Assessment of the offers to host the European Spallation Source ESS in Lund, Debrecen or Bilbao

ESS Site Review Group

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Executive Summary

Overall

The Site Review Group for the ESS was invited to visit all three proponent sites over the course of one week. In all cases the group found the teams to be very well prepared and it met with a very informative and constructive work environment. The SRG would like to thank all participants for their contributions, the presentations and the hospitality.

The SRG has studied the responses to the EWESS questionnaire, carried out site visits and requested additional information and clarifications where necessary. It found no fundamental obstacles to building ESS at any of the three sites. Key elements apart from the obvious ones such as costs are in the view of the SRG preparedness to execute the construction project efficiently by moving into international effort for design review and optimisation and construction, and the possibility to attract highest quality staff and benefit from the already existing infrastructure in science, industry and education.

Non-differentiating aspects

Socio-economic benefits, science, technical design, legal structure and applicable tax regime

The SRG considers four elements as non-differentiating. *Socio-economic benefits* may differ for the sites, but the SRG is of the view that the best conditions for establishing and operating a neutron spallation source that maximizes science and innovation for Europe as a whole should be leading. The *science* ESS will produce at any of the sites will be the same. After all the ESS that will be built *technically* will be the same, whatever different ideas proponents might now have about modifying the 2002/3 design. How proponents have approached these technical aspects does, however, have an impact on their starting position for building up the international effort. Also the *legal structure* does not differentiate. The SRG takes it that at all sites ESS will be a European Research Infrastructure (ERI), the new form proposed by the Commission, if this proposal will be accepted in the EU. If not, in all three cases ES will be a limited liability company according to national legislation. The ERI, if adopted as proposed, will grant VAT exemption; all three countries offer VAT exemption in case of a limited liability company; the ERI as proposed would have additional exemptions as regards excises.

Design review and optimization, in–kind contributions

The SRG wants to add two comments of a general nature. A design review followed by an optimization of the design and completion of baseline engineering, including prototyping, is now urgent. This is probably a 20-30 M€ effort that should start immediately after a site consensus has been reached or earlier if a core group of countries agree on putting together and funding an international team to do so. All sites expect the participation of other countries to be in the form of in-kind contributions. The SRG emphasizes that a sensible sharing scheme based on optimized integration and project execution should be applied and not exclusively on national interests. For the construction to take place in time and budget, there must be a technically strong and well resourced central team with ultimate responsibility and control, also of funds or of the authorization to spend money.

Differentiating aspects

Investment and operational costs; timeline

Sites have used different methods to assess costs on the basis of the Work Breakdown Structure from the 2002/3 design. All sites have costed conventional facilities on the basis of local construction costs, which vary from site to site. Other differences between the three estimates of construction and operation costs are partly the consequence of including different items (e.g. more instruments, site development, design optimization or pre-operations costs), partly genuine disagreements on the cost of important elements (e.g. target or accelerator) and partly site-linked (e.g . the incidence of lower wages in Debrecen on operation costs). A better cost estimate, however, is not possible without completing the baseline engineering. For a 'standardised' ESS (same number of instruments in construction budget, no project/R&D, site development, or pre-operation costs) the SRG derives the following construction costs estimates: Lund 1214 M€, Debrecen 982 M€, Bilbao 1294 M€. The sites concur that ESS can be built within 1.3 B€. Annual operational costs estimates are 103 M€ (Lund), 95 M€ (Debrecen) and 113 M€ (Bilbao). Note that staff complements differ: Lund (450) is slightly higher than Bilbao (415), and Debrecen (600) much higher based on employing or outsourcing many more local support staff, at lower wages than international staff. The SRG doubts that the maintenance of two categories of employment conditions is feasible on the long term, and thus thinks that Debrecen is overestimating this advantage. Decommissioning costs have been estimated in all three cases by experienced companies; they are in the order of several hundreds of millions of €s. However, the inclusion of contingencies up to 100% indicates that uncertainties are huge, as regulations will evolve and probably harmonize. Partners in ESS will pay for decommissioning for example by paying annual contributions into a fund. But depending on who is responsible for actual decommissioning there may be an issue as to who will bear the risks of cost overruns. Here the sites differ. Decommissioning in Sweden is the responsibility of the facility. In Hungary a Public Agency, PURAM, will take over this responsibility. In Spain the electricity utility ENDESA will take over the facility.

With respect to the funding profile all three sites have underestimated the peak needs for construction. In addition the SRG believes that a more aggressive approach could be taken which lowers the overall project cost. Given the conceptual stage of the ESS design the uncertainties in cost at any site are comparable to the variations between the sites which is why proceeding to the next phase of design development is important.

Financing and host country contributions

Regarding the financial offers made by the prospective ESS hosts: Sweden offers to pay 30% of construction costs (including site acquisition and development, and design optimization) until operations start, and is confident that another 20% will come from other Nordic and Baltic countries. For the remainder it expects other countries to contribute on the basis of GDP. It is negotiating with the EIB for some 20% contribution from the Risk Share Financing Facility to avoid delays. Sweden will pay 10% of annual operational costs and expects others to contribute according to expected use. If ESS will not go to Lund, Sweden is prepared to contribute on the basis of its GDP share of non-host participating countries to construction costs (after deduction of host country contribution) and operation on the basis of time, if ESS as built meets Sweden's requirements.

Hungary offers 20% of construction costs, and is prepared to initially buy 12.5% of the shares that will be issued for the remainder. The price of these shares will be 80% of (total construction costs divided by number of shares) but X% of shares will give right to X% usage rights. Hungary is confident the EIB will contribute to the amount of 200M€ from the Risk Share Financing Facility. The EIB contribution and 9.5 % points of Hungary's 12.5% of shares serve as bridge financing to avoid delays and will be sold to countries joining later. Eventually Hungary will pay 3% of operational costs. Site acquisition and development and initial hosting of the ESS team is offered free of charge. If ESS will not go to Debrecen,

Hungary will eventually participate at approximately a 3% level, but may consider buying initially up to 8 % of the shares if it can assume responsibility for a major construction task.
Spain offers to pay at least 375 M€ of estimated 1284 M€ construction costs, amounting to a site premium of some 14.25% on top of Spain's contribution coupled to usage rights. Shares (X% of shares representing X% usage rights) will be issued at 70.75% of (total construction costs divided by number of shares). Spain will buy 15% of shares, bringing the total construction cost share to 29.25%, and contribute at least 17 M€ to operational costs; it expects others to contribute in proportion to usage rights. If agreed in negotiations the Spanish National Fund for Research Infrastructures may be used to adjust the timing of other country's contributions to project financial requirements. Land acquisition and site development are offered free of charge. If ESS will not go to Bilbao, Spain will in principle participate at an 8 to 10% level.

Physical site characteristics

All three sites are physically well suited for hosting ESS. The SRG has identified a few issues for further consideration by the sites. The SRG does not expect these to pose any significant problems but there may be (relatively small) cost implications.

Building up organization and capabilities

The three sites have taken a different approach towards building up the local organization and transitioning to the international organization that will construct and operate ESS. Lund's team is focused on expertise in science, costing, marketing, public relations, project planning and international negotiations. It follows a clear three-step international strategy and proceeds on the basis of "we act as if ESS is built in Lund". 3.5 M€ have been spent so far, another 6 M€ is available. The SRG is impressed by the determination displayed by the Lund team which is backed strongly by the Swedish government. Proceeding towards construction without delay will position the team well should the bid be successful, but there is also some risk in pushing too hard at this stage without the commitment of a core group of countries to support the review and optimization work that is needed and to create the core of the ESS international organization. There may be substantial benefits from joint technical and support facilities, and expertise, with the future, adjacent Max Lab IV. Debrecen has concentrated on preparing the bid with a focus on the main differential, which are the cost aspects including excellent financial conditions for expats, and on creating the local conditions. The latter include making available ATOMKI to initially host the international ESS team and to provide technical support. All work on the technical aspects of ESS awaits the putting together of the international team. As a consequence less money has been spent so far or will be spent by a local team. Some joint arrangements have been made with the Bilbao team. The SRG found the national and local government very committed to ESS. Bilbao's bid is linked to the Basque country's strategy to focus on innovation in general and to build up industrial and scientific competences, in particular in the machine tool industry so as to benefit as much as possible from the construction of ESS. Serious thought has been given to optimizing the ESS design and an R&D programme has been set up involving collaborations all over the world. 10 M€ is available, and an additional 20 M€ is to be spent on industrial projects in front end and chopper technology. The commitment of the national and the Basque country government as well as the determination of the Bilbao team are remarkable. An ion source test stand and a front end test bed will give an advantage to the international ESS team. As in Lund's case there is some risk in using the International Advisory Board to validate new concepts for the design of ESS without there being a core group of committed countries.

Regulations and licensing procedures

ESS will not be a nuclear facility at any of the three sites. Regulations and licensing for a radiation facility, environmental regulations and planning and building permits are the key areas of concern. The applicable legislation, procedures, permit- and license granting authorities, and timescales, including time

required for challenges and appeals, have been clearly identified. The SRG concurs with the sites that, though situations are different in the three countries, licensing can be completed within 2.5 to 3 years.

Working and living conditions to attract the best scientists

Lund provides excellent conditions to attract international scientists. Accessibility is excellent, and its international environment and labour and housing market conditions highly congenial. An international school exists. Leisure and cultural opportunities are excellent. Especially well-qualified persons from abroad can be granted a 25% income tax reduction for 3 years. Debrecen will face a challenge to provide in five years time considerably improved working and living conditions for foreigners. Though conditions definitely will improve and the commitment of the local authorities is solid, for example to start separate classes with foreign language education, high wages for international staff may not outweigh short- and medium-term problems for them and their partners and families. Leisure and cultural opportunities are good. Hungary so far has no special tax regimes for expats. Bilbao provides very good conditions to attract international scientists. Accessibility is very good. Labour market conditions are good, housing conditions fine, as are leisure and cultural opportunities. The Basque country offers an income tax of 24% during 6 years to all expats.

Scientific and industrial environment; business-like culture

Lund's scientific and industrial environments are very amenable to ESS. Max Lab IV's neighbourhood will be an advantage. The Øresund region provides significant additional university and industrial capabilities. The business-oriented culture of cooperation and decision making is impressive. In Debrecen the tissue of science-based companies is not yet as highly developed, but the four industry/technological parks and the Pharmaceutical Industry Cluster show the potential. ATOMKI will provide valuable start-up help to ESS. The private and public sector increasingly cooperate to establish an effective business climate. As for Bilbao, the policy of the Basque government to stimulate industry, science and innovation pays off. Many companies active in ESS-related technologies with experience working for European research organizations are in the Basque country and on the science side there are the University of the Basque country and research institutes. The largest Technological Park in the Basque country is next to ESS. The business-oriented culture of cooperation and decision making in Bilbao is impressive.

Concluding remark

In conclusion the SRG thinks that Europe and the ESS project in particular is in the lucky situation that there are three good offers supported by committed national, regional and local governments. They offer different conditions, but the mere fact that there are these three offers should bode well for ESS.

1. Introduction

In order to assist governments to assess the bids of Sweden, Hungary, and Spain to host the European Spallation Source in Lund, Debrecen, or Bilbao, ESFRI decided in December 2007 to devise a series of questions about the most important aspects relating to building ESS on each of the sites. An independent Site Review Group (SRG) was to assess the answers by the sites in order to enable ESFRI and the ministers to proceed with a decision on the preferred site for ESS. An ESFRI Working Group on ESS (EWESS) chaired by Paul Zinsli prepared the questionnaire. The answers were duly received by 25 April. EWESS invited Catherine Cesarsky (CEA, former DG ESO; *chair*), Norbert Holtkamp (Deputy DG and technical project leader ITER; *vice-chair*) and Thom Mason (director Oak Ridge National Lab) to be SRG members, with Peter Tindemans (former chair ESS Council and ESS-Initiative) as Scientific Secretary. The sites were in agreement with the composition of the SRG plus secretary. The SRG members and the Scientific Secretary have declared to have no conflicting interests. The Terms of Reference of the SRG are attached. Dr Marisa Medarda (PSI) organized the site visit programme. A level playing field was ensured to the satisfaction of the sites: all three sites were allotted similar amounts of time to present and discuss their case with the SRG. The site visits were held in July; the candidates have been asked to clarify a number of specific issues in writing. As a consequence the information in this report is occasionally slightly different from what can be found in the responses to the questionnaire. This report should be taken to contain the views of the sites as per August 2008. In particular the respective sections on financing and the host country contributions which have been approved by the site candidates, reflect how the sites at this moment (August 2008) would engage in negotiations. In a meeting on 5 September the SRG presented and explained its assessment to the chair and members of EWESS. After the meeting the SRG finalised its report taking into account comments by EWESS members as it saw fit. The report is therefore the full and sole responsibility of the SRG.

The SRG first deals with a number of site-independent views and observations. Afterwards it considers the various remaining site-dependent issues raised in the questionnaire, slightly re-grouping their order.

Non-differentiating aspects

2. Overall approach and socio-economic impact

The key purpose of ESS is to produce high quality science, the results of which are expected to be of great economic and societal value. Its importance for the socio-economic development of the host city, its region or the country where it is located, is evident in terms of direct employment and expenditures during construction and operation as well as through the strengthening of the regional knowledge economy. This is part of the rationale of the bids of the sites, and all three sites have argued their case with panache. The SRG feels, however, that its duty is not to assess the sites as to where socio-economic benefits are largest. Instead it has concentrated on those aspects which may have an impact on establishing and operating a neutron spallation source that delivers the highest quality science: maximizing science and innovation for Europe as a whole should be leading.

3. In-kind contributions

The SRG has noted that all three sites are eager to accommodate in-kind contributions, no doubt because governments increasingly prefer that option above cash transfers. The sites understand very well that working with in-kind contributions requires a variety of safeguards to be in place. Valuing such contributions financially needs to be done uniformly and transparently; quality control is essential; interfaces must be defined in great detail; planning is crucial. The Lund proposal for examples explains in some detail the concept of a Work Packages Cost Book which is an essential requirement. Yet, the SRG is of the opinion that all three sites are too optimistic. The basic principle should be clear: if project management is not in control of the funds or has not the authorization to spend the money, quality may be jeopardized and cost and time overruns may result. All participating countries have to realize and accept that solid arrangements need to be in place. Circumstances in Europe are different from the US, and it should be recognized that the way SNS was constructed, while involving multiple partners, did not take the form of in-kind contributions. This example should serve to inform decision makers about the high levels of project management, QA, systems engineering and configuration control needed to deliver the ESS with the agreed specifications, within budget and on time, and avoid, later on, continual (re-)negotiations with a formidable number of laboratories, companies or universities and their national funding organizations supporting them. It should also be pointed out from the beginning, that a sensible sharing scheme not based exclusively on national interest but also on optimized integration and project execution should be applied. There exist within the European context successful models of multi-country projects that combine strong project management, engineering design, and financial controls with suitable scientific and technical involvement and development by the contributing partners. In-kind contributions can work but generally work best when there is a technically strong and well resourced central team with ultimate responsibility and control.

4. Scientific case for the ESS baseline

The SRG has read with interest the various responses on the science case for the long-pulse ESS. It considers, however, that the potential of ESS has been demonstrated by and is part of the 'acquis commun' of the European scientific community that will use the ESS. Different ideas exist at this stage about additional scientific facilities ('satellites') but as adding these eventually will be based on the consensus of the scientific community and the participating countries they do not really differentiate between the sites. The neighbourhood of MaxLab IV in Lund clearly is an advantage, but possibly more through joint support facilities during construction and operations than through adding scientific potential that would otherwise not be available; another advantage of this scheme is the proximity of relevant expertise, in the technical as well as in the construction management area of large scientific projects.

5. Technical design

All three sites adopt the basic design of ESS as proposed in the 2003 Update report for the first LP stage of ESS. A 5MW accelerator fed by an H^+ ion source without accumulator rings

produces 1.3 GeV or 1 GeV (to reduce the length of the linac) protons to a liquid metal target. This is a straightforward derivative of the full ESS design that was judged feasible and without show stoppers by ESS's Technical Advisory Committee in November 2002. This design features on the ESFRI Road Map. The three sites have identified ideas for optimising this design. Clearly, ESS at whatever site it will be built will benefit from all these ideas, and the design as such therefore does not differentiate between the three sites. Nevertheless, the way sites have considered some of the technical issues involved provides an interesting indication of how they build up or envision to build up capabilities as a nucleus for ESS. The SRG will consider this in greater detail in the section on 'Building up organization and capabilities'. A design review, followed by an optimization/ updating of the design and completion of baseline engineering, including prototyping, will be necessary. This is probably a 20-30 M€ effort that should start immediately after a site consensus has been reached or earlier if a core group of countries agree on putting together and funding an international team to do so.

6. Legal structure and applicable tax regime

On the last day of the site visits the European Commission has published its proposal for a Community legal framework for a European Research Infrastructure (ERI). An ERI would be a legal entity and be an international organization. It would of course be governed by the laws of the country where it is located as regards health and safety, environmental protection, hazardous substances, operational permits etc. Its members are EU Member States, third countries or inter-governmental organizations. Countries may be represented by organizations such as research councils in the governing bodies of an ERI. As an international organization an ERI would enjoy considerable benefits: goods and services it acquires are exempt of VAT as are the contributions (cash or in-kind) it receives from its members; it would also be exempt from paying excise duties. An ERI would be free to establish its own personnel and procurement rules, irrespective of the Community procurement rules. Customs duties on goods and services imported from outside the EU (intra-Community customs duties have been abandoned a long time ago) would probably not be levied anyhow as these goods and services most likely would fall under the general exemption for educational, cultural or scientific purposes.

When the site candidates responded to the questionnaire the ERI was in the air, and Bilbao has proposed to use the ERI as the legal form when this would be adopted. Lund follows the X-FEL structure (which is rather similar to ESRF): ESS will be a Swedish company with limited liability with a Governing Board or Council consisting of member states or organizations representing these states, and a Directorate for the facility's management. A convention between the member states (modeled on the X-FEL convention) lays down the principles for establishing and operating the facility, and the rights and responsibilities of the member states. Referring also to X-FEL the Debrecen proposal is to similarly establish a Hungarian limited liability company, accompanied by an agreement between the member states or other shareholders.

The SRG assumes that if the ERI proposal will be accepted by the European Union, ESS will adopt this structure wherever it will be located. Without an ERI ESS will be in all three cases a limited liability company. Experience with ESRF and the X-FEL convention show that the practical differences need not be very large: an ERI would have some more flexibility in e.g. personnel policies. But the X-FEL convention and the Lund, Debrecen, and Bilbao proposals all entail the VAT exemption, and that is what an ERI would enjoy if the current proposal will be

adopted. The current ERI proposal also entails exemption of excise duties, whereas neither the X-FEL convention nor the three site proposals comprise these. The exemption of customs duties which is envisaged in the ERI proposal in practice will not make for a distinction with a company as these would not be levied anyhow. The Hungarian and the Spanish proposal are differentiated from the Swedish proposal because they are based on 'tradeable' shares representing voting rights and beam quota but the difference seems to be the high expectations of active trading rather than the actual mechanism (which is quite similar to ESRF).
The SRG concludes therefore that there is no real distinction between the three sites: they will either adopt the ERI structure, if this becomes possible, or follow the ESRF/X-FEL model, which is also adequate.

Differentiating aspects

7. Investment and operational costs; timeline

The three sites have taken the cost estimate for the LP ESS in the Volume III Update report as their starting point, but used slightly differing methods to arrive at their current estimates for investment and operational costs. The SRG briefly describes for each site the method used, the site-dependent costs and a re-calculated figure for a 'standardized' ESS, as there are some differences in what has or has not been incorporated by the sites. It assesses some of the assumptions used. The three groups concur that ESS can be constructed well within a 1.5 B€ budget in current €s. Considering local costs which are especially relevant for conventional facilities, the SRG sees a small cost advantage in Bilbao, and a larger one in Debrecen, though probably less large than the Debrecen bid indicates. The likelihood these potential savings can be realized depends in large measure on the ability of the team assembled to construct the facility, so should be assessed in light of the discussion in the sections on buildup and staffing. A 15% contingency is included. The final budgeting requires optimizing/updating the design and completing the baseline engineering. Design optimization may lead to certain savings but these cannot be reliably quantified without detailed final optimization and baseline engineering.

Lund
The Lund team has built a detailed database with cost estimates for the various items of the ESS Work Breakdown Structure (WBS) from the 2002/2003 design down to the level at which estimates were or are available. Updating to 2008 prices has been done using general inflation indices as well as differentiated data for special cost categories and certain materials. Critical cost items have been analysed, and discussions with representatives from laboratories and companies have allowed for benchmarking several budget items. Conventional facilities have been budgeted on the basis of the detailed list of buildings and facilities in the 2002/2003 design by applying Lund area construction costs. The total investment is estimated to be 1377 M€[1] . For a good comparison it should be noted that this estimate includes 22 instruments @ 11.3 M€ (including a 15% contingency) each, but only the costs spent until operations start – which amount to the equivalent of about 7.5 instruments – are part of the Swedish offer to pay 30% of

[1] The SRG has not checked budgets in detail but notes that the Lund target cost estimate is remarkably higher than the other two estimates.

construction costs. Site acquisition and preparation and off-site infrastructure costs are site-dependent and amount to an additional 62 M€. The pre-project activities at 39 M€ mentioned in the Lund proposal are the costs involved in reviewing, optimizing and completing the design of ESS.
Operational costs per annum of 103 M€ are based on the 2002/2003 figure, adjusted for inflation and increased labour and energy costs. They include personnel costs for 450 staff members (including post-docs and students) and 22 M€ for energy. Investing in renewable energy and re-using excess heat in Lund's district system is estimated to have an annual earnings potential of about 8 M€. The latter is also a site-specific item but requires more detailed design to validate.
Lund's estimate includes the costs of completing the instrument suite and renewing and refurbishing it afterwards to the equivalent of 2 instruments every year. The aim to reduce power consumption to the equivalent of 35 MW installed power strikes the SRG as ambitious, given the fact that the original estimate of 40 MW may well be too low. The SRG notes moreover that the overall budget of 103 M€, contrary to the 2002/203 operational budget, includes a 15% contingency. If that is the case, the estimate might have to be higher. Decommissioning is estimated to cost 346 M€ with a 100% contingency on top of an estimate by a nuclear company.

Debrecen
The Debrecen team has used the same WBS albeit at a somewhat higher level of aggregation. A consulting company and Hungarian scientific experts have first compared the ESS cost estimate with the actual costs of the SNS project (including the projected power upgrade). The qualitative assessment of the differences between ESS and SNS and assumptions about exchange rates do introduce of course some margin of uncertainty, but the Hungarian estimate includes also a somewhat higher contingency of 17%. General European inflation indices have been used and specific estimates for sharply risen commodity costs such as steel have not been considered. As regards the latter the argument was that increases per component could be covered by the contingency. This may be true arithmetically, but the SRG does not find it good practice to already spend the contingency in advance of construction. Costs for project management and administration are high at 102 M€. Costs per instrument are based on recent ISIS data and evaluated at an average 7.7M€ per instrument (excluding contingency). For the key items of the machine (front end and linac, beam transport, target, instruments) an estimate has been made of how much savings would be possible due to lower labour costs of Hungarian sub-contractors or Hungarian staff assuming specific percentages of Hungarian participation depending on for example the amount of capital and personnel costs in the various construction items. For the machine these savings would amount to between 25 and 30 M€. Conventional facilities have been budgeted on the basis of the detailed list of buildings and facilities in the 2002/2003 design by applying Debrecen area construction costs. The level of construction costs being about 70% of the European average this would imply savings of 110-130 M€ on these conventional facilities. All in all the investment costs are 1016 M€, which includes 8 M€ for R&D (this would be part of the 30-40 M€ mentioned in the section on Technical Design) and 10 instruments @ 7.7M€ (not including a 17% contingency). Eventually ESS in Debrecen would also have 20-22 instruments. The SRG is convinced that a significant difference in construction costs exists in Debrecen, but the estimates seem slightly optimistic as the catching up of wages and prices may well go somewhat faster than anticipated. Comparisons with international manufacturing

companies located in the area must be given careful scrutiny since the fraction of the workforce that is local is high compared to what would be anticipated for ESS.
Operating costs amount to 95 M€ per annum, but it should be noted that the Debrecen proposal involves a total staff complement of 600 fte, in contrast to the 410-420 of the 2002/2003 plan, the idea being that hiring more local technical and support staff not only is affordable at local wages but also increases the efficiency of ESS operations. The estimated power consumption of the equivalent of less than 25 MW installed power (at annual costs of 14.8 M€) definitely seems too low. The SRG thinks that the Debrecen team has a point in that international research organizations tend to be understaffed at the technical and support level, making the scientific exploitation less than optimal. Nevertheless, it has serious doubts about working many years into the operational phase with effectively two different kinds of personnel, one paid at international rates, the other at local rates. However, outsourcing local personnel for specific tasks may be possible, and indeed some modest savings could be made there in comparison with other sites. The idea of hiring permanently 150-200 additional staff without raising the operation costs may therefore not be realistic. Decommissioning is estimated to cost 160-180 M€, but may well be 50 % higher.

Bilbao
The Bilbao team also adopted the same WBS and the original cost data. It proceeded somewhat differently: an engineering and construction consultancy identified the principal cost drivers for the key machine components of the detailed 2002 ESS design (for example copper for the normal conducting cavities) and adjusted costs for the price evolution in Europe for these different parts[2]. For the personnel costs involved the consumer price index rise has been applied. Instruments have been budgeted at 12 M€ each (not including contingency) on the basis of average instrument costs at SNS and ISIS. Conventional facilities have been budgeted on the basis of the detailed list of buildings and facilities in the 2002/2003 design by applying Bilbao area construction costs. The Bilbao team has included 55 M€ (not including contingency) in the conventional facilities budget for additional technical and project management staff which seems to be high on top of the 60 or so M€ for general project management and administration. Lower costs for wages and construction materials in the Bilbao area form a site-dependent element and are the reason that despite increased personnel costs for the conventional facilities, these have still risen less than total ESS construction costs which in Bilbao's bid amount to 1284 M€ including 7 instruments @ 13.8 M€ (including a 15% contingency). Eventually, ESS in Bilbao would also have 20-22 instruments. As regards other site-specific items, a detailed cost estimate has been made for a waste management facility of 18.5 M€ (which may not be necessary as SNS experience indicates and therefore could be a potential cost saving) as well as for the site conditioning at 88 M€. Operating costs amount to 113 M€ per annum. They include personnel costs for 412 staff members and 23 M€ for energy on the basis of 70 MW installed power. The yearly budget for instruments is at 18 M€, too low for the equivalent of the costs of 2 instruments. A preliminary estimate of decommissioning costs is 170 M€ without contingency.

Investment costs compared

[2] The SRG has not checked budgets in detail but notes that the Bilbao accelerator cost estimate, as well as project management estimates for conventional facilities are remarkably higher than the other two estimates.

For a quick comparison a 'standardized' ESS has been chosen, that is, apart from the machine which is the same anywhere, the same number of instruments (i.e. the equivalent of 7.5 instruments, some completed, some under construction) has been included in the construction budget. In addition, site acquisition and preparation are not included; neither are R&D or project development costs, nor pre-operation costs. As regards the costs of each of the components, the figures the sites identified have been used. All contingencies have been lumped together in one budget line (it has been assumed that each individual line item in Lund's budget contained 15% contingency), and also the Debrecen one has been put at 15% for the sake of comparison.

Costing comparison for a 'standardised' ESS, in M€

	Lund	Debrecen	Bilbao
Front end and linac	357	344	465
Beam line to target	17	7	14
Target system	175	77	113
Instruments	74	58	90
Conventional facilities	335	246	363
Control systems	51	35	38
Management and administration	47	87	42
Total construction costs	985	854	1125
Contingency @ 15%	158	128	169
Total construction costs	**1214**	**982**	**1294**

A few concluding remarks are in order.
The design review will automatically deal with the issue of the installed power where the sites have now different assumptions. That same review should also be used to arrive at a common estimate of average instrument costs which are now different too. As noted, sites might have overestimated somewhat the costs of individual components but even at his higher level the current cost estimate does not exceed 1.3 B€.

Decommissioning estimates are notoriously uncertain and subject to changing regulations. They should not now be taken to differentiate between the sites. Appropriate solutions to pay for these costs must be an important issue as soon as the international organization for ESS has been established. And of course the optimization of the design, validated by an international team, should consider all reasonable ways to ease decommissioning and reduce its costs. There is however an important aspect to take into account. ESS partners will agree on a fixed scheme for paying the decommissioning costs and do so for example by paying annual contributions into a fund. But depending on who is responsible for the actual decommissioning the risks of potential cost overruns rests with different parties. As will be noted the sites differ in this respect. In Lund it is the ESS organization itself, in Hungary the host state through a public agency, and in Bilbao an organization designated by the state to take over the facility. In the first case the cost risk is with the ESS organization. A similar difference may result as regards liabilities.

Finally, the SRG has not analysed in detail the presented cost distributions over time. As far as capital costs are concerned, these are in general terms relatively straightforward. The SRG warns however against underestimating the need to build up rapidly a rather large workforce on site and

in the contributing laboratories. Experience at e.g. SNS shows that at peak capacity considerably more manpower is assembled than in the stable operational phase. This has partly to do with the not very aggressive approach the sites present for construction (7 years SNS versus up to 9 or 10 years for ESS). There is no reason why the actual construction of ESS (without for example an accumulator ring) should take longer than SNS: after the site is known and a core group of countries has been formed, 7 years ought to be feasible as well: 2 for putting together the team and reviewing and optimizing the design, doing the baseline engineering and starting the site preparation, and 5 years for the actual construction. As is well known stretching construction only adds to the costs.

8. Financing and host country contributions

The SRG describes in this section the nature of the financial offers, which are quite different for the three sites. It does not prefer one to the other, but identifies risks and peculiarities. The sites have received an advanced version of their commitment, and agree on the current version. At this stage these commitments should therefore be taken as the basis for negotiations. At the end the SRG tries to sum up commitments of the three sites over the lifetime of ESS, assuming a 40-year operational phase.

Lund
If ESS is built in Sweden, the Swedish government offers to pay 30% of the construction costs up to Day One when operations start. These construction costs up to Day One amount to 1314 M€ and include pre-project activities and site acquisition and development. As explained in the section on investment costs the amount of 1314 M€ includes the equivalent of about 7.5 instruments. The Swedish government is confident that an additional 20% of the construction costs up to Day One will come from other Nordic and Baltic countries, which might include contributions from the private sector. Sweden's starting point for negotiations is that the other 50% should be shared by other countries on the basis of pro-rata GDP figures. Furthermore, the Swedish government is discussing with the European Investment Bank the terms for using the new Risk Sharing Financing Facility, which provides gap financing to avoid delays in the implementation of research infrastructures in case other countries cannot meet the project schedule funding needs. The contribution from this facility could amount to 15-20% of construction costs up to Day One and is intended to be an integral element of the finance plan.
The land for the site is available as a single parcel and will be obtained by the City of Lund in a land swap with the current owner and its acquisition is part of the site development.

Sweden offers to pay 10% of operating expenses as of Day One. The sharing of the remaining operational costs will be subject to negotiations. Sweden expects partner countries to suggest that contributions will be calculated according to expected use, and is willing to negotiate on that basis.

Based on the strong Swedish technical and scientific interests in ESS, Sweden will participate in ESS should it be built elsewhere in Europe, provided that the requirements for creating a successful facility will satisfy the Swedish interests. Should this be the case Sweden is prepared to discuss participation in the remaining construction costs, i.e. after deducting the host country

contribution, on the basis of its share in the GDP of all the non-host participating countries. Sweden is open for negotiations on use of time as a basis for contributions to operational costs.

The SRG wishes to comment that it may not be taken for granted that countries will participate in the construction costs on the basis of GDP. Of course Sweden, as is the case for Hungary and Spain, expects larger countries to contribute more, but countries will make an assessment of their need.

Debrecen
If ESS is built in Debrecen, the Hungarian government offers to pay 20% of the construction as site premium. For the remainder of construction costs shares are issued at a price of 80%, of which Hungary initially buys 12.5% (or the equivalent of 10% at full price), bringing its total contribution to 30% of construction costs. Hungary will use approximately 120 M€ from EU structural funds for this, in addition to other means of financing. Each shareholder will pay a yearly contribution proportional to its share, in accordance with the financing needs of the project. Buying a certain percentage of shares gives the country's researchers access to beam time if the country accepts to pay the same percentage of annual operational costs. Of the three scenarios Hungary presented, the SRG has understood that scenario B is the preferred one. This scenario assumes that not all countries are ready to commit themselves before the project starts. It also assumes that though countries would contribute eventually to the total construction costs in proportion to the share they want to have in operations, some core participants (i.e. countries agreeing to participate right from the beginning, Spain being a case in point) would initially acquire a higher stake which they later would sell in a controlled non-profit scheme, agreed upon at the start. This in the first place applies to Hungary itself that eventually wants to reduce its share in construction (apart from the 20% site premium) and operating costs to say 3%. Hungary is engaged in discussions with the European Investment Bank and is confident that the EIB could contribute an amount of up to 200 M€ from the new Risk Sharing Financing Facility. In this way the EIB would acquire shares[3], to be sold to new partners at the end of the construction period. Thus Hungary and the EIB together will assure risk capital bridge financing of up to about 35% of the shares, to be sold at actual costs to countries joining ESS later than the initial signature of the convention.
Debrecen will make the land available for free and also will pay the site preparation costs, including off-site infrastructure and for hosting the ESS core team of up to 50 people at ATOMKI premises for one year. The estimated amount of these free of charge contributions by the city of Debrecen is 50 M€.

In case ESS is being built elsewhere Hungary will participate eventually at approximately a 3% level; Hungary will consider to buy initially up to 8 % of the shares (to be partially sold later on non-profit basis to new joining countries) if in the framework of collaboration with the selected site Hungary assumes responsibility for a major task in the project construction.

Bilbao

[3] The SRG notes that technically speaking the EIB may not want buy shares, but that is a matter of financial engineering.

If ESS is built in Bilbao, the Spanish and the Basque country governments will contribute at least 375 M€ of the estimated 1284 M€ construction costs. This amounts to 29.25% of construction costs, hence a site premium of 14.25% as they intend to keep for themselves, throughout the life of the project, a 15% share of the facility. The remaining shares (85%) will be sold at a price of 70.75% of construction costs, which is 100% minus the 29.25% contribution of Spain and the Basque country. Spain offers the possibility of using the Spanish National Fund for Research Infrastructures to smooth cash flow during the construction phase. If agreed in bilateral negotiations this fund may be used to adjust other countries' contributions in order to tune the yearly expenditure requirements to meet the project schedule. In this way there is no need for Spain and the Basque country or for other countries to resort to e.g. the European Investment Bank.

In addition Spain and the Basque country will make the land available for free and pay for site preparations (together estimated at some 115 M€)

Spain and the Basque country will assume at least 17 M€ (i.e.15%) of the annual operational costs. The remaining operational costs will be borne by the other participating countries in proportion to the usage rights they want to obtain.

If Spain was not to host ESS, Spain would in principle contribute with a share depending on user needs. It is reasonable to assume that this would amount to 8%, maximum 10%.

The SRG wishes to remark that there is some schedule risk as the land is owned by a variety of landowners next to the 30% owned by the Business Park. But it also notes that expropriation procedures are clear and can be applied. Moreover, the core ESS can be built on the land owned by the Business Park.

Total host countries' contribution to ESS full life-cycle costs

To facilitate further comparison the SRG has made an estimate of the host countries' contribution to the full life cycle costs of ESS in M€s of today. There are three types of contributions: to construction, to operations and to additional items such as site acquisition and preparation or to pre-project or R&D costs. The SRG lists them separately as e.g. site preparation is included in the Lund construction cost estimate and not in the others. The possibility that other Nordic and Baltic countries will enhance the Lund contribution is also mentioned, although the corresponding participation to Operations is not known. Also the offer of Hungary to pay initially an additional 12.5% of shares, to be sold later, invites separate assessment. As an additional piece of information the final usage of the facility envisaged by the three candidate countries is mentioned.
An operational phase of 40 years has been assumed. In Hungary's case the assumption is that Hungary would contribute 8 years operational costs at 12.5% and the remaining 32 years at 3%.

Contributions to full life-cycle costs, in M€

	Construction	Additional	Operations	Eventual usage
Sweden	394	in construction budget	412	10%
Sweden + neighbours (tbc)	657	in construction budget	>412 tbc	tbc
Hungary	203 (+102 to be recouped)	50	186	3%
Spain	375	115	680	15%

Acquiring beam time pro-rata of cost contributions (excluding site premium)

The SRG would like to make one final remark on the financial offers. They all take it for granted that a certain percentage of participation amounts to the same percentage of beam time. But there should be left open the possibility to make available some share of beam time to scientists from non member countries presenting outstanding proposals; and also to leave a small share as Director's discretionary time. Also the evaluation of proposals should be done at a strict international level. The experience at e.g. ILL and ESRF shows that it is possible to introduce balancing mechanisms to restore initial distortions in allocation.

9. Physical site characteristics, physical risks and insurances

Lund

The site Lund proposes is well suited to build ESS. The Lund team has done extensive geological and geophysical investigations into soil conditions, including core penetration. There is no history of heavy earthquakes in the region. Meteorological conditions do not provide any problems. Accessibility for construction is fine through for example the port of Malmö, Copenhagen and Malmö airports, and existing motorways. There is room for expansion should the need arise. There is good access to services (electricity, water) on the site and the quality meets the requirements of ESS. Two issues deserve attention, though they pose in no ways serious risks: as the ground water table is shallow at 3.7 m at the target station, it is necessary to confirm the applicability of the ESS reference design for the target foundation to insure there is no additional cost associated with environmental compliance. Second, the proximity of a public road needs to be evaluated in the context of access control to the technical facilities by the public in order to limit doses associated with normal and off-normal beam losses.

The Lund team has devoted some clear thinking to the management of risks and hazards that inevitably accompanies a project such as ESS. An environmental damage insurance is mandatory as well as a remedial insurance, but would be very low: Lund's estimate is ~10k€ annually. Concerning construction and decommissioning insurance is probably best handled by the ESS project company; in the operational phase this is obvious.

Debrecen

The geological and geophysical conditions of the site at Debrecen are good as well. A team of the Academy of Science institute ATOMKI has done a thorough investigation, including core penetration. There is room for expansion should the need arise. Existing drinking water wells

have been mapped extensively and do not pose any problem. Seismic activity has been low for 1500 years. Meteorological conditions do not provide any problems. Three issues need some attention. The first one is that the load bearing capability of the ground is not sufficient by itself. Thus, the ESS target station needs to be built on piles, not directly on bed rock, which is not a problem per se (cf SNS), but cost implications need to be investigated. The site furthermore is very close to Debrecen airport which does not pose a problem for air traffic security: this has been checked. But does ESS need to meet special safety conditions to prevent damage from air crashes? As there are no easily accessible water sources nearby, a dry cooling tower solution is favoured, the cost of which is likely to be slightly higher (construction and operation). This needs to be fully evaluated. In additional information requested by the SRG the Debrecen team has shown that electricity supply is sufficient and meets quality requirements thought the grid structure in combination with the fact that the power comes from one very big plant requires some consideration. Accessibility for construction is good through motorways and Debrecen and also Budapest airport. There are no rivers and therefore no river ports nearby.
The Debrecen team too has identified a number of risks which need to be addressed first by detailed risk assessment during the critical design review, and afterwards by a proper risk management system which will be informed by effective information and security systems. It also has identified a number of insurances that would have to be taken out. An environmental liability insurance will be required in Hungary, but the government has not yet decided on the terms.

Bilbao
Bilbao's site is also well suited to the ESS needs. Extensive geological and geophysical conditions including core penetration have demonstrated that the site meets all conditions: ESS will be built directly on bed rock. Meteorological conditions do not provide any problems. There is room for expansion should the need arise. Accessibility for construction is excellent through Bilbao airport (and other nearby airports as well), through motorways and through Bilbao and San Sebastian seaports. The area is not in use for obtaining drinking water. Electricity and water supply is very good and of sufficiently high quality. Seismic activity is very low. As this airport is as close to the site as Debrecen airport is to the Hungarian site, the same question arises: apart from meeting air trafficrequirements (which has been verified) are any special safeguards necessary against air crashes?
The Bilbao team has done an extensive analysis of the radiological inventory of ESS, based on the 2002/2003 ESS data and SNS data. These and other risks will be addressed during the licensing process. Insurance is mandatory to cover damage from accidents to any third party. The Bilbao team also considers in some detail insurance for personnel and visitors. The SRG assumes that the principles underlying these requirements (for example to cover risks of common illness) are not widely different for the three sites.

10. Building up organization and capabilities

The SRG has discussed extensively with each of the three sites what they have done so far to build up a local organization, which resources are available, which choices they have made with respect to strengthening capabilities in order to benefit as much as possible from the international facility ESS, and how they envision transitioning to the international organization that the

participating governments will create. There are clear differences which the SRG presents and briefly comments upon.

Lund

The Lund team is built around two reputable neutron scientists, with additional expertise in costing, marketing, public relations and project planning. In addition they have launched an international strategy, led by a former Swedish finance minister to convince other governments to participate: step 1 was to inform others, step 2 to discuss options for technical collaboration; and the 3rd step will focus on negotiations. Crucial in Lund's strategy, which is strongly backed by the Swedish government, is to first conclude agreements with Nordic and Baltic countries. That process is under way as the series of press releases shows. Less attention has been paid to technical aspects: Maxlab's expertise seems to be at some distance at present although given the construction schedules it could represent a significant asset if properly coordinated. Recently an International Scientific Advisory Committee and an International Technical Advisory Committee have been established. This is all done on the basis of "we act as if ESS is built in Lund" with the Lund team in charge. 3.5 M€ has been spent so far, and another 6 M€ is available. The SRG is impressed by the determination displayed by the Lund team and proceeding towards construction without delay will position the team well should the bid be successful, reducing the risk of start-up difficulties. There are some risks with this strategy however. ESS is now in a stage where as soon as a site consensus exists weighty decisions need to be taken by at least a core group of countries on creating the nucleus of the international organization and on starting an official design review and optimizing and updating the design. This will require considerable amounts of funding and expertise. Detailed discussions with partners on technical aspects need a focus on technical aspects which has not yet been given priority. And initiating the design review without the prior commitment of a core group of countries to support the review and the optimization work may imply pushing too hard at this stage. The risk is that decisions may need to be changed should a different picture emerge from this work.

Debrecen

The Debrecen team has opted for a different approach. The main function of the local team, built around a scientist who is heavily involved in the current design of ESS, is to prepare the Hungarian bid, and concentrate on the key area where a Debrecen bid would differ, namely the cost aspects both of construction and of operations, by creating excellent financial conditions for expats, and by hiring a considerable number of local staff to facilitate the operation. The team also established the local connections which will help the international team that will be created after a site decision makes a head start: office and lab space is available at ATOMKI, technical expertise at ATOMKI will be available as well, and the University of Debrecen is investing in neutron science. No considerations have been given to modifying the design or elaborating the science case as a basis for instrument decisions. These are in the Hungarian eyes the full and sole remit of the international team. Less money has been and is being spent in Debrecen than in two other sites. ATOMKI will provide a suitable first start venue although the growing organization will quickly outpace its capacity. The SRG found the national and local governments very committed to build ESS in Debrecen.

In addition arrangements have been made with the Spanish team: there is a joint science director; international consultations will often be held together; there is a joint international advisory

board, which unsurprisingly has some overlap with Lund Advisory Boards; and in case one of the two sites is chosen the other will be privileged partner (though the SRG has not clearly understood what the role and prerogatives of the privileged partner would be).

Bilbao

Bilbao has clearly linked its bid for ESS to the Basque country industrial innovation strategy where it helps that the Basque country has a high degree of autonomy and commands significant financial means; at the same time, this bid is strongly supported by Spain's central government. Based on a focus on materials, mechanical engineering and ICT industries, the Bilbao team has identified important components it wants to supply (with more emphasis on the accelerator), what expertise (both industrial and in universities and research centres) it has or needs and how to obtain the latter. In general the aim is also to advance and diversify the level of the machine tool industry.

The team has given serious thought to potential changes for the ESS design, taking advantage of knowledge acquired in the intervening years since the conclusion of the ESS study that was presented to ESFRI. This then leads to an ambitious R and D programme, in which the team tries to involve the best experts all over the world. On this basis the Spanish bid identified a number of areas for critical design which the SRG finds very well chosen, though of course no detailed design optimization and review have been carried out.

Technical R&D efforts so far have largely been decentralized, but the ESS-Bilbao consortium is now in charge of coordinating efforts. An extensive set of collaborations has been set up with e.g. ISIS or CEA or CIEMAT, as well as non European entities, which will provide technical expertise paid for by the Basque government. 10 M€ is available till the end of 2010 for ESS-Bilbao, of which 6 M€ for the time being has been set aside for R&D. In addition there are plans to invest 20 M€ (of which 5 M€ is already available) for a programme proposed by three companies in the area of front end and chopper technology. The Bilbao team plans to operate an ion source test stand, and it is establishing a front end test bed which could give an international technical team somewhat of a head start. They are also involved in presently ongoing improvement projects of existing Neutron Source facilities (Front end upgrade at ISIS and the Power Upgrade at SNS) as well as close connections to CERN. As a result the Bilbao team has more clearly identified roads for cost savings through design optimization. The commitment of the national and the Basque country government, as well as the determination of the Bilbao team are remarkable. The wish to use the International Advisory Board to validate new concepts for modifying the accelerator design seems, like in the case of Lund, rather ambitious as serious work by many full time persons on the basis of an agreement between a core group of countries needs to be carried out. ESS-Bilbao has appointed an interim project manager. The eventual project manager will be appointed by the initial participating governments.

11. Regulations and licensing procedures

Lund

ESS will not be a nuclear facility in Sweden. Instead it will require a permit under the Radiation Protection Act, to be assessed and granted by the Swedish Radiation Protection Authority, a government body. In addition on a voluntary basis a permit will be sought under the Environmental Code. This is assessed and granted by a Regional Environmental Court but the

Swedish government has declared to exercise its right to exclusively assess the permissibility of ESS under the Environmental Code. A building permit is required under the Planning and Building Act and is assessed and granted by the City of Lund. Once the development plan for the ESS site has gained legal force, the site holder has a statutory right to be granted a building Permit. The different assessment procedures will run simultaneously, but of course need to be coordinated. The SRG is satisfied with the clarity of regulations and procedures, and shares the confidence of the Lund team that the licensing can be completed prior to construction. A Permit under the Environmental Code is valid against all other parties, including environmental authorities and private third parties. Sweden has a high degree of planning security, and relevant expertise has already been hired.
Sweden has extensive regulation in place for decommissioning facilities such as ESS, and for handling and storing nuclear waste, as well as considerable experience. Decommissioning is the responsibility of the facility.

Debrecen
ESS will not be a nuclear facility in Hungary. ESS needs a license under Act CXVI of 1996 on Atomic Energy and Act CXL of 2004 on the general rules of public administrative procedures and services to be used during the licensing process. In addition, Act LIII of 1995 on general rules of environmental protection and several ministerial decrees of the Ministry of Health and the Ministry of the Environment need to be taken into account; an environmental license based on an environmental impact assessment will have to be granted by the Environmental Protection Authority. In addition, a consolidated environmental use permit will be required. Permits are given by the administrative office of the first instance on the basis of submitted technical documents and opinions of specialized authorities such as the National Public Health and Medical Officer Service, the National Inspectorate for Environment, Nature or the National Vehicular Authority. The government of Hungary has expressed its firm intention to declare ESS a National Priority Project under the 2006 Law on Simplification and Acceleration of the Execution of Investments with National Priority. This will vastly accelerate the administrative actions to be completed. Legal procedures to settle challenges and appeals against decisions of licensing authorities will be brief. Detailed information provided to the SRG shows that the various steps in the most extensive procedure for challenging and appealing a decision can be completed in 4 months. Hungary has extensive experience and expertise with licensing of nuclear facilities, and there is wide support among the population for nuclear energy. So the Debrecen team is confident that the licensing procedures can be completed within 2.5 year after a site decision, and the SRG is prepared to concur.
Decommissioning is the responsibility of a public company, PURAM (Public Agency for Radioactive Waste Management); for non-nuclear facilities applying ionizing radiation it is governed by two decrees (16/2000 and 47/2003) of the Ministry of Health.

Bilbao
ESS will not be a nuclear facility in Bilbao, unless the residual heat would be used as energy source for domestic or industrial use, but the Bilbao team has no intention to do this. The Bilbao team is confident that ESS will be classified a Radioactive Facility of First Class, similar to the ALBA synchrotron in Barcelona. The Council for Nuclear Safety which has a lot of experience with Class One facilities regulates and advises the minister, but the latter will issue the license.

Licensing in phases is possible if for example one can demonstrate that the front end is a Class Two facility. A full set of environmental regulations exists; carrying out an environmental impact assessment is crucial. A building permit will have to wait for the licensing of ESS to be completed, but site preparation is possible beforehand. The Bilbao team is reasonably convinced that licensing can be obtained in time, but the SRG thinks that careful planning with all the authorities involved is needed. Given the strong capabilities the Bilbao team already has access to, the SRG believes that in this case too the problems can be addressed and solved. The appeals procedures do not seem unduly long. There is the recent example of a store facility for radioactive materials in Madrid in which the delays due to the full cycle of challenges and appeals was not more than 1 year.
Decommissioning will be the responsibility of the electricity utility ENDESA which will take over the facility under agreed terms.

12. Working and living conditions to attract the best scientists

Lund
Accessibility of the Lund site for permanent scientists and visitors is excellent. An international school and an international pre-school, advanced child care laws, steady increases in employment in international companies or where English is the common language, a high number of R&D jobs all provide for very good conditions for partners to find English-language jobs and for ESS staff to work in a highly congenial environment. Housing situation is good and still reasonably priced. Especially well-qualified people from abroad can be granted a reduction of 25% on income tax during 3 years. Local service provision (including catering, cleaning, health services, financial services or ICT services) is highly developed. Next to Lund nearby Malmö and Copenhagen provide excellent general and specialized shopping and cultural possibilities. Leisure opportunities are also excellent.

Debrecen
Accessibility of the Debrecen site still needs improvement. Debrecen airport only handles a few international flights, and Budapest airport is, with the planned improvement of train services, two hours away. The challenge of Debrecen is to provide in five years time considerably improved working and living conditions for foreigners. Housing will not be the first problem as new residential areas are planned, and of course costs of living are an advantage. But the proposal to pay substantial wages to international staff may not outweigh in the short- and medium term problems which they themselves, and even more their partners will have to live in a city where there still is an obvious language barrier, or find work as a partner. No doubt this will improve but catching up takes time. International schools so far do not exist, but the number of schools with advanced level programmes in English, French or German is increasing, and the Municipality has pledged that should ESS come to Debrecen separate classes with foreign language education will start by 2011. Hungary so far has not yet special tax regimes in place to attract foreigners. Local service provision has developed considerably over the past ten years. Health services are very good. As a city of considerable size Debrecen is now offering a variety of smaller and larger stores. Leisure and cultural opportunities are good.

Bilbao

Accessibility of the Bilbao site is very good. There are at least four foreign schools in the Bilbao vicinity with a foreign language curriculum, and the Spanish government will promote the establishment of a European School near to the ESS site. Companies increasingly hire English-speaking employees. Two agencies facilitate the incorporation of highly qualified personnel in the job market, and opportunities for partners to find jobs are nowadays quite good in the Basque country's diversified labour market with low unemployment. R&D jobs are rising rapidly in numbers with the Basque government embarking on a clear policy to investing in the Basque country's position in the areas of knowledge and innovation. Housing conditions are excellent, and leisure and cultural opportunities in Bilbao and the Basque country as a whole, fine. Bilbao offers significant tax advantages to all expats: an income tax of 24% during six years.

13. Scientific and industrial environments; business-like culture

Lund

Lund's scientific and industrial environments are very amenable to ESS. A strong university, a large science park, smaller and larger industrial companies focusing very much on research and development will all be in the direct neighborhood the ESS site. MaxLab IV will be next to ESS offering the possibility of shared technical and support facilities with potential for operational cost savings not reflected in the estimates described above. The wider Øresund region provides significant additional university and industrial capabilities.

The SRG is impressed by the business-oriented culture of cooperation and decision making in Lund to which public and private parties contribute alike.

Debrecen

Debrecen has a large university with very sizeable science and engineering faculties. ATOMKI will of considerable help to ESS in the early phases of the project. Obviously the tissue of science-based companies is not yet as highly developed. This will not doubt happen; the four industry/technological parks and the "Pharmapolis" Pharmaceutical Industry Cluster clearly show the potential. ESS can be an important agent for change, but while, as the SRG remarked before, one should certainly utilize the full potential of ESS in this regard, it should not be the first driver for ESS. The important changes in Debrecen over the last ten years (the first industrial park only dates from 1997) illustrate that the Debrecen private and public sector increasingly cooperate to establish an effective business climate.

Bilbao

Bilbao and the Basque country have made great strides over the past 10 years. The consistent policy of the Basque government to stimulate industry, science and innovation pays off. The University of the Basque country (with four campuses) and a variety of research centres will be a local academic partner for ESS; the specific decisions to strengthen ESS-related expertise have been mentioned before. Of the 60 or so companies active in ESS-related technologies in Spain half are in the Basque country, and many of them have been involved in projects for large research organizations in Europe. ESS would be next to the largest and oldest Technological Park in the Basque country.

As in the case of Lund, the SRG is impressed by the business-oriented culture of cooperation and decision making in Bilbao and the Basque country at large to which public and private parties contribute alike.