living standards of the one-quarter of the world's population that currently has no access to electricity. World population is expected to reach 10 billion by 2100. At present, 80% of global energy demand is met by fossil fuels. Even by 2035 – less than 20 years from now – global energy demand is projected to rise by 40%, according to the International Energy Agency, with fossil fuels still contributing roughly 75% of that energy. Even setting aside concerns related to climate change and the pollution of the atmosphere, at this rate, oil reserves are expected to be minimal by the 2060s, and remaining fossil fuel reserves are expected to be severely depleted by the end of this century.

In contrast to this uncertain and somewhat gloomy outlook, consider the beneficial impact of the widespread commercial launch of fusion-generated electricity, beginning in the 2040s and expanding through mid-century. A convenient encapsulation of that impact lies in "making the C.A.S.E. for fusion energy": energy that is Clean, Abundant, Safe and Economic.

- Clean – Fusion is carbon-free and environmentally sustainable, with no high-activity or long-lived radioactive waste.

- Abundant – 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.
- Safe – The process of creating fusion energy in a Tokamak requires precise parameters. When this fusion reaction is disrupted, the fusion chamber simply shuts down – without external assistance. And since tiny amounts of fuel are used, there is no physical possibility of a nuclear accident.
- Economic – 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. But unlike fossil fuel plants, fusion plants will not have the global environmental impact of releasing CO_2 and other pollutants into the atmosphere; and unlike nuclear fission plants, will not have the costs of high-activity, long-lived radioactive waste disposal.

To put this in concrete perspective: using a 2000 megawatt-electric (MWe) plant as the standard, powering the entire United States would take about 250 fusion plants at current electricity consumption rates. This number could be higher based on population growth, increasing consumption rates, and expanded use of electricity for transportation and other sectors; or it could be lower based on energy conservation measures and an increased use of renewable sources.

Three 2000 MWe fusion plants would, for example, be sufficient to supply electricity to Washington, DC. The capital cost of each such plant will be about $10 billion dollars – costs that are offset by extremely low operating costs, negligible fuel costs, and infrequent component replacement costs over the 60 year life, or even more, of the plant. Capital costs will further decrease with large-scale deployment of fusion plants.

Using Washington, DC again for comparison, assuming a need for 6000 MWe of electricity:

- If this electricity were to be supplied by three fusion plants, it would release no CO_2 into the atmosphere.
- If the electricity is supplied by natural gas plants, it will release about 22 million tonnes of CO_2 into the atmosphere every year.
- If the electricity is supplied by coal plants, it will release about 42 million tonnes of CO_2 into the atmosphere every year – plus another 1.2 million tonnes of sulfur dioxide – plus another 1.2 million tonnes, at minimum, of solid waste pollution, mostly fly ash.

Moreover, if fusion power becomes universal, the use of electricity could be expanded greatly, to reduce the greenhouse gas emissions from transportation, buildings, industry, and even food production and freshwater supply, providing nothing less than a clean energy miracle for our planet.

Fusion energy is not a panacea. It will never be the sole source of energy. The drive to make fusion energy a commercial reality should not in any sense detract from efforts to enhance energy efficiency, expand the use of renewables, improve electricity storage capacity, or innovate in other energy fields.

But fusion offers a unique array of benefits unlike any other energy source. The pursuit of fusion-powered electricity truly offers a “triple bottom line” of benefits: economic, social, and environmental.

Conclusion

The ITER Project is moving forward. At the ITER Organization, we are committed to ensuring the delivery of the ITER machine and the full achievement of the associated scientific and technological benefits, as the launching pad for the commercial deployment of fusion-generated electricity. We are committed to achieving reliably the milestones we have set for ourselves, in a manner that lives up to the trust placed in us by all ITER Members. And we are committed to continuous improvement, to make ITER the model for international collaboration on complex science and technology challenges.

The United States, as the most scientifically and technologically advanced country on earth, is a highly valued ITER partner. We are committed to making ITER a sound investment for the U.S., as for all our partners, and we look forward to a long and fruitful collaboration.

Thank you for this opportunity.

Bernard Bigot, Director-General ITER Organization


ITER Director-General Bernard Bigot

On 5 March 2015, the ITER Council appointed Bernard Bigot, from France, Director-General of the ITER Organization.

Bernard Bigot has been closely associated with ITER since France's bid to host the project in 2003. Following the ITER site decision in 2005, the signature of the ITER Agreement in 2006 and its ratification by all Members in 2007, Mr Bigot was delegated by the French government to act as High Representative for the implementation of ITER in France, a position that he has occupied since 2008.

With the responsibility of coordinating the realization of ITER and ensuring the representation of France to the ITER Members and the ITER Organization, he has followed the project for some twenty years.

In his long and distinguished career, Bernard Bigot has held senior positions in research, higher education and government. Prior to his appointment at ITER he completed two terms (2009-2012 and 2012-2015) as Chairman and CEO of the French Alternative Energies and Atomic Energy Commission, CEA. This government-funded technological research organization—with ten research centres in France, a workforce of 16,000 and an annual budget of EUR 4.3 billion— is active in low-carbon energies, defense and security, information technologies and health technologies.

From 2003 to 2009 Bernard Bigot served as France's High commissioner for atomic energy, an independent scientific authority whose mission is to advise the French President and the French government on nuclear and renewable energy policy and in all the other scientific and technological domains where the CEA intervenes.

On his long experience in the field of energy, he says: "*I've always been concerned with energy issues. Energy is the key to mankind's social and economic development. Today, 80 percent of the energy consumed in the world comes from fossil fuels and we all know that this resource will not last forever. With fusion energy we have a potential resource for millions of years. Harnessing it is an opportunity we cannot miss.*"

Bernard Bigot was trained at the Ecole normale supérieure de Saint-Cloud and holds an *agrégation* (highest-level teaching diploma in France) in physical science and a PhD in chemistry. He is a high-ranking university professor (*classe exceptionnelle*) at the Ecole normale supérieure de Lyon, which he helped to establish and which he directed from 2000 to 2003. Author of over 70 publications in theoretical chemistry, Bernard Bigot was also in charge of research at the Ecole normale supérieure and Director of the Institut de recherche sur la catalyse, a CNRS laboratory specializing in catalysis research.

In parallel to these academic responsibilities, he worked at the ministerial level as Head of the Scientific and Technical Mission (1993-1996), Director-General of Research and Technology (1996-1997), and Deputy Director for Research from 1998 to 2000.

In 2002, Bernard Bigot was appointed Principal Private Secretary to the Research and New Technologies Minister and Assistant Private Secretary to the Minister for Youth, Education and Research. It was during his tenure in this office that France proposed a site in Cadarache (southern France) to host the ITER Project.

Bernard Bigot is a *Commandeur* in the French Order of the Legion of Honour, a *Commandeur* in the Royal Swedish Order of the Polar Star, and an *Officer* the French Order of the National Merit. In October 2014 he received the Gold and Silver Star in the Japanese Order of the Rising Sun.