

ITER SITE ANALYSIS GROUP REPORT¹

1. Introduction

The ITER project represents an opportunity for international science and technology collaboration on a scale that has never been seen before; as such it is a unique global project. European expertise in fusion is recognised worldwide and if Europe wishes to maintain its leading position ITER must be sited in Europe. The question arises as to how best to ensure that a European site is chosen. France and Spain have made two excellent bids for Cadarache and Vandellós respectively. In order to decide which of these two sites should be put forward for the international site selection, the European Commission set up the ITER Site Analysis Group to analyse the two sites proposed for ITER and advise the Commission on how to maximise the opportunity of ITER being sited in Europe. The Competitiveness Council is expected to make a decision on the European site at its meeting on the 23rd September 2003.

The mandate of the Group is set out in more detail at Annex 1; briefly it was to consider issues such as

- project environment,
- cost issues,
- host commitments and
- impact on nuclear fusion research in Europe

in addition to other non-technical matters that might affect the site selection. The Group also believed that Licensing should be considered as a separate issue.

In reaching its conclusions the Group considered information it received from a number of sources such as the presentations and documents submitted by the French and Spanish delegations headed by Christian Poncet and Pedro Morenés Eulate respectively. These documents are set out in Annex 2. A listing of the delegations is given in Annex 3.

2. Project environment (Site properties)

2a. Topology and geology

Cadarache is characterised by slightly higher but fully acceptable seismic loads for both the ITER buildings and the tokamak compared to Vandellós. The standard French design for seismic isolation will however result in a marginal if any cost increase. No seismic adaptations are required for Vandellós as the loads are well below the design value.

Conclusion: No significant differences.

¹ The report has been approved by the Chairman and all the members of the Group on 03/09/2003.

2b. Transport of components

With its seaside location Vandellós could, beyond generic requirements, receive even the largest assemblies particularly if the planned site-internal access road with a new bridge is built. Vandellós also offers substantially shorter road transportation of the largest components listed in the generic requirements. Most of the largest components are likely to be assembled on site in both locations for technical and economical reasons, which may include potential contractors' preferences. However the Cadarache site alone excludes the option of assembling even the largest components listed in the generic requirements at the supplier's site. Issues surrounding transportation of components are unlikely to represent a major risk.

Conclusion: No significant differences identified from a technical point of view.

2c. Technical and scientific infrastructure

The availability of scientific and technical support to assist the realisation of ITER, especially during the construction phase, is an important element in evaluating the sites.

Local availability of highly skilled technical support

- i) Cadarache has a large and well-established nuclear fission research installation with experience in building and operating a large fusion experiment. In fusion, Cadarache operates the research Tokamak Tore Supra, providing local competence in Tokamak technology including superconducting coils. As a result in Cadarache there is a large fully operative research facility currently covering a wide range of relevant activities. Many in the Heads of Associations delegation saw this as a very clear advantage for managing the risk of delays and cost increases if unforeseen technical problems appear especially during the construction phase. It was noted that in time the ITER site will be completely self-sufficient, also attracting competent technicians irrespective of its location. The synergy seen at Culham however is an example of the value of interaction between two fusion-based communities.

- (ii) In Vandellós, the R&D infrastructure has to be developed from a virtually greenfield site, at least from a research point of view, as the technical support at the nearby nuclear power plant has a different focus and competence. CIEMAT plans to establish a Spanish national fusion research branch nearby; this is not comparable to the technical support already available at Cadarache. At Vandellós, ITER will have to attract a self-sufficient group of highly qualified fusion specialists who can be called upon to provide advice. However qualified specialists from all over the world may find it attractive to participate in building up such a large-scale international research facility and community from scratch.

Conclusion: The Group felt that the strong technical support facilities available at Cadarache provide an important risk reducing advantage with a potential impact on cost for that site especially in the construction phase.

2d. Industrial capabilities

On the national scale, both countries have construction industries with a proven record of building large nuclear installations. Both regions, Catalonia and Provence-Alpes-Côte d'Azur, are geared towards servicing local industries using advanced technology.

Conclusion: No significant differences.

2e. University network

Both sides have access to an extensive regional and national network of universities and research institutions. The European perspective will dominate at each of the sites.

Conclusion: No significant differences identified.

2f. Local acceptance of ITER as a nuclear installation

Both sites are existing nuclear sites with a high degree of local political support and public acceptance.

Conclusion: No significant differences identified.

2g. Social and language

The existence of the appropriate social environment to sustain scientists, engineers and their families throughout the duration of the project is an important factor in the site selection.

Education

- (i) France proposes to establish a multi-lingual Welcome Centre on site to operate from the beginning of construction to the end of the operational phase. French and English language training guaranteed by the French state will be available to ITER staff and their families. France also points to the presence of European and other international staff employed by companies such as Eurocopter. There are English speaking international schools in Aix, Marseille and Luynes and a Japanese school in Marseille. In addition to the existing schools France proposes two further options for the ITER participants: creating a European school or a school in accordance with the education of the country of origin under that country's education ministry.
- (ii) In Vandellós, the regional authorities are also prepared to provide welcoming facilities. Educational provision for foreigners is already significant in Catalonia.

The Vandellós-Tarragona-Barcelona area has 33 international schools catering for the US, UK, French, Japanese, Italian, German and Swiss communities. A system is also in place to integrate Russian speakers into the Spanish system. Spain is committed to creating an international school that would be free for the families of European participants in ITER.

Accommodation

- (iii) Both Cadarache and Vandellós are located in areas where tourism is high; Catalonia and Provence are favoured destinations in Europe and facilities have long been put into place for international visitors. The sites appear to be equal on this basis. Temporary accommodation in Tarragona is widely available with many holiday homes on hand for short term lets. Similarly the tourist trade in Provence should provide adequate short-term lets. House prices are comparable on the whole, with properties in the Cadarache area ranging from 100 000€ to 200 000€ for new properties and 160 000€ to 230 000€ in Tarragona.

Healthcare

- iv) France topped the WHO ranking in 2000 with Spain coming 7th. The equipment and healthcare staff levels in Provence are above the French average and the region is accustomed to dealing with the large number of tourists who visit each year. Health provision in Catalonia is well above the Spanish average. The healthcare system already provides for foreigners to receive services in their own language with native translators being available on a 24hr basis. The emergency service 112 can also be provided in French, English, German, Italian and Portuguese.

Culture

- (v) In terms of quality of life the regions around Vandellós and Cadarache offer a remarkably high level of cultural activity with a worldwide reputation. Moreover, it appears that Spain offers a smoother interaction with non-Spanish residents, which would make it easier for the ITER participants and their families to live and work in the area. A Marie Curie Fellowship Association (2003) survey supports this conclusion.

Conclusion: Both sites have existing excellent facilities for international workers and their families, and more would be put into place for ITER.

3. Costs

The implementation of ITER will include a construction phase of about 10 years, and an operational phase of about 20 years followed by a decommissioning phase, with a deactivation phase of 5 years followed by the final decommissioning. The total construction costs are estimated as 4,570M€ in the Commission's Staff Working Paper 2002 and its subsequent Communication to the Council dated 28 April 2003; total operating costs are estimated to 265M€ per year, including 25M€ per year set aside for future decommissioning costs. All ITER parties will share 80% of the construction costs estimated to fall in the

common area; 20% of which is estimated to fall in the non-common area, to be paid by the host party.

The Group examined four different reports on costs for the construction and operational running of the site. The four reports, two EISSG Reports prepared for EFDA, the Ove ARUP Report prepared for the Spanish Government and the OTH-Technicatome Report prepared for the French Government, all concluded that ITER construction cost would be lower at Vandellós.

The EISSG Reports show that the difference between the sites in the non-common area construction costs is in the range of 127-152 M€, including on-site assembly and fabrication work, in favour of Vandellós (127 M€ is the difference in construction costs with the generic cooling option: the difference in construction costs using the sea-water cooling option is 152 M€). The range would be 90-115 M€ if the on-site assembly and fabrication work item were disregarded. The EISSG cost assessments report no significant differences in the common area costs.

As the ARUP report was delivered during the visit of the Spanish delegation and had not been examined by other international bodies, its methodology and conclusions were given particular attention as discussed below.

The ARUP Report provides a comparison of the costs for the ITER project between Canada, France, Japan and Spain and found that Spain would be the cheapest host country to locate a future fusion energy research plant. It covers the costs of the building construction and 80% of the ITER machine equipment. The common area and non-common area constructions costs in Spain would be 11% less than in France.

The main difference between the ARUP results and the earlier analysis (FDR, EFET, EISSG) stems from two sources:

- the differences in material prices and wages between France and Spain, including respective differences in salaries of the international teams according to local living costs.
- the amount of locally supplied raw materials and labour force which has been assumed as 100% for all construction work.

This method of cost analysis is applied mainly to the construction cost, to the procurement packages of the non-common part and to the on-site assembly of the specialised equipment in the common part.

The ARUP results show a cost difference in the non-common area in favour of Vandellós of 274 M€ and a further advantage in the common area of about 114 M€ (specialised equipment manufacturing and installation cost). CIEMAT applied the same method beyond the ARUP report to the management and support costs during construction, finding a further cost advantage of Vandellós against Cadarache of 128 M€. On this analysis the total cost saving advantage to Vandellós during the first 10 years would be 516 M€.

It should be noted that the analysis focused on three key areas; on site building construction costs; specialist equipment manufacturing and installation costs; and operation and maintenance costs. The non-common area costs during the construction phase would be lower

by 274M€. In addition the common area costs would be lower by 242M€ for Vandellós from the analysis presented by ARUP together with the CIEMAT presentation for building design changes and additional management costs.

The Group noted the thorough assessment of the costs associated with the building and running of each site. It also noted the analysis of the ARUP representative who pointed out that the construction costs would eventually be overtaken by operational costs and that operational costs for each site could be very different over time, with a potential for substantially lower costs of 75M€ per year over 20 years at Vandellós. However, the Group considers the current differences in labour and material costs are not necessarily sustainable over a medium period of time. Moreover, operating costs will be highly dependent on the staffing and procurement policies of the ITER organisation, which are not known at present.

The OTH-Technicatome Report and its representative were also subjected to cross-examination. The OTH-Technicatome Report concluded that the non-common part of the construction costs would be higher in Cadarache by only 34M€ rather than the 127-152 M€ mentioned in the EISSG Report. The Group noted that the costs for Cadarache had been estimated using a database for different cost factors (labour, materials, etc.) derived from actual costs for recent large construction projects in France, where international tendering had taken place.

Conclusion: The Group noted that during the construction phase the non-common area costs were likely to be in the range of 34 to 274 M€ less at Vandellós than at Cadarache. The difference between these figures is based on different assumptions relating to local material and labour costs. Neither the OTH-Technicatome nor the ARUP reports are likely to be correct: they represent extremes on the percentages of these costs, which would prove unrealistic within the obligatory procurement process. Any differences in the common area costs will probably be of less significance as procurement in the common area is regulated by the work packages to be assigned to the ITER parties and therefore largely site-independent. Any differences in operational costs would be difficult to predict with accuracy as differences between southern France and northern Spain may tend to vanish over time. The Group concluded that the potential cost saving favours Vandellós.

4. Licensing

Both sites are extensions of existing nuclear sites, which simplifies licensing procedures, as the basic properties of the sites already have been extensively investigated and reviewed. The first preparatory steps in the licensing process have already been successfully completed at both sites, on initiatives by CEA and CIEMAT with a view to a smooth transfer to the ITER Legal Entity (ILE) if and when established.

Nuclear licensing

- (i) Both countries have highly competent authorities and well defined licensing procedures. France has licensed a variety of complex nuclear installations whose basic designs had not previously been approved by safety authorities in other

countries. The French licensing experience with tritium is more extensive although related to smaller quantities of tritium than would be required for ITER. The Spanish regulatory body probably has somewhat more experience in licensing systems and components designed and manufactured in accordance with standards of different countries. Spain has less experience with tritium transports. In both countries tritium transports are licensed under the existing national legal frameworks, which are based on the applicable international regulations for the transportation of radioactive material. No problems are foreseen in either of the countries.

Environmental permits

- (ii) Both countries have established procedures for environmental permits, including public consultation procedures. No “show-stoppers” have been identified. In both countries, the final decision will be taken by the national government.

Conclusion: No significant differences have been identified that could have an impact on the envisaged overall time schedule for ITER.

5. Host commitment

Host commitment ranks among the most important issues to be assessed in the decision making process as ITER needs long-term stability in its immediate political surroundings and the broader public and political consensus for fusion technology projects and nuclear power in general. The representatives of the local and central governments of both countries and national fusion associations of both countries confirmed their acceptance of the Commission’s assumption wherein the host party financial commitment would be shared equally between EURATOM and the host nation.

Monsieur Poncet confirmed his government’s commitment to ITER and the three governments of the regions of Provence, Alpes and Côte d’Azur pledge to provide half of the host nation share of the construction costs. The French Government would make no additional funds available for this project. The remaining host contribution would therefore be found from savings in the national fusion programme and elsewhere in the French Research budget. Tore Supra would be closed as a contribution to this cost. The project is supported by all major parliamentary parties and the support has been stable over a general election leading to a change of government.

Señor Morenés also confirmed his government’s commitment to ITER, which was endorsed by a formal parliament decision with an overwhelming majority (284 - 5). ITER has been assigned higher political visibility in Spain, as it would be an important component in establishing Spain as a prominent player in international R&D co-operation and in the development of the regional infrastructure of Catalonia. The funds for ITER will come from the government as a new commitment over and above the budget increase for research recently announced of 6-9% per annum. Both regional and central governments are committed to the project.

Nuclear energy has a good public acceptance in both countries. Neither country anticipates protests from local NGO’s.

Conclusion: Both countries have shown a long-term commitment to ITER at local and central government level. We noted that the Spanish proposal would maintain their national fusion program.

6. Impact on European fusion research

Current contributions of France and Spain

(i) France

The strong motivation of France for ITER is based on the nation's long-lasting commitment to promote the security of energy supply, in particular through major efforts and investments in applied nuclear energy research including fission and fusion. Currently over 75 % of the electricity production in the country is of nuclear origin. France has been a major contributor to the European Fusion Programme since its inception. Since 1982, the experimental resources for fusion energy research have been concentrated at Cadarache. Euratom-CEA provides 30% of the EU staff seconded to JET. Today The Euratom-CEA's main activities are the exploitation of Tore Supra, plasma theory and modelling and participation to JET. It also contributes to ITER in such fields as superconducting coils, remote control, first wall materials, tritium breeding blankets, and site studies and specifications. The Euratom-CEA Association has a staff of 420 people (300 for the fusion core and 120 for the technology programme) and represents today 14 % of the EU fusion spending (26% of the technology spending).

(ii) Spain

Spain has also a long-standing experience in nuclear energy. Presently 28 to 30 % of the electricity production in the country is of nuclear origin. Since Spain joined the Euratom Association in 1986 work on fusion at CIEMAT Association has expanded considerably. It has a staff of 120 people, including 60 professionals, 35 support staff, and about 20 support contractors. CIEMAT represents today 3 % of the EU fusion spending (3% of the technology spending). The crux of the domestic programme is the exploitation of the TJ-II stellarator; participation in JET and the W7X stellarator is being pursued. The TJ-II programme would be pursued in parallel with the construction of ITER at least until the start of the W7X experiments, now foreseen in 2010.

6a ITER and the EU accompanying programme

The EURATOM Fusion Programme in FP-7 and beyond should have two components:

- Participation in the ITER Project
- A strong accompanying Programme

A strong accompanying programme is going to be critically important in maintaining a lively and active European fusion community who will in the long run be able to maximise the advantage of having ITER in Europe.

Spain has a strong commitment to keep its own domestic, stellarator-based fusion programme in full power, and even to reinforce it, if ITER is located at Vandellós. France plans to re-structure its own fusion programme and to phase out the operation of Tore Supra should ITER be hosted at Cadarache, in order to free up adequate resources (funds, personnel and equipment) for the construction of ITER.

Conclusion: The construction of ITER in the EU will require a deep reformulation of the organisation and management of the EU Fusion Programme irrespective of the site chosen within Europe.

7. Conclusions

France and Spain have presented outstanding bids for hosting ITER. The Group was very impressed by the quality of the presentations given by both parties and the material submitted on the 9th and 18th July 2003. Each site has some advantages over the other in different areas. The strong technical support facilities already available at Cadarache provide an important risk reducing advantage for that site especially during the construction phase. However the opportunity for creating a large new international research site at Vandellós is also seen to have benefits. Costs during the construction phase at Vandellós would be lower. It is difficult to predict operational costs so far ahead of time, but these might also provide a significant saving in the long term in Spain. We note that both sites are in unusually attractive areas.

Both sites are very strong contenders for the international competition. The main differences lie between the technical and financial advantages. The Group believes that either site would be likely to win the international site selection.

Mission

Analyse the two sites proposed in Europe for ITER, Cadarache (France) and Vandellós (Spain), with a view to report to the Commission on maximising the possibilities that ITER is based in Europe.

Terms of reference

- Adopt the objective criteria, including cost, covering also aspects other than purely technical that will be on the core of the site analysis. The criteria belong to the following categories:
 - project environment
 - cost issues
 - host commitments
 - impact on nuclear fusion research in Europe

- Analyse the Cadarache and Vandellós sites in the light of the above criteria and of the answers provided by the French and Spanish Authorities to the specific questions that the Group may have.

- The analysis will benefit from the technical studies performed in the framework of international negotiations on ITER (i.e. the JASS Report) and from complementary studies carried out by the fusion programme Committee, the CCE-FU.

- The Conclusions of the Group should reflect the views of the majority of its Members.

- The Report of the Group should be made available to the Commission by the end of July 2003.

Criteria***Project Environment***

- Scientific, technical, industrial, cultural and social environment of the project, taking into account the results of the JASS process
- Site specific aspects, including the site attractiveness to the international scientific communities involved in ITER;
- Site preparation and organisation of host support

Costs issues

- Costs to be incurred by the Community during construction, operation, de-activation and decommissioning phases

Host commitments to the realisation of the Project

- Political, financial and administrative commitments of the Host country to the realisation of the project
- Licensing/permits issue
- Privileges and immunities

Impact on nuclear research in Europe

- Programmatic, financial and organisational impacts on the European fusion programme
- Impact on nuclear research in Europe

Group Members

Sir David King, Chief Scientific Advisor to the UK Government and head of the Office of Science and Technology, Chairman

Prof. Angelo Airaghi (IT), Chairman of Ansaldo, Finmeccanica

Dr. Gerd Eisenbeiss (DE), Member of the Board, Forschungszentrum Jülich

Mr. Marcel Gaube (BE), General Manager of Belgatom

Prof. Alkis Grecos (GR), Visiting Research Associate of the University of Thessaly, Volos

Dr. Lars Högberg (SW), Special Advisor to the Ministry of the Environment in Sweden

Prof. Carlos Matos Ferreira (PO), Chairman of the Instituto Superior Tecnico, Technical University, Lisbon

ITER proposals

Response to the ITER Sites Analysis Group questions –July 2003

Summary of the discussions of the Group of Chairmen/Heads of Associations-May/June 2003

Hearing with the European Fusion Development Agreement (EFDA) members on 10th July 2003

JASS Final Report 24th January 2003

EISSG Reports-Cost Estimates-May 2003

European Cities Monitor quality of life ratings - Cushman & Wakefield Healey & Baker 2001

The Marie Curie Fellowship Association - MCFA member survey on the implementation of fellowships - Results - January 2003.

(www.mariecurie.org/index.php?frame2=/surveys/fellowships/)

Summary of Soil Structure Interaction Seismic Analyses of Tokamak Building in the Candidate Sites –June 2003

Ove ARUP report- May 2003

Ove ARUP – Response to ITER Group Questions, July 2003

OTH and Technicatome - Further presentation on costs, July 2003

OTH and Technicatome-Further information provided to the Group July 2003

Report on Vibration effects on ITER plasma and diagnostics – 10.07.03

Annex 3

Presentations by delegations

France

Christian Poncet	The French Government's representative
Jean Jacquinet	Director of Fusion Research Cadarache
Hervé Bernard	Director of CEA Safety Management
Bernard Frois	Director of the Energy and Environment Department, Ministry of Research
Pascal Garin	Project Leader of Cadarache Site Studies
Christian Masset	Deputy Permanent Representative Brussels
Stéphane Salord	Chairman of Regional Employment Council Aix en Provence
Thomas Salla	Technicatome
Eric Fournier	OTH Méditerranée

Spain

Pedro Morenés Eulate	Secretary of State for Science and Technology
José Antonio Sanchez Quintanilla	Principal Private Secretary to Mr Morenés
Carlos Alejandre Losilla	Director of the Fusion Laboratory CIEMAT
Carlos Valero	Manager of the Inward Foreign Investment Department of the Centre for Commercial Innovation and Development of the Catalunya Generalitat
José Ignacio Doncel	Technical Co-ordinator of ITER Spain technical Studies
Angel Ibarra	Scientist CIEMAT
Joaquin Sanchez	Manager of Diagnostic Systems on TJ-11 and Deputy leader of Diagnostics on JET
Michael Coburn	ARUP Consultants
Maria Teresa Dominguez	Empresarios Agrupados

European Fusion Development Agreement (EFDA) members

Professor A.Bradshaw, (Max-Planck-Institut für Plasmaphysik - Germany) Chairman of the Group of Chairs in the Euratom fusion programme

Dr F.Briscoe, (UKAEA - UK) Senior Manager of JET Operation

Dr F.Romanelli, (ENEA - Italy) Co-Chairman of the Science and Technology Advisory Committee in the EURATOM fusion programme

Professor P.Vandenplas, (ERM/KMS - Belgium) Vice-Chair of the Consultative Committee for the EURATOM Programme in the Field of Nuclear Energy (Fusion)

Professor C.Varandas, (IST - Portugal) Chair of the EFDA Steering Committee in the EURATOM fusion programme