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## Focus Lund. The ESS Scandinavia submission to the ESFRI Working Group on ESS siting

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The  
**ESS Scandinavia**  
submission to the  
**ESFRI Working Group on ESS siting**

25<sup>th</sup> April 2008



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## Acknowledgements

This document represents the work of many dedicated people since October 2000 when a group of young Scandinavian scientists dared to believe that they could bring the European Spallation Source to Lund. We salute them!

The report itself has been created by a small (but perfectly formed!) group of people from the ESS Scandinavia Secretariat – *Malin Malm, Karl McFaul, Patrik Carlsson, Christian Vettier* and *Colin Carlile*. We take personal responsibility for the contents of this document. We thank Allan Larsson warmly for his constant guidance and advice and our colleagues at the Secretariat for their support and companionship.

## Contact

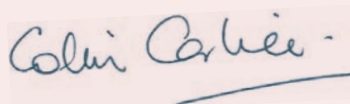
Contact us through our website: [www.esss.se](http://www.esss.se)

**A** big step towards choosing the site for ESS was taken on Friday 25th April, 2008, when the three sites of Lund, Debrecen and Bilbao submitted their reports to the ESFRI (European Strategy Forum on Research Infrastructures) Working Group on siting ESS (EWESS).

These specialised reports are the response to a detailed questionnaire from EWESS on all aspects of the characteristics of each of the sites. EWESS has appointed a Site Review Group (SRG) composed of high level scientists, experienced in large scientific facilities, in order to evaluate the different sites. The SRG will produce a report during September 2008.

This report will be made available to Research Ministers in Europe. The SRG is not expected to recommend a specific site but instead to address the qualities of the three different sites.

The Lund response to EWESS is contained in this document which can also be downloaded from our ESS Scandinavia website: [www.esss.se](http://www.esss.se)  
The questions appear in red.



Colin Carlile  
Director, ESSS Secretariat





## ESS IN SCANDINAVIA - THE NEXT GENERATION NEUTRON SOURCE

**M**odern society places tremendous demands on scientific research. We want new materials that are lighter, stronger and cheaper, medicines that cure diseases quickly, effectively and with no side effects, and everything must be environmentally friendly, non-toxic and non-polluting. Many are the mysteries yet to be solved: why and how do proteins fold and unfold; why do glasses form and by which mechanism; and how do high temperature superconductors actually work? In the past most major advances were not planned: the laser, ubiquitous today, was stumbled upon; the IT age was not foreseen when the transistor was invented; the applications of satellite technology were not even glimpsed when Sputnik was launched. Nanoscience, fullerene, high  $T_c$ s and GMR materials were completely unexpected. Although that element of serendipity will surely remain, scientists will in the future be able to design new materials, using databases of information about material properties and behaviour on the atomic and molecular level that have been assembled from many different advanced experimental techniques - neutron scattering being an essential one amongst them - coupled to methods of computer simulation and modelling.

**The technical and scientific case for the next generation neutron source for Europe – The European Spallation Source – is complete and persuasive.** The ESS will be the world's most powerful neutron source. It will be essential for Europe's competitive edge. It is one of the highest priorities on the ESFRI<sup>1</sup> Roadmap and has gained such momentum that its construction, after many years of preparation, has been recognised as both essential and inevitable. There are three worthy site contenders, and this competitive situation has fuelled the scientific and political debate and driven the project up the agenda throughout Europe to the highest levels. Now is the time for commitments to be declared and for decisions to be made.


**ESS will be the best neutron facility in the world.** To achieve that goal it must provide facilities that will stretch the imagination and the ingenuity of the 5,000 researchers in Europe who use neutron beams as part of their armoury of tools to understand materials. Excellence will be the watchword. The scientific output will drive innovation and will contribute to Europe reaching the Lisbon targets. The intellectual and economic activity it generates will have a transnational impact. This effect will be amplified by the presence of the MAX IV synchrotron radiation source on the same site as ESS, and by XFEL only 300 km away. This compact region of Europe, linked by bridges and a common culture, will become an unparalleled cluster of scientific excellence.



Satellite image of the Öresund region showing Copenhagen, the bridge to Malmö and Lund with the ESS site in the upper right-hand corner.

1. European Strategy Forum on Research Infrastructures

## THE SWEDISH BID TO HOST THE ESS IS FOUNDED UPON THE FOLLOWING ELEMENTS:

- **Political and financial support from the Swedish government embodied in a series of decisions at Cabinet level.** [Section A](#)
  - **The ESS Scandinavia Reference Design is fully compatible with the description outlined in the ESFRI European Roadmap for Large Scientific Infrastructures 2006.** It will be a world-leading 5 MW long pulse spallation source with 22 instruments, potentially upgradeable to 7.5 MW and 33 instruments. [Section B](#)
  - **ESS in Lund will be a joint European venture** offering instrumentation with more than an order of magnitude improvement compared with existing capacity, leading to new scientific breakthroughs. It will incorporate technical headroom and will be built in collaboration with a broad range of scientific laboratories in Europe and beyond. [Section B](#)
  - **The Swedish Government will pursue a funding model based on generosity and fairness.** Sweden, a nation of 9 million people, will contribute 30% of the costs during the construction period to Day One. This offer will form the cornerstone of a coalition of Nordic-Baltic Sea States that Sweden is presently assembling, with the aim of raising a further contribution of 15% to the investment costs. Furthermore Sweden is preparing to involve business in the financing of the facility at the level of a further 5% contribution to investment costs. Sweden expects other partners to pay the remaining 50% of investment costs, calculated on the basis of GDP-shares. [Sections C & D](#)
  - **A solid and reliable organisational base** in terms of governance, legal framework and managerial structure. Innovative methods to administer the joint site with MAX IV, to exploit intellectual property and to deal with the energy inventory will be implemented. Environmental impact and risk mitigation will be a central theme. [Section E](#)
  - **The location for ESS in Lund is ideal.** The site in Scandinavia has, according to expert opinion, close to the best imaginable conditions for building such a facility. Quality of life for staff and their families, and for the community of users is excellent. Sweden is a socially advanced, reliable nation that places great emphasis on social and environmental responsibility and aspires to be respecting of all people. The Öresund region of Sweden and Denmark is *de facto* bilingual with fluency in English exceeding 85%. [Section F](#)
  - **ESS in Scandinavia will be integrated into one of the most advanced scientific and innovative environments in Europe** – a renowned ancient university in the most innovative nation on earth (page 41) surrounded by a modern and diverse business community. Sitting on a joint site, the high brightness synchrotron MAX IV and ESS will be a meeting place for the world's materials scientists, bringing brains and prestige to Europe. The commitment of the various levels of government to this project is unquestioned and the region has a transport infrastructure that is comprehensive, efficient and people-friendly. [Section F](#)
  - **Sweden has set the goal of making ESS and MAX IV both CO<sub>2</sub> and climate neutral** – the first scientific facilities with this expressed aim. A low environmental impact, blending in with Swedish environmental care, will be the goal of ESS founded upon a reduced consumption of energy which is generated by renewable means and which is maximally recycled into the Lund district heating system.
- 
- We commend our site wholeheartedly and enthusiastically to you!

**The Lund case rests upon the scientific impact of the facility.** It will be built on a green field, certainly, but it will not be a green-field-site. The site is surrounded on all sides by excellence, both traditional and modern, and ESS in Lund will be embedded in a fertile intellectual, innovative and industrial milieu which is ideal. Lund is situated in Öresund, the cross-border region between Sweden and Denmark. The region is characterised by economic growth, scientific and academic excellence, new ideas and environmental responsibility. Decision

making is transparent and consensus-oriented, providing good long-term stability.

The Lund-Copenhagen area is a major European centre for knowledge-based industry. It is particularly strong in the biotech, medical, pharmaceutical and telecommunications sectors. Sweden is documented as the most innovative country in the world and offers an exceptional climate for innovation-related activities. The European Innovation Scoreboard (EIS) showed Sweden retaining its number one position

yet again in 2007, ahead of countries like the USA, Switzerland, Japan, Israel, Finland, Denmark, Germany and the UK.<sup>2</sup>

**Conditions already exist today in Lund that others promise will exist in the future.** There is no need for decisions on other infrastructural projects to be reached for ESS to thrive here. As a consequence the ESS in Lund will be a low risk project.

*We commend our site wholeheartedly and enthusiastically to you!*

2. [www.proinno-europe.eu/admin/uploaded\\_documents/European\\_Innovation\\_Scoreboard\\_2007.pdf](http://www.proinno-europe.eu/admin/uploaded_documents/European_Innovation_Scoreboard_2007.pdf)



## A) General aspects

### A1 Who is acting as project proposer (ministry / organisation / agency / other)?

The Swedish Ministry of Education and Research is the project proposer. There are two main levels of organisation:

1. The Government of Sweden is responsible for the offer to host ESS and has appointed a Chief Negotiator, reporting to the Minister of Higher Education and Research, supported by the Swedish Research Council (VR).
2. The University of Lund, with a mandate and funding from the Government to organise the preparations for ESS (with a Secretariat, a Director and a Supervisory Group, all appointed by the Government).

The siting of the ESS in Lund is the official policy of the Government of Sweden as expressed in a decision taken on 26th February 2007 by the Swedish Cabinet. A series of associated decisions were taken by the Government during 2007, in order to set up the framework supporting the Swedish bid, as follows:

- i. The Government of Sweden offers to host the European Spallation Source**  
On 26th February 2007, the Swedish Government invited other countries in Europe to join with them in the realisation of ESS in Sweden, based on the proposal put forward by ESS Scandinavia and offering 30% of the construction phase and 10% of the operating phase costs.<sup>3</sup>
- ii. Nomination of Chief Negotiator**  
On 15th March 2007, the Government appointed Allan Larsson (former Swedish Finance Minister) as Chief Negotiator for the ESS in Sweden.<sup>4</sup>
- iii. The setting up of a Secretariat**  
On 20th June 2007, the Government charged Lund University with setting up a Secretariat for advancing the project together with its Terms of Reference.<sup>5</sup>
- iv. Nomination of Director**  
On 5th July 2007, the Government appointed Colin Carlile (former Director of ILL Grenoble) as Director of the ESS Scandinavia Secretariat.<sup>6</sup>
- v. Setting up a Supervisory Group**  
On 4th October 2007, the Government appointed a Supervisory Group for ESS Scandinavia. This group, chaired by Lund University Rektor Göran Bexell, oversees the activities of the Secretariat and advises the University and the Government on matters related to ESS.<sup>7</sup>

The Minister responsible for ESS within the Swedish Cabinet is Lars Leijonborg, Minister for Higher Education & Research. The Minister confirmed the Swedish offer in his opening speech to the ECNS Conference in Lund on 25th June 2007, in the presence of 700 neutron scientists. The construction of the ESS in Lund was formally included in the Swedish Foreign Policy Declaration in a speech to the Swedish Parliament on 13th February 2008 by the Foreign Minister Carl Bildt.<sup>8</sup>



The Swedish Riksdag.

3. [www.esss.se/documents/promem\\_070226.pdf](http://www.esss.se/documents/promem_070226.pdf)  
4. [www.esss.se/documents/reg\\_besl\\_070620.pdf](http://www.esss.se/documents/reg_besl_070620.pdf)  
5. [www.esss.se/documents/reg\\_besl\\_070620.pdf](http://www.esss.se/documents/reg_besl_070620.pdf)

6. [www.esss.se/documents/forordn\\_070715.pdf](http://www.esss.se/documents/forordn_070715.pdf)  
7. [www.esss.se/documents/forordn\\_071004.pdf](http://www.esss.se/documents/forordn_071004.pdf)  
8. [www.regeringen.se/sb/d/5298/a/98014](http://www.regeringen.se/sb/d/5298/a/98014)





Lund University - Founded 1666.



### Lund University

Founded in 1666, Lund University<sup>9</sup> is Scandinavia's largest higher education establishment with 39,200 students, 55% of whom are women. It has an enviable reputation. Lund University is a member of the League of European Research Universities, LERU<sup>10</sup> and Universitas 21.<sup>11</sup> It is the 3rd highest attractor of Frame-work Programme funding.

### ESS Scandinavia

ESS Scandinavia represents a Consortium of academic and governmental bodies working towards the location of ESS in Lund, on the Swedish side of the Öresund Bridge which connects Copenhagen to Malmö. The Consortium is composed of more than 20 universities, research laboratories, national neutron scattering societies, trans-national organisations and regional authorities.



The members of the Consortium and the details of this proposal for the siting of ESS in southern Sweden can be found in the document "Expression of Interest to host the European Spallation Source in Scandinavia".<sup>12</sup> The Consortium is formally represented in the Stake-holders Advisory Group to ESS Scandinavia, one of three such groups advising the Secretariat together with the Science Advisory Group and the Technical Advisory Group. The Stakeholders Group is chaired by Henning Christophersen, former Finance Minister of Denmark and EU Commissioner.

The original seed for this proposal was sown on October 3rd 2000 by a group of committed researchers from the Scandinavian countries. They convinced local politicians and leading academics to provide the necessary finance for Lund to participate as a site candidate at the ESS Conference in Bonn in May 2002.

9. [www.lu.se](http://www.lu.se)

10. [www.leru.org/?cGFnZT0z](http://www.leru.org/?cGFnZT0z)

11. [www.universitas21.com/Member/memberlund.html](http://www.universitas21.com/Member/memberlund.html)

12. <http://esss.se/index.php/ESSS-documents/>

## The ESS Scandinavia Secretariat

The Swedish government in June 2007 set up, by a formal Cabinet decision, the ESS Scandinavia Secretariat operating under the auspices of Lund University and funded through the Swedish Research Council, the Vetenskapsrådet (VR).<sup>13</sup> At an operational level this project is executed by the ESS Scandinavia Secretariat. Its principal mandate is to prepare for the construction of ESS on the Lund site. The ESS Scandinavia Secretariat currently has 17 full-time staff and 2 part-time staff, together with Allan Larsson the Swedish government's Chief Negotiator for ESS, who is assisted in that role by Lars Börjesson, Secretary-General of the VR and Colin Carlile, Director of the Secretariat, making a total of 21 people. Appointments in the pipeline will bring this number to 27. The Secretariat has a budget of 32 MSEK (~3.5 M€) and a mandate until the end of 2008.

The secretariat has been charged by the government to plan and prepare for the construction of ESS including the international organisation for it. Major elements of the Secretariat's work are:

- Negotiations for an international partnership for ESS in Lund
- Characterisation and validation of the chosen site
- Liaison with local and national political bodies
- Planning permission and licensing procedures
- Costing and Financing
- Optimising the scientific use of ESS
- Creating links to industry
- Increasing the scientific and technical capacities for neutron utilisation in Sweden
- Publicity, Information and Communication

The Secretariat is being created in such a way that it will form the basis of the future European Project Team when, following the site decision, we move into the execution phase.



The ESS Scandinavia Secretariat.

13. [www.vr.se](http://www.vr.se)



## B) Basis on which the site proposals are presented:

B1 What is the technical basis (the published technical design) of the ESS on which the site proposal is based?

The original technical basis of the ESS proposal was presented to the public in Bonn in 2002. Six years have passed. What is the same? What has changed? Are there plans for upgrades, further developments of source, accelerator, target?<sup>14</sup> (Please send a summary of the technical design including a table of the main parameters; not more than 4 pages, include reference to the technical design documents)



### The ESS Scandinavia Reference Design

**ESS Scandinavia proposes a new Reference Design upon which to base its bid.** This design has evolved from the published technical design presented in June 2002 (Ref B1.1). The ESS Scandinavia Reference Design contains significant innovations, but is nevertheless fully compatible with the design described in the ESFRI European Roadmap for Research Infrastructures 2006.<sup>15</sup>

In the following paragraphs we describe the new ESS Scandinavia Reference Design, our time plans, options for further optimisations of this Reference Design, and our policy for potential upgrades.

**The ESS Scandinavia Reference Design incorporates flexibility and technical headroom.** It is equivalent in performance to the long pulse option of the 2002 design, but is different in certain crucial technical aspects. The proposed site is very spacious and could accommodate significant future developments if desired.

### The 2002 Design

The 2002 design comprised a 10 MW linear accelerator feeding H<sup>-</sup>ions at 1.334 GeV into a long pulse target station in 2 ms long pulses at a frequency of 16.6 Hz and, via a compressor ring, into a short pulse target station in 1 μs long pulses at a frequency of 50 Hz. The H<sup>-</sup>-ion beam is stripped to protons on injection into the compressor ring. H<sup>-</sup>-ions are however only necessary when injection into a compressor ring is required to create short proton pulses. The linear accelerator has, in order to produce the different time structures of pulses required to feed both a long pulse target and a short pulse target, a complex chopper line. This defines the upper limit of frequencies for the accelerating cavities. The two target stations for short and long pulses were of similar design in order to benefit from economies resulting from duplication. See Table B1.1 for details.

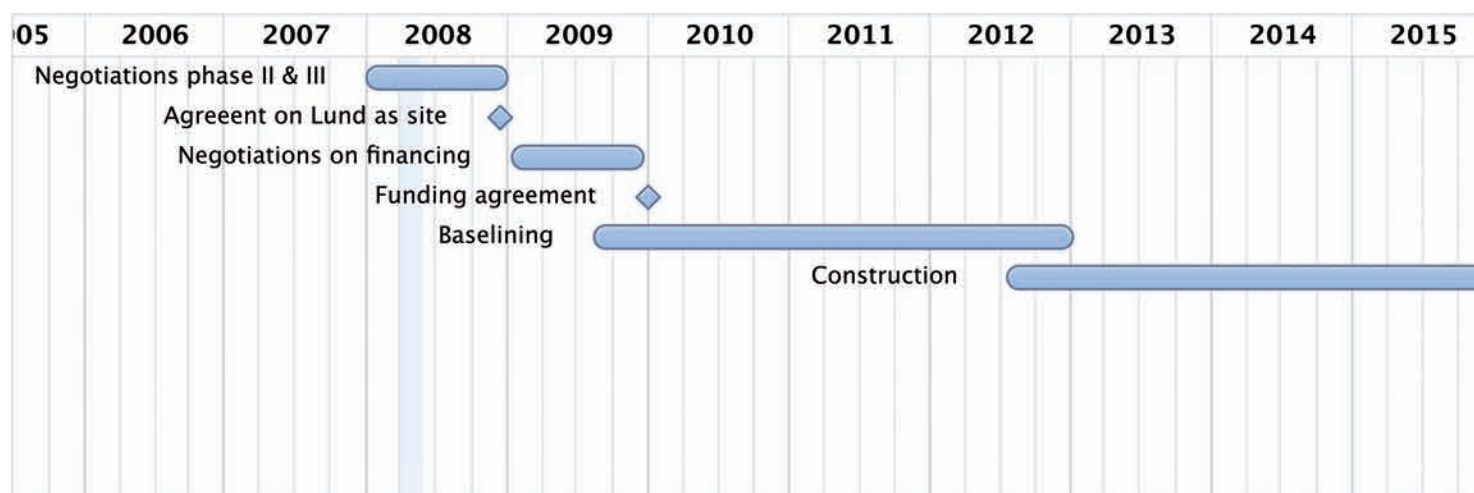
ESS Scandinavia does not however envisage high levels of investment early on to prepare for major upgrades that may never be realised. The added flexibility and headroom must, to first order, be financially neutral and allow for optimisation to be realised now, rather than accepting sub-optimisation today in the hope of anticipating major upgrades in the future. ESS Scandinavia firmly holds the view that a 5MW long-pulse spallation source will be world-leading and technically ambitious in itself. Future major upgrades should be considered on the same time scale as future new facilities. The design is described further below. Possible upgrades are indicated.

**ESS in Lund will be a pan-European facility.** ESS Scandinavia will welcome, and indeed expect, that during the forthcoming negotiation phase, discussions on additions and modifications to the Reference Design. Preparations for future upgrades will form part of the essential process of ensuring that the capability of ESS matches, as far as possible, the ambitions of the user communities in the different partner countries.

**The ESS Scandinavia Reference Design is based on existing technology** and does not require significant further R&D work, but rather technical design-work and engineering. ESS Scandinavia is currently embarking upon a technical design review aimed at optimising its own Reference Design still further, taking into account recent experience and technical advances achieved at laboratories and facilities worldwide. The focus will first be on the accelerator and the target, as these components have long lead times and have a pronounced international dimension. ESS Scandinavia is currently setting up a *Technical Advisory Committee* that will oversee the review. Also, in order to take in recent experience and know-how, we have recently embarked on a development programme with CERN on proton accelerators and high-power targets. Technical visits to SNS and J-PARC and collaborative discussions with technical teams in these facilities have led to considerations that are included in the ESS Scandinavia Reference Design.

14. What is the improvement of the concept? Has there been any R&D work to further develop aspects e.g. the target? Is the already gained experience of the projects in USA and Japan included in the project proposals? Is there further R&D necessary to have the optimum technical solution at the time construction starts?

15. <http://cordis.europa.eu/esfri/roadmap.htm>



**The ESS Scandinavia Timeline.**

The timeline above for the realisation of ESS in Lund is as follows: decision on site selection in December 2008, followed by an agreement on funding during 2009. Construction preparations (including engineering baselining) and organisational build-up is envisaged from mid 2009 to 2012. Construction is planned from 2012 to 2019. First beam on target (Day One) will be in 2018, user mode in 2020 and full user mode at full power with 22 instruments in 2025.

## The Ion Source and the Linear Accelerator

For the stand-alone purpose-built long pulse facility, as proposed by ESS Scandinavia, a simpler, more reliable and lower technical risk proton accelerator will provide the same neutronic performance as the long pulse part of the 2002 design. In addition, the cost would be lower and the component activation that the stripping of protons engenders would be avoided. ESS Scandinavia recommends that this route be followed. The linear accelerator, comprising part superconducting and part normally conducting elements, would then, in the ESS Scandinavia Reference Design, be built to deliver a beam of 1.00 GeV protons at a peak current of 150 mA (average current 5 mA) in 2 ms long pulses at a frequency of 16.6 Hz (Ref B1.2). Again this corresponds to an average power of 5 MW (Table B1.1).

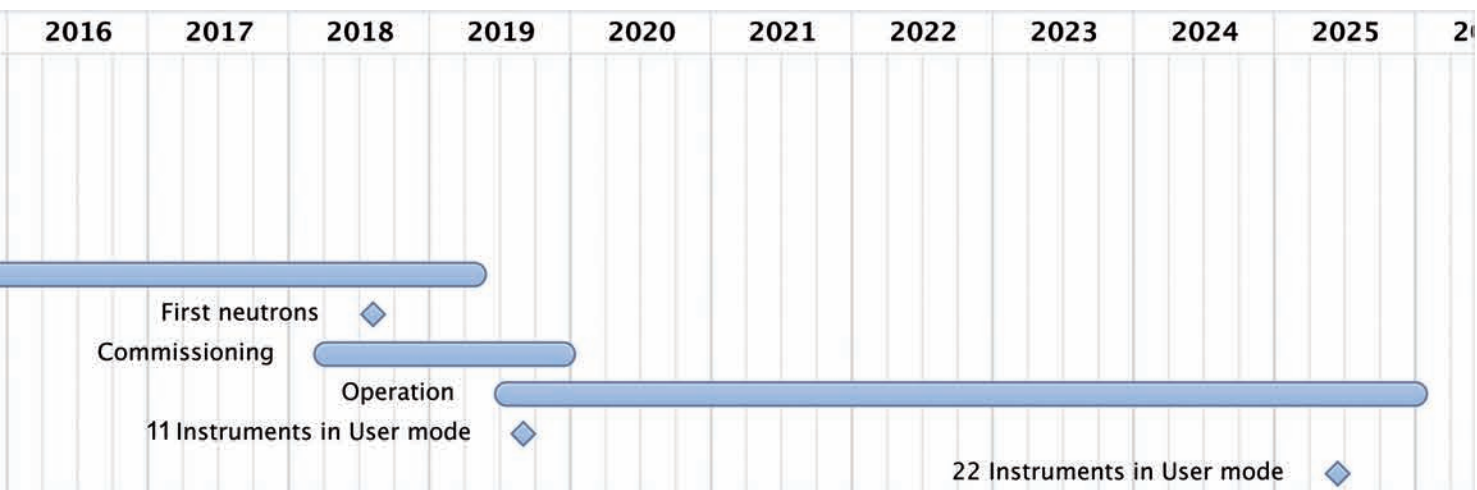
The front end of the accelerator is as described in the update report on the 2002 design (Figure B1.1), comprising two 85 mA proton sources, each followed by a Radio Frequency Quadrupole (RFQ) and a Drift Tube Linac (DTL). The proton beams are accelerated to an energy of 20 MeV after which they are funnelled into a Cell Coupled DTL (CCDTL) creating one 150 mA, 2 ms pulse.

For a purpose-built long pulse facility, there are no restrictions in the choice of frequency. ESS Scandinavia therefore intends to

choose frequencies which will allow benefits from standardisation, such as the sharing of resources and R&D collaborations on testing, engineering and development of common technology and components with other projects such as Linac4 at CERN, TESLA at DESY, SNS and J-PARC. Figure B1.1 shows the block design for the ESS Scandinavia accelerator with frequencies compatible with the modern technology developed for XFEL. The final decision on frequencies will be made through discussions in the ESS Scandinavia Technical Advisory Committee.

Parameter	ESSS Reference Design	ESS 2002 Design	
		Long pulse part	Short pulse part
Accelerator	Linear accelerator for protons, part superconducting, part normal conducting	Linear accelerator for H <sup>-</sup> ions, part normal conducting, part superconducting, with a compressor ring	
Frequency	325/650/1300 MHz to be confirmed	280/560/1120 MHz	
Target station	A single long pulse target station	One long pulse target station and one short pulse target station	
Energy	1.00 GeV	1.334 GeV	
Peak current	150 mA	114 mA	
Average current	5 mA	7.5 mA	
Beam power	5.0 MW	10 MW	
Duty cycle	4%	11%	
Pulse frequency	16.6 Hz	16.6 Hz	50 Hz
Period between pulses	60 ms	60 ms	20 ms
Pulse length	2 ms	2 ms	1 μs
Target material	mercury, liquid lead or liquid lead-bismuth	mercury	mercury
No. of beam ports	22	22	22
No. of instruments	22	22	22
Cooling	Heat exchangers to Lund district heating and cooling system	Cooling towers	

**Table B1.1: Design characteristics for the ESS Scandinavia Reference Design and the 2002 ESS design presented at the Bonn meeting in May 2002. This table describes the parameter changes in the ESS Scandinavia Reference Design compared to the 2002 design.**



**ESS Scandinavia is launching a design review to further optimise the specification of the accelerator and target station.** Milestones in the programme would be a Conceptual Design Report for an optimised design and later a Technical Design Report. The work will build on the previous design reports on ESS (Ref B1.1) and know-how in similar projects and include beam dynamics simulations and error studies. Elements in the programme would address the following issues:

- Could a single proton source be used? This would avoid the funnelling but might have implications on the couplers through a higher bunch charge.
- Optimisation of couplers for high power proton pulses with a high bunch charge.
- Is the bunch rotation required, or can a small enough energy spread be directly achieved which allows transfer directly to the target? Which frequencies are sound to choose from a technical and collaborative perspective?
- The need for an accelerator cavity test-stand for studies of collective effects.

## The Target Station

A single target station design provides both simplicity and the potential for cost-effective upgrades in power and capacity without costly contingencies. The target itself will consist of a circulating liquid metal. The material will be either mercury, lead, or lead-bismuth, all of which provide similar neutronic performances ( $\pm 20\%$ ) according to an ESS Scandinavia workshop on targets held in March 2007 (Ref B1.3). The final decision does not need to be taken until 2012 meaning that information will have been accumulated from the experience gained on the use of mercury at SNS and J-PARC, on the very successful MEGAPIE prototyping Pb-Bi target studies at SINQ (PSI)<sup>16</sup>, and on the neutron economy of the low power solid target used in the TS-2 project at ISIS. Equally well since the ESS target will be used to generate cold neutrons it is logical that the beam port configuration be optimised with an emphasis on neutron guide tubes. We are reviewing the target station design

so as to incorporate 22 guide tubes on one side of the target station. See Figure B1.2. This would avoid the need for expensive shutters and large beam stops and would allow an incremental increase in the number of instruments to 33 if that were required.

ESS Scandinavia proposes to select the target material according to criteria of neutronic performance, capital and long-term maintenance costs, as well as reliability, safety and decommissioning aspects, paying close attention to potential environmental effects. ESS Scandinavia's licensing application, currently underway would allow the use of either lead, lead-bismuth or mercury as target materials according to the future final technical decision. One of the objectives of the ESS Scandinavia design review programme is to provide a technical basis for this decision. Drawing on comparisons with the SNS, we have, in the ESS Scandinavia Reference Design for the target, introduced a test bench for the target development work package.

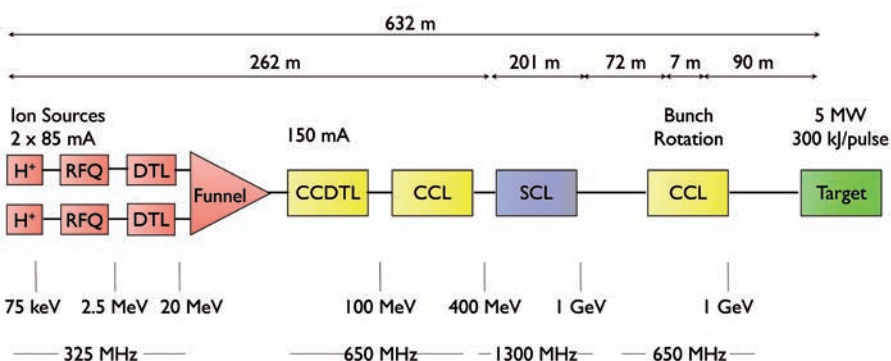


Figure B1.1: Block diagram of the accelerator for the ESS Scandinavia Reference Design.

16. [www.psi.ch](http://www.psi.ch)

## The Instruments

**The ESS Scandinavia Reference Design will have a suite of 22 instruments.** The suite of instruments will be specially designed to exploit the characteristics of a long pulse stand-alone neutron source and will be complementary to those world-leading instruments available on other European sources, thus providing the best possible combination of neutron scattering capabilities for European researchers. See [Section B2](#).

### The Reference Instrument Suite proposed by ESS Scandinavia

Instruments to be built at ESS will be optimised to the long pulse structure of the source ([Ref B1.4](#)). The scientific case for ESS ([Ref B1.5](#)) indicated a set of instruments to be constructed on a long pulse source. Since that study was concluded, scientific priorities have evolved and experience has been gained from the new generation of spallation sources (SNS and ISIS-TS2) and from instruments developed elsewhere (ILL, FRM-2, JRR-3). At ESS Scandinavia we are critically re-examining this instrument suite with our Science Advisory Group - a team of younger scientists from the active European research community.<sup>17</sup>

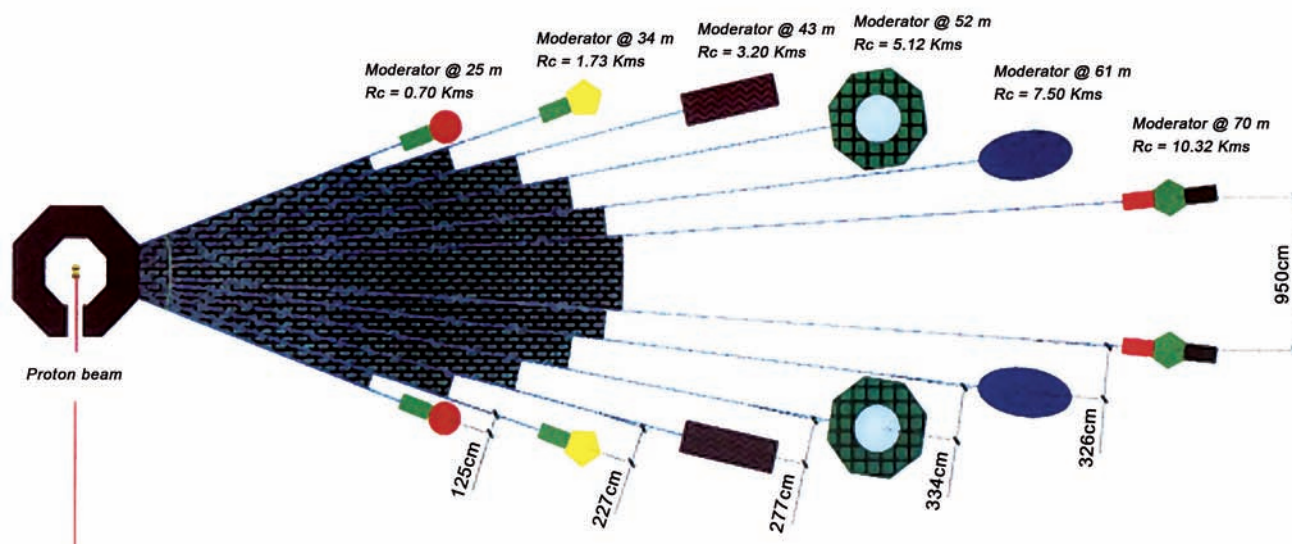
Instrument	Applications
High intensity SANS	Polymers & high dilution systems
High resolution single crystal	Protein crystallography
High intensity reflectometer	Membranes & self-assembled clusters
High resolution NSE	Soft Matter & Complex Fluids
Powder diffractometer	Magnetism, Chemistry & Kinetics
Cold Neutron Spectrometer	Dynamics of large assemblies & diffusive processes
Engineering Diffractometer	Materials, Stress-Strain analysis
Thermal neutron Flat Cone Instrument	Magnetic fluctuations & excitations in Solids
High resolution reflectometer	Functional materials & magnetic devices
High resolution powder diffraction	Solid State Chemistry, Catalysis
Thermal chopper spectrometer	Dynamics of complex systems, liquids & glasses

**Table B1.2: List of possible Day One instruments on the ESS in Scandinavia.**

This will allow decisions to be taken on which instruments to select and how to optimise them and prioritise their construction. This European group also helps to define other user facilities on site, and advises how best to exploit the synergies with MAX IV. Currently, an eleven-instrument suite is being considered, to be available on Day One of operations. See [Table B1.2](#).

Several scoping workshops are planned by ESS Scandinavia in order to finalise the actual first wave of instruments at ESS in Lund and to prioritise their build. What is paramount is the science drivers behind the selection of new instruments. The determining goal of ESS Scandinavia is that the facility should be world leading for many decades to come, as the ILL has been for the past 30 years. Achieving this scientific excellence for the ESS research community must be our guiding principle.

Long pulse instruments are novel in the sense that they can potentially collect data with several different resolutions and energy and momentum transfer ranges simultaneously. Resources will be directed towards the further development of methods for data management and software development for instrument control and data analysis that, in combination with powerful modelling techniques, will substantially increase the scientific added value of experiments carried out on ESS. ESS Scandinavia therefore proposes, to this end, to make use of the Nordic Data Grid node NORDUnet, close at hand in Copenhagen, and is planning an independent Data Management Centre there. See [Section D5](#).



**Figure B1.2: A fan of neutron guides which would allow a doubling of beam-lines removing the need for heavy shutters and large beam stops.**

17. <http://esss.se/index.php/Vad-ar-ESS-Scandinavia-/Scientific-Advisory-Group.html>



## The Conventional Facilities

Buildings, roads and the provision of services such as electrical power have been appropriately sized for the ESS Scandinavia Reference Design. The conventional facilities have also been adapted according to the characteristics of the site within the northeastern development corridor of Lund. Architectural studies are underway. Many of these facilities will be shared by the adjacent MAX IV synchrotron radiation facility, which will therefore allow the conventional facilities to be enhanced significantly but cost-effectively. A real estate company, MAXESS, is being set up to manage all aspects of the joint site.

A particular feature of the Lund site is the city district heating and cooling network, which opens up the opportunity of providing heating and cooling to the whole of the ESS whilst simultaneously recycling the excess heat. A connection to the district heating and cooling system via heat exchangers will replace the cooling towers in the 2002 design, thereby reducing the capital cost and

minimising the environmental impact. ESS Scandinavia is, together with Lunds Energi AB, exploring various ways of connecting ESS to the district heating system. See [Figure B1.3](#).

More effective use of the excess heat, and investment in a renewable energy windmill park will lead to lower operating costs and will protect against the escalation of electricity costs. The internal cooling system of ESS will be adapted to match the Lund district heating system. ESS Scandinavia will follow this route, making ESS in Lund a demonstrator facility for future large-scale scientific installations with a low environmental impact. See [Section F2](#) for details.

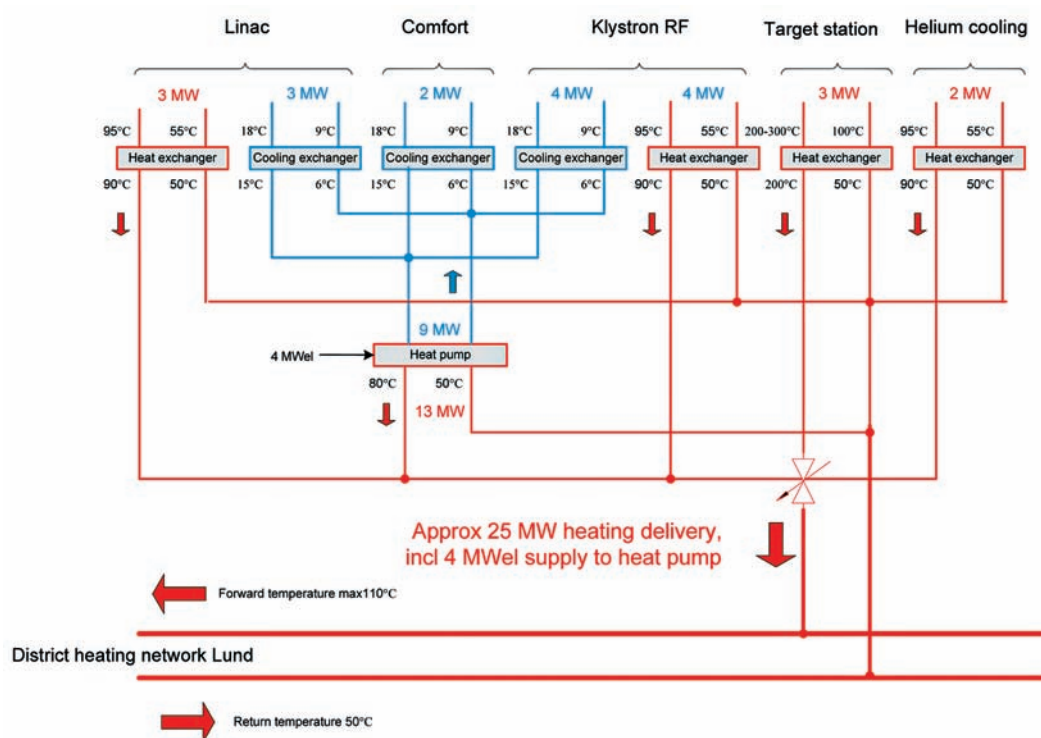
### References:

- B1.1 [The ESS Project Volume III ISBN 3-89336-302-3, 2002 and update ISBN 3-89336-345-9, 2003.](#)<sup>18</sup>
- B1.2 [ESS Plans and Synergy with CERN, K. Bongardt, proceedings of BEAM'07, Geneva, 2007](#)
- B1.3 [Summary from ESS Scandinavia Workshop on Targets, March 2007.](#)
- B1.4 [Tailored instrumentation to Long Pulse Neutron Spallation Sources, H. Schober et al. Nuclear Instr. Methods A589, 34-46 \(2008\).](#)
- B1.5 [ESFRI Report: Working Group on Neutron Facilities, January 2003 and available at:](#)<sup>19</sup>

## Possible upgrades

Some upgrades to the ESS Scandinavia Reference Design could be performed at any time making use of the technical flexibility and headroom in the design. However other upgrades need, in order to be realistic, to be prepared for in the design from the start. In several cases not only the cost for the upgrade, but also for the preparations, can be significant. ESS Scandinavia firmly holds the view that the Reference Design is in itself an ambitious project but is willing to consider and explore the inclusion of a number of future major options, in the negotiations to come. These include:

- A target station upgradeable to 7.5 MW.
- A target station designed for 7.5 MW.
- A drift space of an extra 115 m in the linac, to be later filled with accelerating modules that would allow a proton energy of 1.5 GeV corresponding to 7.5 MW.
- 33 beam ports: 11 conventional beam tubes with massive shutters and full beam stops on one side of the target, and 22 curved neutron guide tubes without massive shutters or full beam stops on the other side shown above.
- Incremental increase to 33 instruments.
- Preparations for a 2nd long pulse target station to be added later.



**Figure B1.3: Exploratory layout for connecting the cooling system of ESS to the district heating system in Lund. This layout includes a heat pump for boosting the temperatures to feed into the district heating system.**

18. <http://esss.se/index.php/Scientific-and-Technical-documents/>

19. [http://esss.se/documents/infr\\_esfri\\_wg\\_neutrons\\_report.pdf](http://esss.se/documents/infr_esfri_wg_neutrons_report.pdf)



B2 In particular, what is the scientific impact of the choice of the long pulse option?



## The European landscape for neutron science

**The construction of ESS is a key element in the European strategy to develop the best research infrastructures within a competitive global economy.** ESS underpins the vision expressed in the Lisbon strategy as embodied in the concept of the European Research Area. Today's technological and scientific challenges are related to energy, health, climate & environment, and communication.

Europe has assembled an impressive array of leading facilities to support scientists in their research: neutron sources, synchrotron light sources, high energy particle accelerators, telescopes and high-end electron microscopes and NMR centres amongst them. These are all exquisite instruments for observations of matter within particular time windows and on different length scales.

Neutrons have unique applications as probes of the science and technology of materials and low-energy nuclear physics. The vast majority of information on the structure of magnetic materials for example, which are at the heart of many components in everyday devices, has been revealed from neutron scattering methods. Furthermore, neutrons are ideally suited to polymer and bio-molecular science, as well as the engineering of new structures. Neutrons constitute an indispensable and unsurpassed probe for the new materials and components that will shape our future lives. As materials become more complex and the questions asked more refined so ESS will advance the methodology to provide the tools to help to answer these more difficult enquiries.

Indeed neutrons are beautiful, but there are too few of them. Neutron sources have a low relative brightness and neutron beams are flux limited. This is not to say that ESS is only meant to produce more neutrons:

**ESS Scandinavia will offer neutron instruments with more than one order of magnitude improved efficiency allowing new experiments to be performed with finer spatial resolution over wider dynamic ranges.**

The concept of ESS was to overcome the barrier to increased intensities that research reactors had reached. ESS was originally designed to produce more and better neutrons (Ref B2.1). In 2003, a careful study (Ref B2.2) indicated that a stand-alone long pulse target station would maintain Europe's worldwide position in neutron science. Many considerations - improved neutron economy, significantly lower technical risk, high cost effectiveness, more scope for innovation - led to the conclusion that a long pulse single target layout was the optimum technical design for the needs of the European science community.

### Long pulse sources in brief: Higher production of cold neutrons, increased flexibility

The spallation process is almost ten times more efficient than fission in terms of neutron production at constant thermal energy deposited in the source. The proposed long pulse target station coupled to optimised moderators will create time-averaged neutron fluxes much higher than those available at reactor-based sources, especially in the cold neutron range. The LP target is the only option that can produce time-averaged fluxes above those available at ILL or FRM-II (Ref B2.3). Simply relocating certain of ILL's instruments to the ESS, paying no attention to the time-structure of the ESS beams, would result in more powerful and efficient instruments. However the big advance in scientific output will come from the construction of specific instruments which are able to exploit the 30 times increase in brightness of the ESS.

A further major advantage is that the 2 ms neutron pulses can be re-shaped using choppers: pulse shape and pulse length can be adjusted. This allows a set of instruments to be built where

tight resolution is needed. Thus three categories of instrument can be built on ESS: "continuous source-type"; long-pulse; and short-pulse; each having significant advantages over what exists today. In the cold neutron range, even "short-pulse" instruments will benefit from pulse shaping at ESS. Thermal neutron high resolution instruments will remain highly competitive compared to existing facilities.

The SNS in Tennessee and J-PARC in Tokai have both embarked upon the short pulse option for their MW-class spallation sources. This was the correct decision given the context a decade ago. Today both facilities are planning to include long-pulse targets in order to benefit from the more effective neutron economy and the greater potential for power upgrades. ESS, a decade on from these decisions, will exploit the benefits of the long pulse source principles with a purpose-built design.

### Science drivers

The gain in cold neutron flux achieved at ESS will allow the wide ranges in time and space domains that neutron methods can cover to be even further extended. Domains of application which will benefit include: small angle neutron scattering for soft matter and dynamical biochemistry studies with medium resolution ( $t < 0.5$  ns); neutron spin echo for slow dynamics in the  $\mu$ s range; and real-time kinetics experiments - possible with time resolutions in the 10  $\mu$ s range by using sample modulation techniques (Ref B2.1). Pulse-shaping will enable high-resolution spectrometry and Laue diffraction (protein crystallography) to be further advanced.

Similar advances will become possible in the real space domain, exploiting the particular advantages of neutron beams. The neutron fluxes available at ESS will allow the focusing of neutrons below beam sizes of 100  $\mu$ m to observe very small samples, or the use of collimated beams to increase lateral resolution when studying structures of thin films or membranes over 1  $\mu$ m ranges.

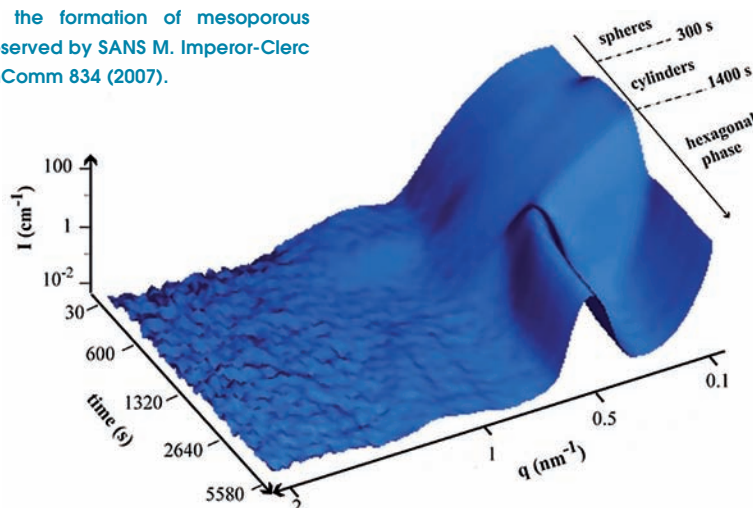
## What are the areas in science where ESS will open new perspectives and paradigms for neutron experiments?

We can identify six major areas:

- **solid state physics** (complexity, effect of dimensionality, transient phenomena).
- **materials science & engineering** (processing and characterisation, mechanisms of deformation and damage, energy and conversion devices, extreme conditions for planetary sciences).
- **chemistry** (kinetics, *in situ* monitoring of chemical reactions, electrochemistry at surfaces).
- **soft condensed matter** (molecular rheology, nano-composites, bio-materials).
- **biology and biotechnology** (functional membranes, dynamics of conformations, large complexes, neutron macro-molecular crystallography).
- **fundamental physics** (low energy nuclear physics, gravity at short distances, the neutron as an object).

ESS in Scandinavia will focus on methods that can be mapped onto these science drivers.

Kinetics of the formation of mesoporous material observed by SANS M. Imperor-Clerc et al. ChemComm 834 (2007).



ESS over cold neutron instruments at ILL will boost studies of conformations and folding of large biomolecules in very dilute solutions for example. Moreover, innovative methods (such as neutron spin echo encoding) combined with pulsed neutron beams will extend the range of SANS in terms of accessible length scales (beyond 50  $\mu\text{m}$ ) or short time slicing for time-resolved studies.

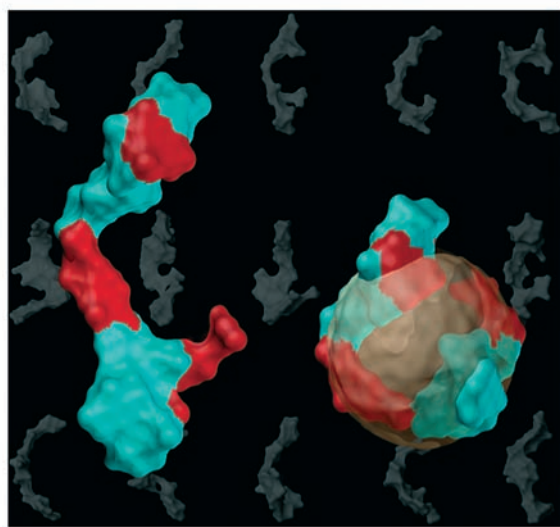
Sweden is strong in this area. Pulse shaping techniques at the ESS will offer gains of more than 10 compared to current instruments. This significant gain factor will make it feasible to attempt to observe the slow dynamics processes at surfaces.

### Inelastic scattering:

Mapping the local and collective excitations in materials allows the determination of couplings and interactions at the root of materials properties. On the ESS, high-resolution inelastic scattering for slow processes (up to 1  $\mu\text{s}$ ) will become achievable with the neutron spin echo method, which benefits most from the low repetition rate of the source. High-resolution neutron spectrometers in general will gain almost an order of magnitude when located on a long pulse source. Even emblematic instruments such as single crystal triple-axis spectrometers, which were developed for reactor-based facilities, can be adapted with significant efficiency gains on ESS.

### References:

- B2.1 The ESS Project Volume II ISBN 3-89336-302-5, 2002 and available at: See footnote <sup>20</sup>
- B2.2 ESFRI Report: Working Group on Neutron Facilities, January 2003 and available at: See footnote <sup>21</sup>
- B2.3 Tailored instrumentation to Long Pulse Neutron Spallation Sources, H. Schober et al. Nuclear Instr. Methods A589, 34-46 (2008).



Model for flexible structure of Human Apolipoprotein B-100 from SNA and shape reconstruction algorithms. A. Josh et al. J. Biol. Chem. 281, 19732 (2006).

### Small angle neutron scattering:

SANS is the method of choice for observing large dimension structures from 1 nm to 1  $\mu\text{m}$ . It applies to many diverse kinds of material (alloys, complex chemical composites and colloidal suspensions) but it is especially relevant to soft matter and biology. The large gains (up to 10-20) offered by the

### Diffraction:

Neutron powder diffraction remains a probe of choice for magnetism and materials science. Medium resolution and high throughput instruments having large gains compared to continuous sources (over 20) will allow parametric studies of complex systems. As indicated above, high resolution Laue methods will benefit from the pulse shaping and frame multiplication techniques not available on a short pulse source as well as the

improved background conditions with time-sorted beams on pulsed sources unavailable at reactor sources.

### Reflectometry:

Neutron reflectometry employs long wavelength neutrons to study surfaces and interfaces (phase separation, interfacial roughness, membrane penetration, magnetism in thin films).

20. <http://esss.se/index.php/Scientific-and-Technical-documents/>

21. [http://esss.se/documents/infr\\_esfri\\_wg\\_neutrons\\_report.pdf](http://esss.se/documents/infr_esfri_wg_neutrons_report.pdf)



## A world leading position for Europe

**The overall scientific impact of ESS** will be determined by many factors: the source and the instrumentation naturally; but also the scientific staff and the professionalism of management are crucial issues. The vitality of the scientific environment itself cannot be too strongly emphasised. ESS, twinned with MAX IV, will be a meeting place for the world's material scientists and this will be uppermost in our minds when planning the layout of our joint site. The choice of a high-power long pulse spallation source will guarantee a world leading position for Europe in many themes encompassed by materials science: health and biotechnology, functional soft materials, nanotechnologies, complex systems and studies under extreme conditions.





A view over the northeast of Lund stretching from the University Science area via Ideon past Sony Ericsson and on to the Max IV and ESSS site.





## C) Costing points

[Site-dependent costs should be distinguished from site-independent costs]

**C1 What is the cost projection and its calculation model?**

**For the construction and commissioning**

1,377 M€ (+101 M€ for Project Preparation).

**For the operation**

103 M€ p.a.

**For the decommissioning**

346 M€.



ESS Scandinavia has, since 2004, continuously been developing an analytical costing model for its own Reference Design. It is a radical reappraisal of costs designed to give confidence in the data for potential partners. It is informed by the costing for the 2002 ESS design (Ref C1), reports from the European collaboration on ESS, comparisons with other facilities, and studies by consultants in the construction and nuclear engineering areas. The ESS Scandinavia costing has been developed in a relational data-base to allow cost estimates of various design and upgrade options to be produced and discussed in a timely and effective manner in the Swedish negotiations process currently underway and the subsequent realisation of the facility. ESS Scandinavia benefits from employing Hugo Bohn, who oversaw the ESS Council costing process when he was employed by FZ Jülich.

The costing assumes that the ESS is built by a European collaboration at the site proposed in Lund, with European procurement rules, Swedish prices, Swedish salaries and taxes. VAT will be treated as per the XFEL agreement.

Cost Category	M€ <sub>2008</sub>	Method	Level
(i) Pre-project activities	39	PM, OCEM/VB	3
(ii) Site development phase	62	BU, OCEM/VB	3
(iii) Facility investment	1,377 (all 22 instruments included)	See Table C3.2	See Table C3.2
(iv) Operations phase	103 p.a.	BU, PM	4
(v) Decommissioning	346	PM	3

**Table C3.1: Costs of the different phases in the ESS Scandinavia Reference Design. Categories (i) - (iv) contain a 15 % contingency. Category 5, the decommissioning, has a 100% contingency.**

Subcategory	M€ <sub>2008</sub>	Method	Level
Linac and Front End	411	BU, PM, OCEM/SS	5
Beam transfer to target	19	TD	3
Control Systems	59	PM	3
Target systems	201	BU, PM	3
Instruments (22)	248	PM	3
Conventional Facilities	385	BU, PM	5
Management & Administrative support	54	TD, PM	3
<b>Total</b>	<b>1,377</b>		

**Table C3.2: Costs of the subcategories at level 2 for the ESS Scandinavia Reference Design indicating the lowest level to which costing has been evaluated.**

Our costing is site specific and applicable to this particular site in Lund. It is furthermore assumed that tasks are taken on by the most suitable partner, and that a significant part of the contributions will be in-kind. As for many large construction projects in Sweden, the tender for the construction of the conventional facilities is assumed to go to a European industrial consortium. See **Figure C1.1**.

The methods applied in calculating the cost have been diverse in order to give confidence in the consistency of the data. These are:

- **Analogous/Top down (TD)** – a comparison with costs for similar items/projects.
- **Bottom up (BU)** – allows the individual cost of activities and components of work packages to be estimated and thus rolls up individual estimates to a project total.
- **Parametric modelling (PM)** – involves using project characteristics/parameters in mathematical models to predict costs (scaling).
- **Other Cost Estimating Methods (OCEM)** – such as vendor bid analysis spread sheet, or unit extrapolation.

### References

C1 The ESS Project Volume III ISBN 3-89336-302-3, 2002 and updated ISBN 3-89336-345-9, 2003.<sup>22</sup>

**C2 To which year does the cost estimate refer?**

Current costings generated by ESS Scandinavia are in 1st January 2008 values.

**C3 What do these projections contain and what is the cost of the different components?**

- **Construction:** machine, site development, guest houses, experimental stations, salaries, other.
- **Operation:** salaries, investments, electricity, water, emission and waste, cooling, insurance, other.
- **Decommissioning:** waste disposal, remediation / rehabilitation.

The costing for the ESS Scandinavia Reference Design can be divided into five main categories each referring to one major phase in the project. **Table C3.1** summarises these categories, indicates the methods applied for the costing and to which level details are available. In finalising the costing database during the remainder of 2008, the method applied will be predominantly bottom-up for all categories. The scope of these cost categories is as follows:

22. <http://esss.se/index.php/Scientific-and-Technical-documents>



**i Pre-project work** includes the engineering baselining and the adaption of the ESS Scandinavia Reference Design to the site characteristics.

**ii The site development phase** contains the site preparation [Refs C3.1, C3.2], the cost of the land, the electrical supply system [Refs C3.2, C3.3], and off-site infrastructure for services such as electricity, water and telecommunications. These costs are likely to be reduced by the sharing of resources and infrastructure with the MAX IV synchrotron as embodied by the proposed MAXESS Real Estate Company.

**iii The total investment** required for completion to full design specification, including the suite of 22 instruments and all user facilities, is 1,377 M€. These costs include a 15% contingency and are detailed in Table C3.2.

**iv Costs during the operations phase** are estimated to be 103 M€ p.a. Compared to the inflation-indexed 2002 estimate of 85.5 M€ for a single target separated out from the two target design, our estimate includes additional costs: manpower 3 M€ p.a., energy prices 1.5 M€ p.a. and energy tax 11 M€ p.a., all of which have risen substantially and are expected to rise further [Ref C3.4]. The 103 M€ p.a. could be set to 95 M€ p.a. by implementation of the energy and climate concept (hedging against energy prices by investment in a renewable energy park and the reuse of the excess heat in the district heating and cooling system of Lund). The operating costs include a contingency of 15%.

**V The cost for decommissioning** will be dependent on the legislation and technology available at the time - from 2065 onwards - which makes any estimate inherently uncertain. By 2065, it is expected that the relevant legislation will be more or less homogeneous throughout Europe; this aspect is therefore likely not to be site specific. But it also depends on possible synergies and collaborative efforts with other facilities due for decommissioning at the time. A lesson learned is also that the cost will depend on whether the facility is constructed and operated in order to be easily decommissioned. Assuming a construction accordingly, the cost for decommissioning ESS to an industrial area, treatment and storage of the target included, was estimated by Studsvik Nuclear AB [Refs C3.5, C3.6] to be 173 M€ (in values of 1st January 2008). Other estimates, making slightly different assumptions find a higher price [Ref C3.7]. ESS Scandinavia therefore sets the guideline cost for decommissioning of ESS at 346 M€, including a 100% contingency. If it is required that the decommissioning be funded by annual contributions it would result in an additional 6 M€ on the annual cost. This again is a matter for the negotiations. ESS Scandinavia will ensure that ESS is designed to be built and operated with decommissioning in mind, thereby minimising environmental impact and optimising life-cycle costs. As the design progresses more detailed estimates on the decommissioning cost will be presented.

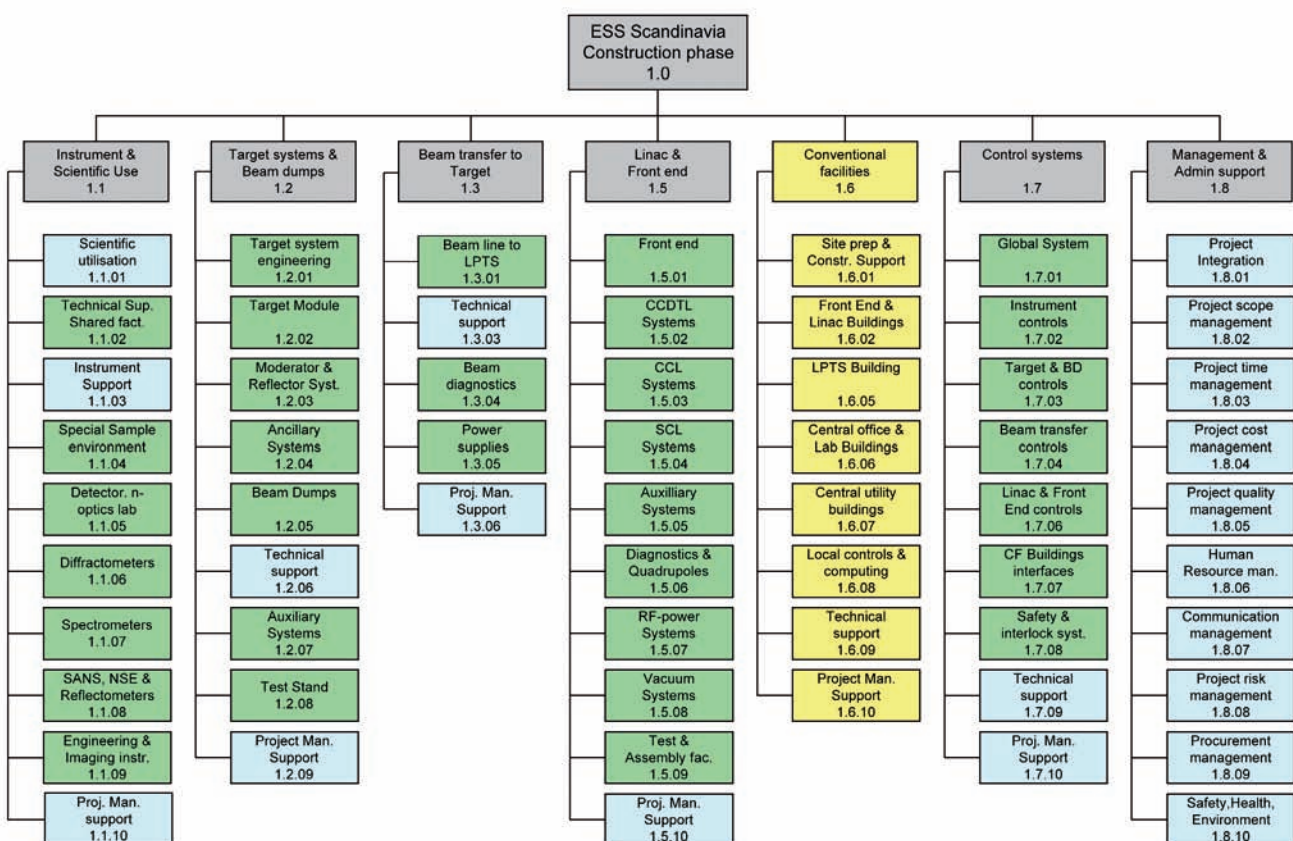


Figure C1.1: The Work Breakdown Structure of the construction of ESS Scandinavia. Activities and subsystems suitable for in-kind contributions (green), for a consortium of European companies (yellow) and for management by the host country (blue).

Note that the greater part of the total investment costs of 1,478 M€ (= 1,377 M€ + 101 M€) will be committed during the construction phase, before beam is taken to the target (Day One). However a residual part of the investment required for completing the facility to full design specification will be made when the operations phase has started. That part of the budget stream devoted mainly to completing the instrument suite will, in the longer term, be merged into the operations budget as an investment line, as at ESRF. During the whole of the operations phase, the budget will then be flat at a level of 103 M€ p.a.

ESS Scandinavia considers that the costing for the ESS Scandinavia Reference Design is very close to all-inclusive. All items referred to in **Section C3** are included. The costs

for satellite infrastructures are not included, however an advantage of the Lund site is that these can be incrementally built from what is already available at the university. The access to existing libraries on the Lund site is an additional benefit.

#### C4 Do you have an estimation of a contingency? Is it included?

A contingency of 15% is included in investment and operating costs and 100% is included in decommissioning costs.

#### References

- C3.1 Kostnadsbedömning för iordningställandet av markområdet vid Brunnshög för ESS Scandinavia (Cost estimates for the preparation of the site at Brunnshög for ESS Scandinavia) SWECO, 2005
- C3.2 Kostnadsbedömning för iordningställandet av anslutningar av teknisk infrastruktur vid Brunnshög för ESS Scandinavia (Cost estimates for technical infrastructure to the ESS Scandinavia site at the Brunnshög), SWECO, 2007
- C3.3 C Altvånger, Ångpanneföreningen, personal communication, 2004
- C3.4 Ekonomisk analys gällande elförsörjningen av European Spallation Source byggd i Lund, Öresundsregionen ÅF 2004
- C3.5 Overview of decommissioning of the European Spallation Source, located in Sweden, Ulla Bergström, Evert Eriksson, STUDSVIK/N-05/074, 2005
- C3.6 Overview of aspects for safe disposal of mercury from a European Spallation Source, located in Sweden, STUDSVIK/N-05/073, Ulla Bergström, Erik Hellsten
- C3.7 Information received under a non-disclosure agreement.

	2009		2011		2013		2015		2017		2019		2021		2023		2025		SUM
Capital spend	0	15	26	78	132	223	256	248	128	96	59	37	28	21	15	10	5	0	1377
Operations									0	7	44	66	75	82	88	93	98	103	553
Site preparation	7	31	43	17	3														101

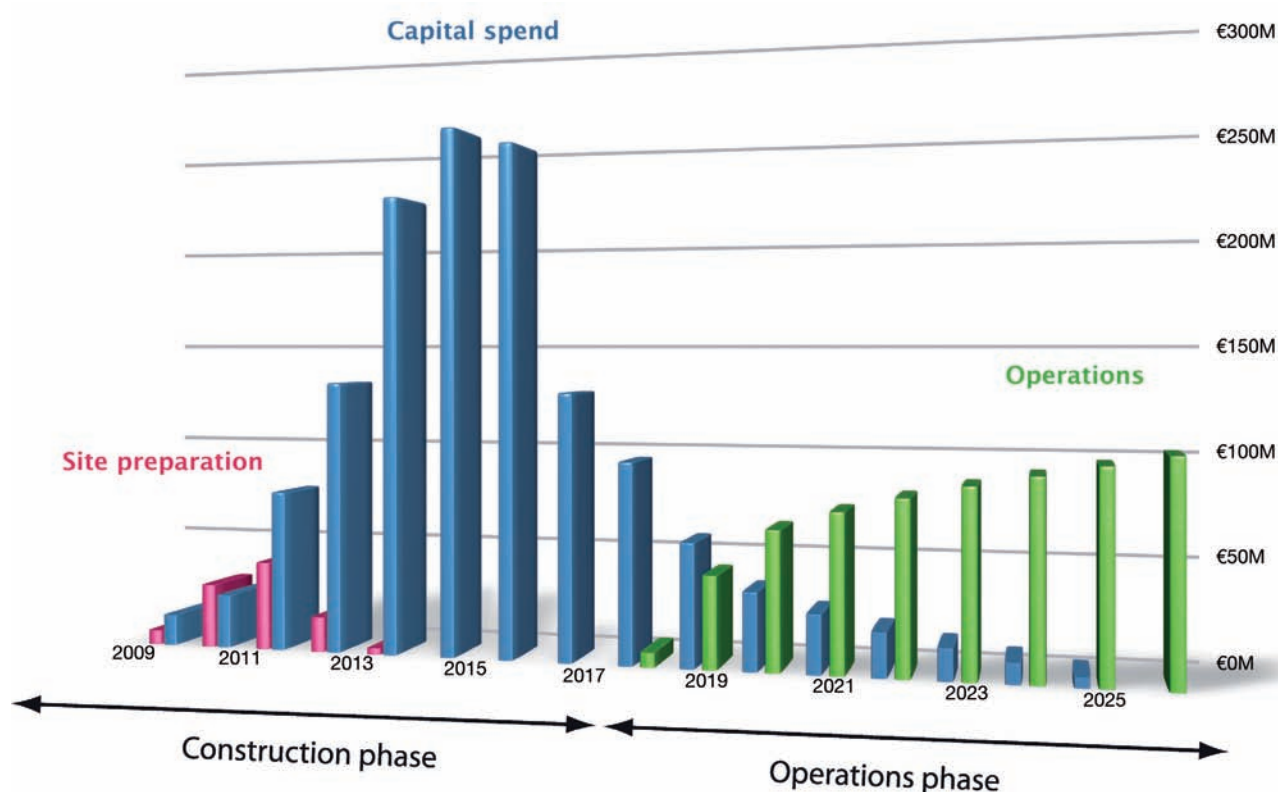
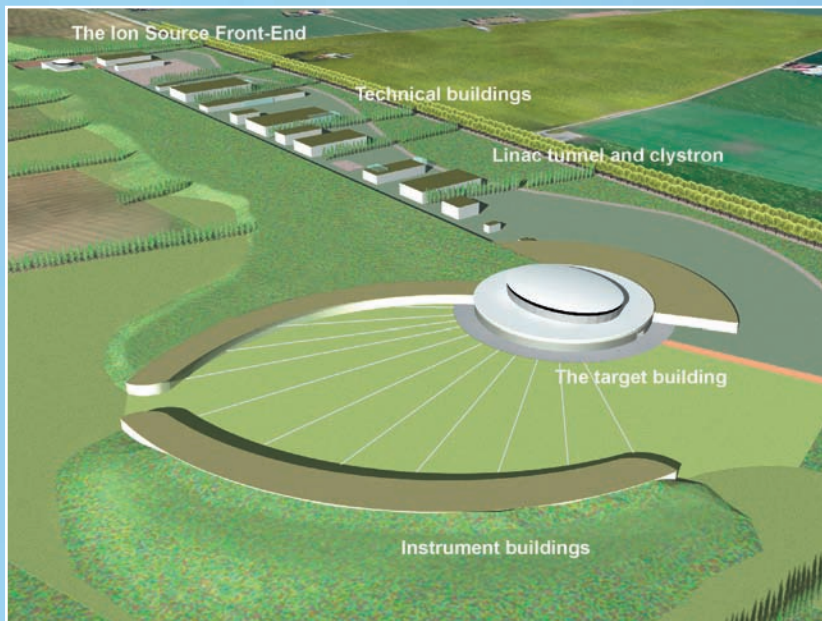
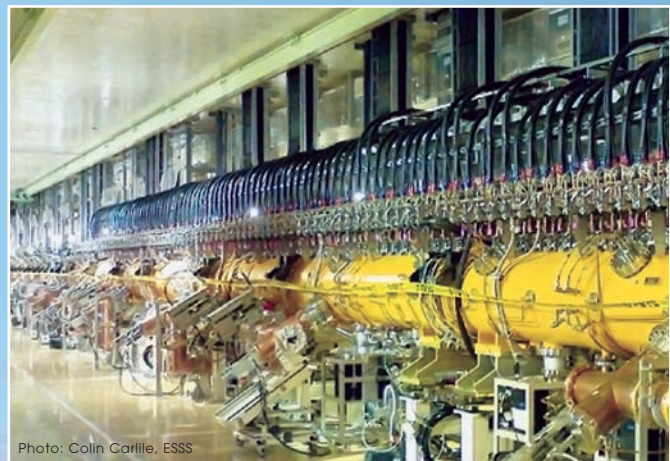


Figure C4.1: ESS construction phase and operations phase.





Elements of the ESS facility in Scandinavia



The linear accelerator at J-Parc, Japan

The ESS Scandinavia site



Photo: Karl McFaul, ESSS

## D) Financing points

D1 What is the financing model, what are the financial contributions foreseen and/or guaranteed for construction / commissioning / operation / decommissioning?



**The ESS Scandinavia financial model consists of the following elements:**

The Swedish government has offered to pay 30% of the investment costs during the construction period to Day One. Sweden is preparing a coalition of Nordic-Baltic Sea States with the aim of raising a further contribution of 15% to the investment costs. As part of such a coalition, Sweden and Denmark have started negotiations on co-hosting the ESS. Furthermore Sweden is preparing to involve business in the financing of the facility with the aim of raising a further 5% contribution to investment costs.

Sweden expects other partners to pay the remaining 50% of investment costs, calculated on the basis of GDP-shares (**Figure D1.1**).

	Capital contribution	Percentage share of ESS
Country 1	166,617	12,1
Country 2	137,7	10,0
Country 3	125,307	9,1
Country 4	95,013	6,9
Country 5	61,965	4,5
Country 6	34,425	2,5
Country 7	20,655	1,5
Country 8	17,901	1,3
Country 9	15,147	1,1
Country 10	6,885	0,5
Country 11	6,885	0,5
<b>SUM</b>	<b>688,5</b>	<b>50,0</b>

Operations costs are the major part of the lifetime costs of facilities such as ESS, and represent long-term commitments. Sweden offers to pay 10% of operating costs from Day One, including the completion of instrumentation. Sweden expects the majority of other partners to contribute to the remaining operating costs on the basis of GDP shares. Financial negotiations will involve as many partners as possible in order to offer a stable and predictable sharing of operating costs, as well as a homogeneous sharing of neutron beam time.

### Contribution of the host

#### Construction Phase:

30% of the investment costs during the construction period to Day One.

#### Operating Phase:

10% of the operating costs as from Day One, including the completion of the instrument suite.

### Expected contributions of members:

#### Construction Phase:

15% of the investment costs during the construction period to Day One from a Nordic Baltic Sea coalition. 50% of costs from other partners according to GDP.

#### Operating Costs:

On the basis of GDP shares.

### Expected contributions of 'associate scientific members'

Currently Sweden is not distinguishing between "partners" and "associate scientific members".

### Industry, private investments

5% of investment costs during the construction period to Day One.

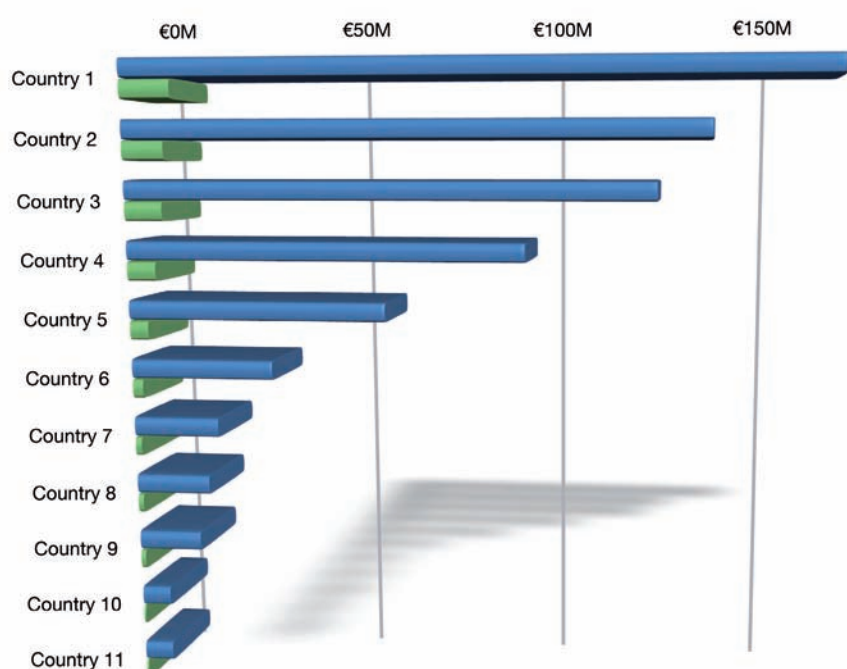
### Other bodies (non-profit foundations, trusts, charities)

None.

### Structural funds

Sweden will not use structural funds for their national contribution, but understands that some partner

**Capital contributions on GDP share for 50% non N-B Countries**



**Figure D1.1: A hypothetical model for Partnership using a GDP basis**



countries might use such resources for their contributions. No contributions from the EU are available for the moment, except for the preparatory phase. FP 8 might include provisions for capital funding of European Research Infrastructures.

### Loans, EIB

Sweden is working with the European Investment Bank and the Nordic Investment Bank, with the aim of providing bridging credits, and accessing the Risk Sharing Financing Facility (RSFF) for business involvement and long-term loans for partner countries in need of such facilities. We will also work with the Nordic Investment Bank as regards financing of the Energy-Climate strategy CARESSS of ESS Scandinavia, and with national agencies (STEM, VINNOVA and VR, the Swedish Research Council) who already provide seed money for this project.

### Risk money

The building up of a Risk Fund (Capital Seed Fund), unusual for scientific facilities but normal for a commercial company, will be a topic for the negotiations.

### Other financial projections not included in cost projection

Intellectual Property will be managed through an Innovation Company, called ESSSENSE, which will take responsibility for licenses, patents, the launching of spin-out companies, horizon-scanning for exploitable ideas and the sale of beam-time and other services. We set as our goal an income of ~ 5 M€ p.a. at equilibrium.

The Energy Strategy is projected to produce income from electricity produced by renewable means ~5-6 M€ p.a. and from hot water fed into the Lund District Heating system of ~2-3 M€ p.a.

## D2 Are in-kind contributions foreseen? At what level?

Our consultations with major European laboratories clearly indicate that in-kind contributions will form an integral and essential element to the financing of the ESS facility. There are two main reasons for this. Firstly, no single country in Europe has the comprehensive scientific, technical and engineering know-how to build such a facility of its own. Such capabilities must be assembled from throughout the European partners. Secondly, the creation of cash budget lines in the spend profile of individual Research Ministries is not a simple matter and financial commitments are more easily raised by offering contributions-in-kind which, clearly, are related to the known capacities in a given country.

In order to deliver such an ambitious project as ESS to budget, to specification and on time, Sweden envisages a project management structure with a strong central team which contains a number of task managers whose role is to control the activities of a limited number of major suppliers of in-kind equipment. A decentralised project like this needs special management skills since it deviates widely from the project management of large civil engineering projects such as roads, bridges or airports where an overall budget is normally voted to the project team centrally. For this reason we are developing the concept of a Cost Book, as explained below.

The second part of the 3-phase negotiation strategy, which Sweden embarked upon in the middle of 2007, was to survey capabilities in Europe, not just for specific elements of the ESS project itself – accelerator, target, beamlines, instruments and user facilities – but also to assess methodology in recent large-scale scientific projects.

This second phase has involved discussions and technical visits to CERN (LHC/SPL/Linac4), ITER, DESY (XFEL), ILL, ESRF, CEA Saclay, PSI (SINQ), HMI and FZ Jülich within Europe, as well as SNS and J-PARC. These visits have provided a rich overview of the common elements and major divergences of the scientific projects in Europe. One initial observation is that what are mainly national projects such as Diamond and the second target station at ISIS contain in-kind contributions only as a minor element. Without exception, projects with an overarching European or global character contain *as a major element* in-kind contributions.

Let us take ITER as an example from whose experience we will benefit. Broadly, for ITER, 90% of all contributions were to be provided in-kind and only 10% in cash. The in-kind contributions are further sub-divided into non-high technology work (22%, provided in-kind by the host) and high technology work (68%, provided by the partners and the host). The cash contribution is dedicated to "integration on the site". There are three major consequences: project management is complex; individual work packages must be valued within a commonly agreed "Cost Book"; and the adherence to procurement laws is the responsibility of the contributing partner. ESS Scandinavia proposes to consider this model of contribution and project management for ESS.

Accordingly the costing process, which we have been working on for 4 years, has been "pivoted" into Work Packages associated to cost values in order to inform the negotiation process which Sweden is now embarking on. The format of our relational database allows us to cut the costing data relatively



rapidly to enable effective and speedy negotiations. In-kind project management is helped when partners contribute above a certain minimum proportion. Otherwise fragmentation of supply will result, which is best avoided. ITER mainly avoids this problem since the partnership quantum is 10%. The work package Cost Book concept relies upon an accepted overall cost for the full capital value of the facility at full design specification based upon the Reference Design. This value must be validated by each partner, as must all the separate work packages down to the lowest level of contribution. This cost book is then reconciled and finally accepted. Contingencies are applied separately and appropriately to each Work Package. Partners then bid for Work Packages as part of their contribution. "Field-teams" are set up to oversee in-kind equipment. The central ITER project

team was responsible for defining the reference design, documenting the technical specifications, and setting manufacturing codes and standards, as well as project co-ordination. ESS Scandinavia plans to follow this method. ESS Scandinavia further benefits from experience gained in the set up of the XFEL project.

### D3 What are the financial commitments of the central and/or regional governments of the host state not included in D1?

- Commitment of local government
- VAT [exemption, reimbursement]
- Taxes, exemptions, refunds

Commitments of local government are included in the financial package from the Swedish government. As regards VAT and taxes, Sweden will apply the rules agreed in the XFEL Convention.



Photo: Monica Nilsson, ESS



Photo: Jörgen Wiksten, ESS

ESS Scandinavia Round Table 1, Swedish Embassy, Copenhagen, Oct. 2007.

Above: ESS Scandinavia Round Table 2, Swedish Ambassadors Residence, The Hague, Feb. 2008.

#### D4 Are there already commitments of other countries? Which ones? At what levels? Connected with preferential treatment?



### ESS Scandinavia Negotiating Strategy

Consequent to the decisions of the Swedish government in the spring and early summer of 2007, a proactive strategy of negotiations was laid down by the Swedish Chief Negotiator

and his team, in consultation with the Research Minister and his State Secretary. This comprises three main phases which are to be pursued chronologically, although a certain amount of overlap has naturally occurred. These three phases are:

- I. Consultation and Information on the Swedish bid.
- II. Preparation for a Technological Partnership to build ESS.
- III. Negotiations on Financial Contributions and Facility Specification.

#### I. Consultation & Information

*July 2007 to  
September 2007*

The Swedish team was led by Allan Larsson together with Lars Börjesson (VR) and Colin Carlile (ESS Scandinavia). Meetings arranged by the respective Swedish Embassies in the different countries were held with 15 Research Ministries where the elements of the Swedish bid to host ESS were explained and progress on the preparations to host ESS in Lund were outlined. Input to the Swedish process was requested. In several cases return visits took place. In all cases support for Lund as the preferred site for ESS was positively expressed.

Funding aspects were addressed only in general terms and commitments were neither asked for, nor were they given. Formal meetings were held with DG Research, the NIB and the EIB and several follow-up meetings occurred. In the case of the investment banks financing instruments were addressed including the RSFF. During this phase many one-on-one meetings were arranged with key players such as Commissioners and Director Generals in the EU Commission and high level industrialists, University Rectors and many Swedish Ambassadors.

This phase concluded on October 15th & 16th 2007 with a Round Table meeting attended by representatives of 23 countries, chaired by the Swedish State Secretary for Research and held in the Swedish Embassy in Copenhagen and in Lund.

There were three main conclusions:

- The transparency and coherence of the Swedish negotiation strategy was commended.
- There is a need in Europe for a world leading high-power spallation source to become fully operational by 2020.
- The Lund site and the Swedish offer represent an excellent opportunity for the realisation of the ESS.

#### II. Preparation for a Technological Partnership

*October 2007 to  
February 2008*

For this phase the Swedish team was led by Colin Carlile (Director ESS Scandinavia) together with Christian Vettier (Deputy Director ESS Scandinavia-Science) and Patrik Carlsson (Deputy Director ESS Scandinavia-Projects). Meetings were held with 10 European and International Research laboratories mainly, but not exclusively, neutron laboratories where technical and scientific progress with the ESS Scandinavia bid were outlined and possible scientific and technical partnerships were explored.

In addition many one-on-one discussions were arranged. In all cases the ESS delegation was warmly received and the discussions were conducted in a very productive atmosphere. Common issues were identified and in certain cases technical collaborations (e.g. CERN, Copenhagen University) were initiated. Meetings with key industrial suppliers also took place ranging from accelerator component manufacturers to electricity producers and suppliers.

This second phase of negotiations concluded with a further Round Table, this time held in the Swedish Embassy in The Hague and at the IRI in Delft.

Again the meeting was very lively and four main conclusions emerged:

- The quality and scope of the ESS Scandinavia work was appreciated.
- The capacity and capability to build ESS in Lund is available in Europe.
- ESS Scandinavia was encouraged to revisit the design of the facility within the broad financial envelope presented.
- The concept of a Cost Book was to be further elaborated.

#### III. Negotiations on Finance and Facility Specification

*March 2008 to  
September 2008*

The third phase in the strategic process has already begun to yield fruit. On April 7th 2008 the Danish Government announced its decision to embark upon formal negotiations with the Swedish Government with a view to co-hosting ESS in Lund. The Danish Research Ministry has conducted a wide-ranging consultation process & has assessed positively the siting of ESS in the Öresund Region which hosts the fastest growing science and technology network in Europe.

Discussions are well advanced on the setting up of a Nordic-Baltic Sea states coalition and the ESS was discussed by the five Nordic Prime Ministers on April 8th & 9th in Riksgården.

Our aim is to secure 50% of the capital cost from neighbour countries. The negotiation procedure will move on to other nations strongly involved in neutron facilities and research with neutrons. Our goal is for a site decision to be announced at Versailles on December 8th & 9th. The 2008 European Conference on Research Infrastructures meeting will be dedicated to European competitiveness, innovation and growth in a global context. A decision on ESS at that meeting, which is certainly a key instrument for Europe development, will strengthen the European position and the ESFRI process.



### Satellite infrastructures

- For the construction phase of ESS we take it for granted that the project will be a distributed project relying heavily upon technical and scientific capabilities and co-operation throughout Europe.
- For the operating phase we foresee two kinds of satellite infrastructures – those on-site and those off-site.

#### On-site satellite infrastructures

Following developments at ILL which members of the ESS Scandinavia team initiated – the “more than simply neutrons” approach – we envisage the twin facilities of MAX IV and ESS should be furnished with scientific support laboratories. The example that we look to as our model is the Partnership for Structural Biology (PSB) on the ILL/ESRF site. It groups together the resources in biological science of 5 participating laboratories in order to enable more effective use of the beam time on the two sources. The function of the PSB is not to do biological research but rather to supply resources close-at-hand such as special sample preparation, manipulation and characterisation or to create a critical mass of expertise in areas such as isotope labelling and protein expression which an individual university research group would not, in general, be able to resource. These satellite infrastructures are enablers for better science. In some ways laboratories such as the PSB are stepping stones to better use of ILL and ESRF. We consider it to be essential that ESS and MAX IV should embrace and develop this initiative and we foresee the following scientific support laboratories on-site:

- **Materials under Extreme Conditions**

This laboratory will group together facilities for high pressures, high temperatures, extreme cleanliness (e.g. catalysis studies), chemical reactions, electrolysis, gas absorption and gas handling. Special emphasis will be devoted to materials science with a unit dedicated to mechanical engineering (residual stress analysis) similar to FaME at ESRF and ILL. The activity of this laboratory is not be to confused with more standard sample environment which will be dealt with by the appropriate ESS experimental group (jointly with MAX IV).

- **Soft Condensed Matter**

Interface laboratories will allow full characterisation of sample materials before or during neutron scattering experiments. Soft matter systems are very often sensitive and evolve with time. Furthermore, the use of complementary methods (visible light microscopy, light scattering, x-ray reflectivity, differential scanning calorimetry) will bring more complete sets of information and will lead to a more efficient use of neutron beam time.

- **Biological Sciences**

Multidisciplinary approaches are the keys to success in the biosciences. Materials under investigation (proteins, viruses, membranes...) must be prepared in adequate form and quantity to be studied with neutrons (or x-rays at MAX IV). A platform dedicated to isotope labelling of molecules and to the expression of proteins in a deuterated environment will facilitate high quality projects in structural biology and will attract industry-sponsored activities.

We believe that the PSB model should be applied to the ownership and operation of these satellite infrastructures linking into capabilities in Lund and Copenhagen Universities and further afield. The proximity to these universities will allow us to gradually build the onsite infrastructures from the university academic departments.

#### Off-site satellite infrastructures

Off-site infrastructures are essentially technical in nature. We envisage three:

- **ESS Data Management Centre (DMC)**

The ESS will generate large quantities of data (15-20 TBytes per day or ~ 4 PBytes per year). We propose to set up an independent entity to deal with this data and all aspects of data processing. In particular an ESS Data Management Centre will have the following responsibilities:

- **Data archiving**
- **Data retrieval:**
  - for the users
  - for other interested parties, as part of developing Freedom of Information policies in Europe
- **Data security**
- **Data integrity**

Furthermore, such a Centre would handle all aspects of simulation ranging from scientific studies, instrument design, instrument control, and experiment protocol. Also included would be remote user training and virtual access. We foresee very significant advances in these areas and the setting up of a dedicated Data Management Centre would allow these uses to develop naturally and ahead of time. By 2020 the use of robotics and virtual access will have changed unimaginably. An ideal location for such a centre would be Copenhagen University that manages the Nordic Data Grid, although there are other good candidates for this role. ESS Scandinavia is already scoping out this concept with Copenhagen University.

- **Innovation Centre - ESSSENSE**

ESS will generate much which is innovative and marketable. Sweden has an excellent track-record in the nurturing of innovation and in the recently published Innovation Index [Ref D5.1] Sweden retained its first place position world-wide once again. The IDEON Science Park at Lund, which hosts around 275 start-up companies, is a model of its kind. 80% of the start-ups at IDEON have originated from Lund University, amongst them being Bluetooth.

Horizon-scanning for exploitable developments will therefore be put in the hands of a company – ESSSENSE – which has already been set-up. We envisage ESSSENSE to be similar to the EMBL enterprise management company EMBLEM in Heidelberg whose profits would be fed back into ESS.

- **ANTS - Advanced Neutron Technologies for Science**

The pooling of technical resources in neutron instrumentation in Europe would of course offer economies of scale. More importantly reaching a critical mass of such expertise would be important to become fully self-sustaining.

The idea of ANTS was put forward at ILL by the authors of this proposal, but remained unfunded. ESS Scandinavia would resurrect such an idea in the context of the ESS. ANTS would incorporate development laboratories for neutron detectors, supermirrors, polarisers, optical devices, and sample environment equipment employing ~ 80 scientists and engineers.

The obvious place to build such a facility would be at the ILL itself, but the exact location will depend upon the predicted life expectancy of ILL when we approach the middle of the next decade. HMI Berlin or BNC Budapest are also very appropriate candidates.

#### References

D5.1 See footnote<sup>23</sup>

23. [http://www.proinno-europe.eu/admin/uploaded\\_documents/European\\_Innovation\\_Scoreboard\\_2007.pdf](http://www.proinno-europe.eu/admin/uploaded_documents/European_Innovation_Scoreboard_2007.pdf)





The City of Lund is planning a new visitor centre within The Highest Point development.

### Public appreciation of science

Lund City is planning a total re-development of the area close to the ESS site – the so-called Högsta Punkten (Highest Point). The Högsta Punkten development will include a quality hotel, a large conference centre and a Public Appreciation of Science centre. This centre will have access to a science pathway that will guide the interested public through the two facilities, MAX IV and ESS, on foot or on bicycle, viewing exhibits as they proceed. The new visitor centre at CERN has been remarkably popular and we wish to emulate it.



## E) Legal, organisational and security points



### ESS Scandinavia approach to Governance

#### E1 What is the national legal and political framework?

##### For building and operating nuclear installations

**The ESS facility will not be defined as a nuclear installation under Swedish law,** and so this question will be answered in brief, summarising the legal framework for nuclear installations, since ESS in Lund will be built voluntarily to these same standards.

Under Swedish law, the principal regulatory provisions for nuclear installations are set out in the Nuclear Activities Act (Kärntekniklag, SFS 1984:3), which regulates “nuclear activities”. The Act (Sec. 1) (Ref E1.1) defines nuclear activities as the erection, possession, or operation of a nuclear plant; the acquisition, possession, transfer, processing, transport or other handling of nuclear substances or nuclear waste; the import of nuclear substances or nuclear waste, as well as the export from Sweden of nuclear waste. None of the aforementioned activities are of relevance to the ESS facility.

Instead, under Swedish law, the ESS facility will require a Permit under the Radiation Protection Act (Strålskyddslagen, SFS 1988:220), since it is a facility which involves a process emitting ionising radiation. Such a Permit is assessed and granted by the Swedish Radiation Protection Authority (Statens strålskyddsinstitut), an authority under the auspices of the Government.<sup>24</sup>

It has also been envisaged, that – due to the size and complexity of the ESS facility – a voluntary Permit application for the entire operations (including construction) will be made pursuant to the Environmental Code (Miljöbalken, SFS 1998:808), which is the fundamental instrument of Swedish environmental legislation. Such a Permit is assessed and granted by the relevant regional Environmental Court (miljöödomstol).<sup>25</sup> However, the Swedish Government has declared that it intends to exercise its right to exclusively assess the permissibility of the ESS facility under the Environmental Code (Ref E1.1). This means that the Environmental Court will be bound by the Government’s decision (i.e. the Court is obliged to grant a Permit where the Government has declared the ESS facility permissible), and the Court’s role will be limited to the setting of detailed conditions for the operation of the facility.

Furthermore, the location of the ESS facility on the Lund site will be subject to a detailed development plan (detaljplan), which will be produced and adopted by the City of Lund in conjunction with ESS Scandinavia.

The different assessment procedures will run simultaneously, and must to a large extent be co-ordinated *inter alia* as concerns the Environmental Impact Assessment (EIA). This process has been determined and

agreed with the relevant authorities. There are no apparent obstacles to completing the planning and the licensing process in time as required for construction and operation of the facility, see Figure E1.1. The exact schedule will depend on negotiations and the progress of completing the design work.

##### Would under such legislation ESS be a nuclear installation?

No. The legislation for nuclear installations (the Nuclear Activities Act) covers fission facilities only. The spallation process at ESS will not involve any fissile materials (such as uranium, plutonium or thorium). Hence, no fission processes will take place. This conclusion on the legal classification of the ESS facility is supported by a report issued by Studsvik Nuclear AB (Ref E1.2), a leading Swedish nuclear power consultant service provider, originally established by the Swedish Government.

##### Decommissioning legislation

As mentioned above, the ESS facility will be licensed under the framework of both the Environmental Code and the Radiation Protection Act.

Pursuant to the Environmental Code (Ch. 16, Sec. 3), the Environmental Court (which grants the main operational Permit) will have the power to establish conditions on decommissioning and dismantling of the ESS facility. The Environmental

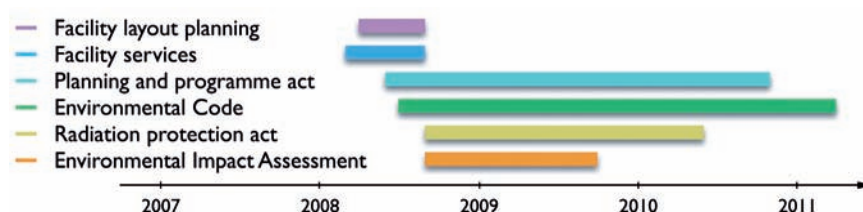


Figure E1.1: Time schedule for the planning and licensing of ESS in Lund according to the relevant parts of the legislation.

24. As of 1 July 2008, this authority will be denoted “Strålsäkerhetsmyndigheten” (the Radiation Safety Authority).

25. A voluntary permit application under chapter 9 of the Environmental Code is as the main rule to be submitted to the County Administrative Board (länsstyrelsen). However, as the construction of the ESS facility is expected to include the discharge of groundwater (which activity requires a permit by the Environmental Court under chapter 11 of the Environmental Code), ESS Scandinavia holds the view that the Environmental Court will be authorized to assess the entire permit matter under the Environmental Code (i.e. as a combined matter under chapter 9 and chapter 11).

Court may also render conditions that financial guarantees be given in order to ensure that there are adequate means to safeguard the decommissioning and the dismantling of the facility, as well as the handling of radioactive waste.

Under the Radiation Protection Act (Sections 13-14) anyone who runs, or has run, activities involving radiation shall be responsible for ensuring that radioactive waste, or technical devices capable of generating radiation, are handled or placed in a final storage in a manner that is satisfactory from the viewpoint of radiation protection. The same applies to discarded radiation sources that have been used in such activities. The Swedish Radiation Protection Authority has issued detailed regulations on the handling and final storage of radioactive waste, and may decide that radioactive waste be handled or placed in a final storage in a specified manner.

Furthermore, anyone who runs, or has run, activities involving a technical device capable of generating radiation is responsible for ensuring that the device is rendered harmless when it is no longer to be used for the activities concerned. Based on the Radiation Protection Act, international recommendations and agreements, the Swedish Radiation Protection Authority sets the limits, rules and requirements that apply to different types of radioactive devices and waste.

Decommissioning aspects of the ESS facility, including the question of safe disposal of mercury in Sweden from such a facility, have been separately examined by Studsvik Nuclear AB in two different reports. (Ref E1.3) According to these reports, there are several options for the handling and/or final disposal of waste from the ESS facility depending on the radioactive content of the waste. These

options comprise decontamination, incineration, disposition in landfills or bedrock repositories. Final disposal of any radioactive mercury-contaminated waste must, according to Swedish law, be made in deep bedrock (Ref E1.4).

A well-developed legal framework exists as regards the transport, handling and final disposal of radioactive waste as well as domestic technical competence in these areas. Sweden is at the forefront as regards the handling of high-level radioactive waste. For example the Swedish Nuclear Fuel and Waste Management Company (Svensk Kärnbränslehantering AB), which is owned by the Swedish power industry, performs research and development in issues related to deep bedrock repositories and is planning to construct and license a deep bedrock repository for high level radioactive waste to be operational around 2018. The authorities in the nuclear and radiation protection sectors (the Nuclear Power Inspectorate and the Radiation Protection Authority) have, by way of regulations which they are authorised to issue, specified the requirements on the future deep rock repository (Ref E1.5).

The Studsvik reports conclude that it is perfectly feasible to safely decommission a Swedish ESS facility from an environmental point of view and that a deep bedrock depository is considered to be an acceptable option for final storage of radioactive mercury if used as the target material in the ESS facility. This would most certainly be the case should other target materials be chosen.

#### **Related to environmental restrictions, safety regulations**

Under Swedish law, there are currently no specific regulations aimed at large scale accelerators and spallation sources. Nevertheless, as mentioned above, the ESS facility will first and foremost be subject to, and licensed

under, the framework of the Radiation Protection Act and the Environmental Code.

The Radiation Protection Act, including the ordinances and regulations issued under the Act, set forth the fundamental legal framework for matters concerning radiation protection and connected safety and precautionary regulations. Additional conditions ("restrictions") may be attached to the requisite Permit under the said Act.

The conditions ("restrictions") for the operations of the ESS facility in areas other than radiation protection matters will to a significant extent be regulated in the Permit granted under the Environmental Code. This concerns both general questions on the location and extent of the operations, as well as detailed matters on the effects on the environment and to human health, including but not limited to energy use, land usage and safety matters. The Code (including connected ordinances and regulations) transforms a number of EC directives into Swedish law, inter alia on EC environmental quality standards, and the important EIA Directive (85/337/EEC, as amended). The EIA directive will constitute the basic document for the relevant Permit procedures, as well as the municipal decision-making.

Under the Environmental Code, a Permit that has gained legal force is valid against all other parties – including the environmental authorities and private third parties – as far as the matters examined in the Permit are concerned. Thus, under Swedish law, an Environmental Code Permit offers a strong protection for the holder, who in general does not have to fear that authorities or other third parties will impose additional environmental requirements upon his operations with respect to matters that have already been examined in the granting of the Permit.

The ESS facility will contain a liquid metal target – mercury, lead, or lead-bismuth – to generate neutrons. At present, Swedish law restricts the use of mercury primarily with respect to use in different products and for specific purposes (which restrictions are not aimed at research facilities). Sweden intends to implement a general ban on the selling, usage and export of mercury, which would be expected to enter into force during 2008 (Ref E1.6). However, under the new mercury regime, the use of mercury for the purpose of research and development will be subject to a general exemption in accordance with Directive 76/769/EEC (Ref E1.7) (article 2) and (after 1 June 2009) the REACH-regulation (article 67) (Ref E1.8). In the ESS facility, mercury would be used in a closed circuit for the purpose of research and development. Therefore, we are of the view that an exemption allowing the use of mercury in the ESS facility would apply both under EC law and Swedish law.

### Related to building legislations / regulations, expropriation legislation

The ESS facility will be subject to a separate building Permit requirement under the Planning and Building Act (plan- och bygglag, 1987:10). The building Permit is assessed and granted by the relevant municipality (here the City of Lund). The building Permit assessment will, in the present case, largely be limited to the visual shape and configuration of the buildings to be constructed on the ESS site. Once the detailed development plan for the ESS site has been adopted and has gained legal force, the site holder has a statutory right to be granted a building Permit, provided that the buildings in question are in conformity with the detailed development plan.

Pursuant to the Expropriation Act (Expropriationslag, SFS 1972:719), the Government or a municipality (such as

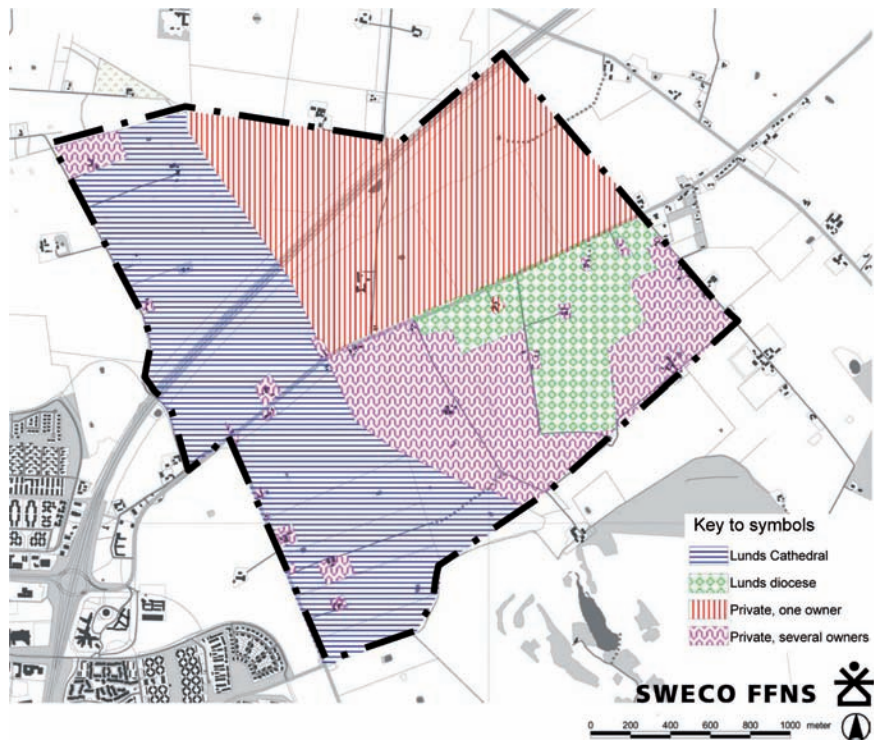


Figure E1.2: The land ownership on and around the ESS site in Lund.

the City of Lund), are entitled to claim real property (by way of freehold title, easement or right of use) belonging to a third party through expropriation, provided (i) that the expropriation serves an important public interest, (ii) that the relevant purpose cannot be achieved in another adequate manner, and (iii) that the benefits from a public point of view outweigh the disadvantages from an individual and public viewpoint (cf. the principle of proportionality). Furthermore, in case of expropriation, full compensation must be paid (in principle the market value of the property or encroachment). The Expropriation Act defines a number of purposes that are deemed to be of "important public interest", *inter alia* the establishment of a facility that is of significant importance for the state or a municipality. As a rule, an expropriation permission is assessed and granted by the Government.

At present, the land for ESS is owned by a single landowner which will facilitate the securing of the land for the site (Figure E1.2). The landowner has an agreement with Lund University, as the host for the ESS Scandinavia

Secretariat, to provide this site for ESS. Similarly, the MAX IV site is at present owned by Lund Diocese but will be made available to Lund University. The legal processes for the acquisition of this land are ongoing.

In this context it could be mentioned that ESS Scandinavia and the City of Lund aim to set up a property company called MAXESS under which the ESS and MAX IV sites are formally acquired by the City of Lund and then leased to the relevant ESS and MAX IV entities by way of site leasehold (tomträtt). Site leasehold constitutes a very strong usage right under Swedish law, which is similar to ownership in all material respects.

The role of MAXESS would extend beyond being landlord to ESS and MAX IV. For example the piece of land between ESS and MAX IV is envisaged for facilities such as scientific centres, mechanical workshops, restaurants, incubators for start-ups, conference and lecture halls and other service providers and could be owned by the real estate company. This company, jointly owned by the two facilities, could operate the site providing





## Organisational model / structure (construction / commissioning / operation / decommissioning)

There are a number of distinct phases in realising the ESS. These fall into the following categories:

### I Pre-site decision

This is the current position. ESS Scandinavia is embedded within Lund University. LU has set up an ESS Scandinavia Secretariat that currently has 17 full-time staff, the majority with LU contracts. As numbers increase, job definitions change flexibly. We have decided to organise our team assuming that the site will be Lund. Only in that way can we begin to construct an organisation that will map on eventually to the equilibrium organisation when ESS is in its operational phase (IV). The current organigram is illustrated, consisting of 4 major groupings – Accelerator, Target and Instruments, Science and Users, and Administrative Services. A cross-group Project Leader is shortly to be appointed. An overall Super-visory Group and three Advisory Groups – Scientific, Technical, and Stakeholders have been set up. The members are listed at the back of this questionnaire. As a guideline we are working towards a site decision in December 2008.

### II Pre-financing decision

This phase will be characterised by the continuous absorption of new staff into roles within the above structure, as countries commit to Lund as the site. We are already anticipating this phase by incorporating Danish staff into the Secretariat following the decision of the Danish government to seek a basis for co-siting ESS. New staff will be placed within the 4-Group organisation as in phase I. At the end of this period we foresee a staff of between 40 to 50. We are working to achieve a full financial partnership agreement by December 2009. In terms of Partnership we are considering two categories:

1. Co-hosts – this could include the three Scandinavian countries.
2. Co-owners
  - i. - further Founding Partners, comprising mainly, but not exclusively, the Nordic-Baltic Sea countries.
  - ii. - other countries or groups of countries in a consortium, who will play a full role in the build and operation of ESS.

The precise nature of this proposed organisation and the financial model underpinning it will be an important part of the agenda in forthcoming negotiations between Sweden and potential partners.

### III Construction

This phase will see a rapid build-up of staff ([Figure E2.1](#)), the first priority being engineering and design staff. We envisage a strong central team responsible for all aspects of design and specification including field-managers who liaise very closely with in-kind contributors. The Project Leader will report directly to the Director General of the facility. The other Groups will evolve into Divisions. Division Heads (Directors) will form the Management Board of ESS. The question of the contractual situation of staff is to be discussed during the negotiations, however it will clearly be advantageous to have a good proportion of the staff on secondment because of the evolving and fixed-term nature of the work. Instrument design scientists will begin to be built up, more slowly, from the very beginning of the construction phase. Software engineers (instrument control, data handling, instrument simulation) and neutron techniques people (detectors, optics, sample environment) will also be taken on board progressively but again more slowly. At the end of the construction period, there will still be instruments to be built and upgraded. It would be necessary to transfer staff from technical services to instruments and user support groups.

### IV Operation

Full operations at design specification with a complete suite of 22 instruments will not be reached until 5 years into the operations phase (around 2025). During this phase there will be an overlap period as we move into full operations. This 5-year phase will require careful management and will be concluded with the phasing out of the Project team. Many staff will already have been redeployed into other aspects of ESS operations. At this point the organisational structure of ESS will look very much like the framework of the ESS Scandinavia Secretariat does today with four major Divisions but with an enhanced DG's Services including Safety, Medical, Radiation Protection, Risk Management and Energy Management. Staff numbers will be approximately as follows:

ESS Staff Numbers	
Accelerator	~100
Target & Instrumentation	~115
Science	~125
Administrative Services	~75
Director's Services	~35
<b>Total</b>	<b>~450</b>

### V Decommissioning

The decommissioning phase should ideally be started immediately that planned closure of ESS as a scientific facility has been decided upon. Closure of ESS might be foreseen for 2065 after 40 years of full design specification operations. Decommissioning would take five years until 2070. It is essential to consider decommissioning needs in the design of the facility from the very outset.

The organisation of ESS in this sunset phase would be slimmed down considerably. ~150 staff would be required. It is important to realise that decommissioning is a specialised function and that the process may require to be handed over to a new team which would by necessity incorporate technical experts from the engineering and maintenance teams of ESS.

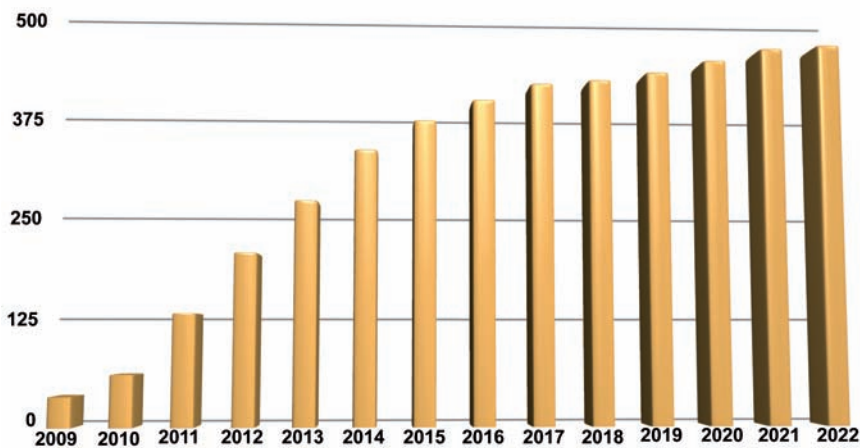


Figure E2.1: The build up of staff in full time equivalent years working for the ESS project and excluding contractors' labour.

### IPR policy

In responding to this question, it is *inter alia* relevant to consider the recommendations of the European Commission Expert Group Report on the Management of Intellectual Property in Publicly-Funded Research Organisations (PROs) from 2004 (Ref E2.1), as well as the European Research Area (Ref E2.2) 2007 Green Paper.

The Expert Report reviewed different knowledge transfer processes relating to PROs, and distinguished between three different models, as set out below.

- (i) **The "Open Model"** in which the PROs do not retain any intellectual property rights (IPR).
- (ii) **The "Licensing Model"** in which the PROs to various degrees retain, protect and commercialise inventions based on their discoveries, essentially through licensing the IPR to industry or to start-up companies.
- (iii) **The "Innovation Model"**, in which the Licensing Model is supplemented by a more active policy of collaborative research with industry, and by a pro-active involvement of spinout companies.

The Expert Group recommends the adoption of the *Innovation Model* by European PROs.

The Expert Group concluded that the common feature of the Licensing Model and the Innovation Model is the identification, registration and

management of an intellectual property pool from which the various innovation models can draw. The Expert Group holds that the best practice is to vest initial ownership of results and inventions funded by public funds to the PROs where the research has been conducted. ESS Scandinavia agrees with this conclusion, however we would wish to pursue this in the widest sense by including the user community as an integral part of what is defined as the PRO in the context of IPR.

As regards different forms of collaboration with industry – which is one of the essential components of the Innovation Model – the Expert Report points out that a distinction

should be made between *contract research*, wherein no IPR is generated or retained by the PRO, and *collaborative or sponsored research*, wherein substantial intellectual property is generated by the PRO and may be retained as a basis for further research and collaboration with the same or other partners.

The Expert Group submits in its report, a tentative set of guidelines for collaborative research addressing the issues of ownership, rights of use, access to background management of IPR, and compensation. ESS Scandinavia would wish to follow these guidelines although once again, this is a matter of negotiations.

In order to emphasise the importance of Intellectual Property and its value both to the ESS and to its stakeholders, ESS Scandinavia has already taken steps to create a Company called ESSSENSE within the Lund University innovation framework to manage, package and exploit IPR. The Board of ESSSENSE will comprise representatives from a highly placed bank, LU Innovation, the ESS Scandinavia Secretariat and the extremely successful IDEON Science Park, close to the ESS site.

### References

- E2.1 EC Expert Group Report EUR 20915<sup>27</sup>
- E2.2 COM (2007) 161 final 4 April 2007



27. <http://ec.europa.eu/research/era/pdf/iprmanagementguidelines-report.pdf>



## E3 What are the important risk and insurance issues?

### What risks does the host state foresee

ESS Scandinavia has identified and gauged the important physical risks associated with the ESS which could have an impact on legal and insurance matters. As risks have to be continuously identified and managed in all phases and in all parts of the project, it requires that a proper organisational structure is set up to handle it. The most important physical risks and a method for risk management are described below. Social, economic, and political risks associated with the site and the host region are addressed in [Section F4](#).

### Physical risks

The preliminary studies on safety aspects regarding the construction and operation of an ESS facility in Sweden that have been conducted so far indicate that the hazards and risks with a facility like the ESS do not differ from any process industry or power station with diverse activities. Rather, the hazard sources can be described as well-confined and not in direct contact with the operating personnel ([Ref E3.1](#)).

According to these studies, the source of primary consideration from a general risk point of view is deemed to be the existence of mercury, an option for the target material, and radioactive spallation products concentrated in the target system of the facility. The licensing and EIA process will include a detailed and comprehensive safety analysis in which these and other risks, as well as safety guidelines and protective and precautionary measures, will be described and analysed ([Ref E3.2](#)).

In addition to the use of the best available technology and other technical design measures, the recruitment of a well-educated staff is an important issue, in order to maintain reliable and safe operations.

In this context (although concerning a fundamentally different type of operation), it could be mentioned that in Sweden, nuclear facilities have been operated for almost 40 years with a very high safety standard and safety culture.

The main conclusions from the above-mentioned safety studies are (i) that, from a safety point of view, the ESS facility can be designed with a high safety standard and be built and operated anywhere in Sweden, and (ii) that the facility can be constructed so that the impact on the environment can be kept very low. Thus, the choice of Lund as the Swedish site for the ESS facility is primarily based on other aspects than safety and environmental impact considerations ([Ref E3.3](#)).

The ESS requires the implementation of the highest standards of hazard assessment and risk management. These need to be applied during all phases of the project but should also take into consideration at an early stage the technological and environmental

hazards, the vulnerability of buildings, installations and their occupants.

The European Spatial Planning Observation Network (ESPON) was set up to support policy development and to build a European scientific community in the field of territorial development. The main aim of the ongoing project is to increase the general body of knowledge about territorial structures, trends and policy impacts in an enlarged European Union. The hazards and risks regarding the location of the ESS project are reviewed based on the findings of the ESPON study.

### ESPON Territorial Development Policies

A unique feature of ESPON has been that its study area encompassed all 27 EU states and the neighbouring countries of Norway and Switzerland. The main aim of the project is to represent the spatial patterns of natural and technological hazards in administrative regions of the ESPON space.

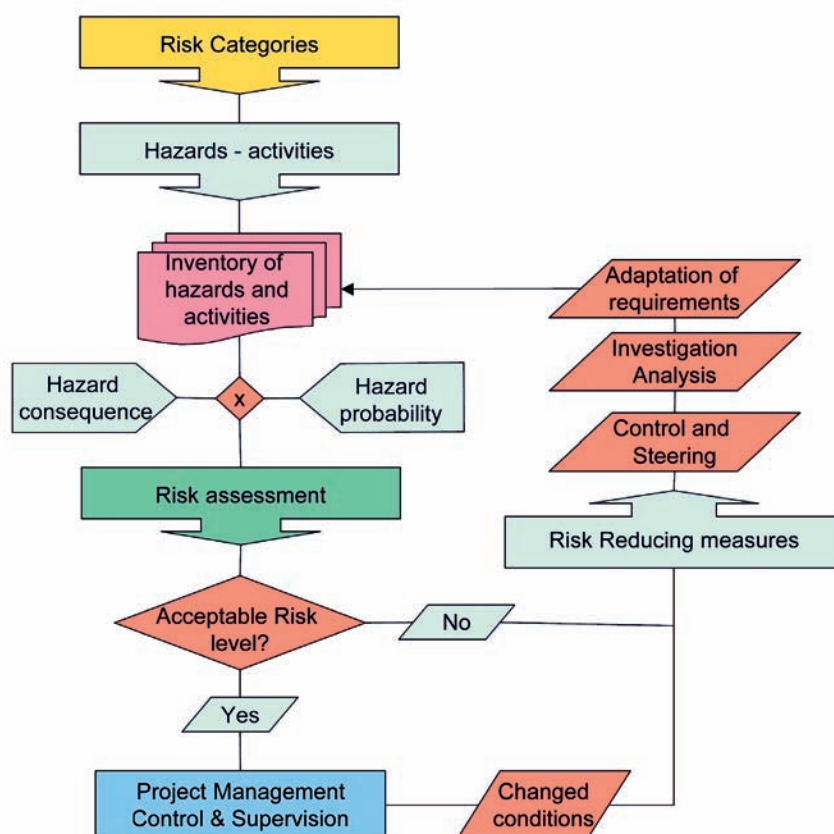


Figure E3.1: Implementation of risk management process based on ESPON recommendations.

Hazards are natural extreme events or technological accident phenomena that can lead to threats and damage among the population, the environment and/or material assets. Eleven hazards have been studied. Key results of the project are the development of individual hazard recurrence maps, integrated hazard maps showing the location of high/low hazardous areas in Europe, and risk maps (combining hazard recurrence and vulnerability of a given region), presenting areas most at risk with respect to different hazards. In a more long-term perspective, the influence of climate change on the probability of occurrence of certain hazards (droughts, forest fires, floods) has also been addressed.

### Findings of ESPON Hazard Study

European regions are exposed to hazards in varying degrees, placing them in different "risk positions". The report (Ref E3.4) shows the spatial picture of natural and technological hazards that pose challenges for balanced and sustainable development in Europe. Risk management should be understood as an important task for planning policy. In that respect, the project formulates policy recommendations at European, Transnational/National, and Regional/Local levels for a better integration of risk management into policies and spatial planning practices.

### Natural and Technological Hazards at the ESS Site

A map of aggregated hazards see [Figure F4.2](#) (See page 45) includes the Öresund region.

**It can be concluded that the ESS site in Lund is located very favourably with respect to combined natural and technological hazards, and without any major risks.**

### Risk & Hazard Management Concept for ESS Project

Risk Management plays an essential role when planning, implementing and operating complex projects such as the ESS. Risk management should be in harmony with other project requirements. These considerations include not only environmental concerns, quality control and quality assurance, safety for workers, occupants and the surroundings, but also other aspects such as time constraints, financial and economic considerations, political instability, quality of life, cultural and heritage aspects.

In order to achieve optimal results for the ESS project owners and future users of the facility, risk management concepts will be considered during all phases of the project (planning, construction, operation and decommissioning).

### Implementation of Risk Management

The Risk Management process plays an important role especially during the planning phase of the project in order to identify at an early stage potential hazards, vulnerabilities of buildings, installations or occupants and possible remedial measures. The risk management process is outlined in [Figure E3.1](#).

Risk management is thus an ongoing process that takes into account the objectives, envisaged activities and requirements during the planning, construction and operation of ESS.

As a first step, risk categories are identified by the project managers in close cooperation with the owners and future users of the facility. The next step is to list natural hazards (e.g. earthquakes, wind loads etc.), technological hazards (e.g. traffic) or other activities (e.g. construction processes) and to carry out a detailed hazard inventory.

Risk assessment is based on the determination of the risk level, which considers the probability of the hazard and the consequences thereof (vulnerability). A risk management database is set up and kept updated, to keep track of risks during the various phases of the project.

If the risk level is acceptable, the risk is transferred to the project management. If the risk is not acceptable, various risk-reducing measures will be implemented. The risk management loop is repeated until an acceptable risk level is achieved. The whole process is overseen by a Risk Manager who reports directly to the Director of ESS ([Ref E3.5](#)).

### Mandatory requirements for insurance

Pursuant to chapter 33 of the Environmental Code, a person or entity who conducts an environmentally hazardous activity that is subject to a Permit or notification requirement is obliged to pay an annual fee to a public *environmental damage insurance*. Compensation from the insurance is paid to those suffering personal injury or property loss, provided the injured party is entitled to compensation but for various reasons cannot obtain indemnification from the defaulting party.

Further, an annual fee to a public *remedial insurance* must be paid. Compensation from this insurance is for example paid when remedial or clean-up actions shall take place at the expense of a defaulting party who is unable to pay for such actions.

It should be noted that the abovementioned insurances are held by the state and not by the operator himself, although the latter is obliged to pay premium fees. These fees would, as far as can be assessed at the time of writing, be insignificant given the context, and would currently amount to ~ 10 k€ annually.

## Additional insurances (non-mandatory)

Insurance matters need to be considered in different stages of the project separately. A distinction should be made between the *construction phase* and the *operation phase*.

Concerning the *construction phase* (as well as the decommissioning phase), two main approaches are in principle possible: either a 'traditional approach' where the contractors procured for the work shall themselves maintain an adequate insurance cover, or a 'project insurance approach', under which the *designated ESS project company* (the procuring entity) will take out and maintain a project insurance policy. Such a project insurance policy would encompass contractor's 'all risk' insurance, public liability and excess public liability insurances. The contractors and their sub-contractors would be co-insured under those insurances.

An advantage of the latter approach is, given the complexity and magnitude of the project, that the ESS project company would be in a better position to control the insurances and the placement thereof in order to achieve the best terms and conditions possible, to select underwriters who are reputable and financially robust and to reduce any problems in relation to the interface between insurances taken out by different parties involved in the project. The contractor would – given this approach – merely take out and maintain certain supplementary insurance cover, for instance, his constructional plant and transportation. A project insurance approach of this kind was, for example, successfully used in the Öresund bridge project.

As to the operations phase, all insurance coverage should vest in the project company. Such insurance coverage would include property insurance (own property), and liability insurance (damage to third party property and persons other than employees). Damage caused by radiation may to a varying extent be excluded from the standard insurance instruments available. In Sweden, insurance coverage for employed personnel is often accomplished through generally applied collective bargaining agreements.

**In summary ESS Scandinavia is confident that obtaining adequate insurance coverage for an ESS facility located in Sweden will pose no problem (Ref E3.5).**

### References

- E3.1 Studsvik Nuclear AB, Report (2005), Overview of Safety Aspects for European Spallation Source (ESS), for a location in Skåne, N-05/070, p. 15
- E3.2 Ibid, p. 16-17
- E3.3 Ibid, p. 25-26
- E3.4 ESPON Report 1.3.1: "The Spatial Effects and Management of Natural and Technological Hazards in Europe".
- E3.5 Tillståndsprövning av ESS-anläggningen i Lund, Mannheimer Swartling Advokatbyrå, 2006.



## F) Environment and socio-economic points



### Characteristics of the Lund location

#### F1 What is specific for the site?

##### Size, topology, geology, site stability (record), ownership of site

ESS Scandinavia proposes to build ESS on a site located to the north east of Lund, on the Swedish side of the Öresund strait. The site chosen is within the extension of the area outwards from the University, the University Hospital, the BioMedical Centre, and the IDEON science park, and constitutes a joint site occupied together with the planned synchrotron MAX IV, see [Figure F1.1](#). In the following, the size, the ownership, the topology, the geotechnical characteristics, including stability and vibration characteristics for the site, are described. The site characteristics are shown to be technically excellent for the ESS facility, and a suitable location for the buildings is presented. The access to the site for people, goods and equipment and the services available is excellent.

##### Size and location

The site was chosen from a candidate area of 7 km<sup>2</sup> and has been thoroughly investigated ([Refs F1.1, F1.2](#)). The area identified for building ESS is approximately 1.2 km<sup>2</sup>. The ESS Scandinavia site is ~1,600 m long, and ranges between ~ 500 m to ~1,000 m in width. The footprint required by the ESS Reference Design is approximately 0.7 km<sup>2</sup>. See [Figure F1.1](#).

##### Ownership

ESS Scandinavia will hold the site by way of leasehold from a property management company jointly owned by the organisations for ESS and

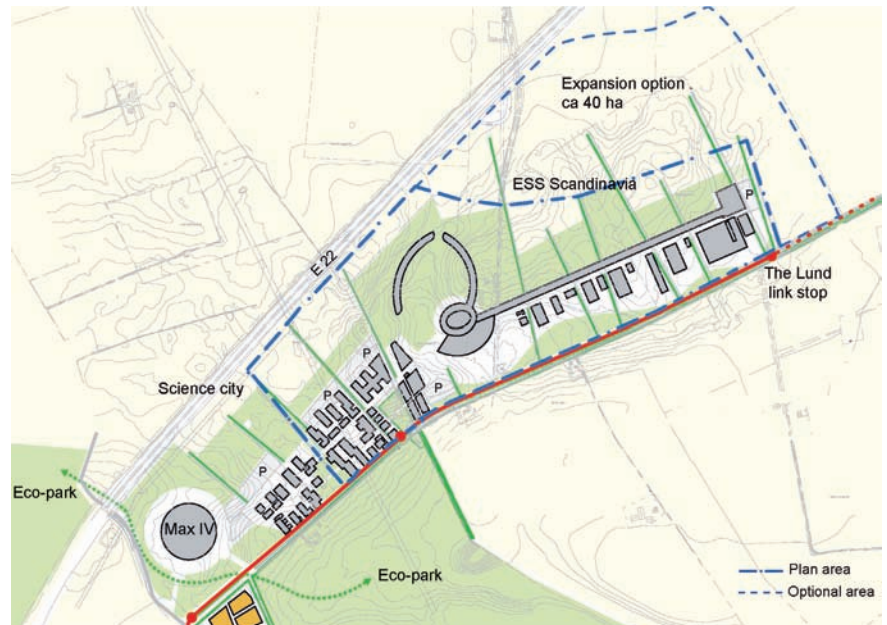


Figure F1.1: The layout for the ESS on the site neighbouring the site of the MAX IV synchrotron.

MAX IV. At present, the land for ESS is owned by a single landowner.

##### Topography

The site is situated close to the top of a broad low crest, 80 m above sea level. The land surface has slight slopes towards the east and south but is approximately flat and its topography has been surveyed aerially to a vertical and lateral resolution better than 10 cm ([Ref F1.3](#)), see [Figure F1.2](#). This allows optimum location of the facility with respect to land cut and fill, and drainage.

##### Geology

The geology of the site is well characterised and is considered by experts on large constructions to be excellent for the ESS facility. In the following, an account of the characteristics of the soil layers, the bedrock and the hydrological conditions are given. The stability and the vibrational characteristics are presented and detailed data are given for the chosen position of the target station. The planned position of the facility relative to the bedrock and the soil layers is described.

##### Soil layers and bedrock

On the site, there are four different soil types of thickness between 5 and 15 m lying on top of a shale bedrock ([Refs F1.1, F1.2](#)):

- (i) Postglacial soil layers occur sporadically as scattered regions in undrained depressions up to 3 m thick, mainly within the north-western parts of the area. These layers consist primarily of organic or fine-grained deposits with some organic material and will not affect the construction of the plant.
- (ii) Upper glacial soil layers - clay tills - occur as coherent units up to 5 m thick within the western and northern parts of the area. This stratigraphic unit is mainly composed of fine-grained poorly-sorted and till-like soil layers with a clay content that generally varies between 25% and 40%. The area is poor in boulders and stones. The foundations of the facility will most probably be bedded below these deposits.
- (iii) Lower glacial deposits, consisting of highly compressed till with a clay content of 40%. The layers have been deposited below the inland ice and have thus been compressed by an extremely heavy load during the last ice age. The layers are suitable for carrying heavy buildings and have a load bearing capacity higher than 50 t/m<sup>2</sup>.
- (iv) Middle glacial deposits, consisting of sediments dominated by sand/silt. The sediments appear locally within the till layers and are related to areas where melt water has appeared during the recession of the inland ice. Normally the thickness of these layers is of minor interest but local occurrence of ground water in these strata may cause minor problems during the construction phase.

The sedimentary rock below the soil layers within the site consists of Silurian strata (Colonus shale) with a thickness between 600 and 1100 m. This stratum is considered to have been stable since the last tectonic activities more than 500 million years ago. These tectonic activities led to the formation of a number of dolerite dykes. The geophysical measurements indicate that one or two such dykes cross the site (Ref F1.3). The precise pinpointing of these dykes is currently underway in order to determine where the bedrock has differing characteristics.

The soil as well as the shale rock underneath can be excavated by means of a toothed bucket with which the shale rock can be broken out. An alternative is breaking with a hydraulic jackhammer. The use of these methods will lower construction costs.

ESS Scandinavia has optimised the location of the accelerator and the target station allowing the accelerator to be anchored in, or placed directly on top of, the bedrock (Refs F1.3, F1.4). The target station will be placed a few meters into the bedrock. See Figure F1.2 and Figure F1.3.

*The site is considered to be highly satisfactory from a civil engineering aspect.*

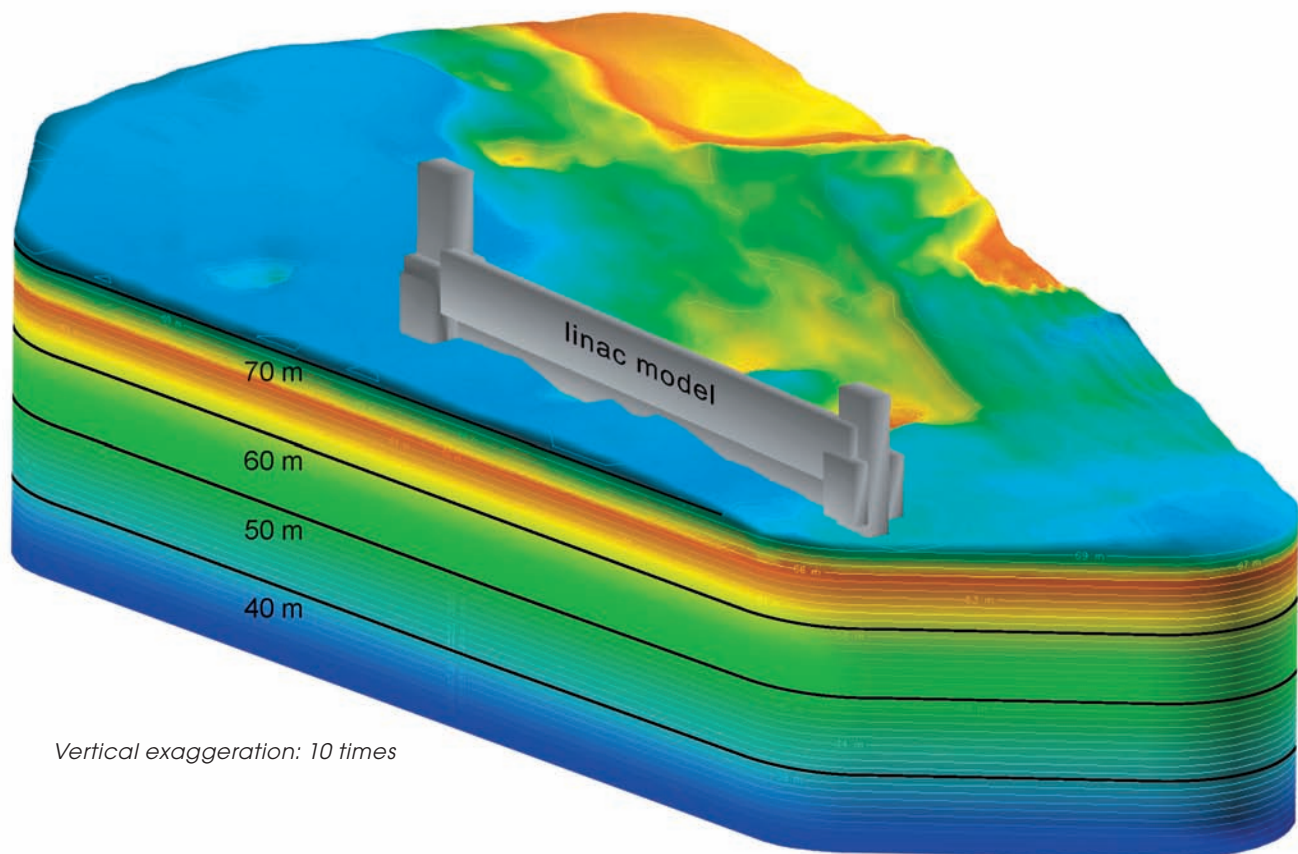
### **Load bearing capacity, stability, seismic activity and vibrations**

The load bearing capacity of the lower glacial layers, where many of the ESS buildings will be constructed, is from experience capable of carrying a load higher than 50 t/m<sup>2</sup>. The bedrock is judged to be able to carry loads exceeding 100

t/m<sup>2</sup>. Core drillings and pressiometer measurements are underway to confirm this.

*Detailed studies of the geophysical characteristics at the location chosen for the target station confirm that the conditions are excellent for the ESS (Ref F1.4).*

At the precise location of the target station geophysical investigations confirm that the load carrying capacity of the soil is higher than 50 t/m<sup>2</sup> and that of the bedrock has a capacity higher than 200 t/m<sup>2</sup>. The shear modulus increases with depth from ~150 MPa at 1 m depth in the soil and to more than 400 MPa at 10 m depth (in the bedrock). Core drillings and pressiometer measurements are underway to confirm that this is the case for the site in general.



**Figure F1.2: Geophysical determination of bedrock topography at the ESS site. The level of the bedrock along line R2, corresponding to the stretch of the accelerator and the target station has also been determined by means of resistivity measurements. The bedrock is found at a depth of 5 – 10 meters.**

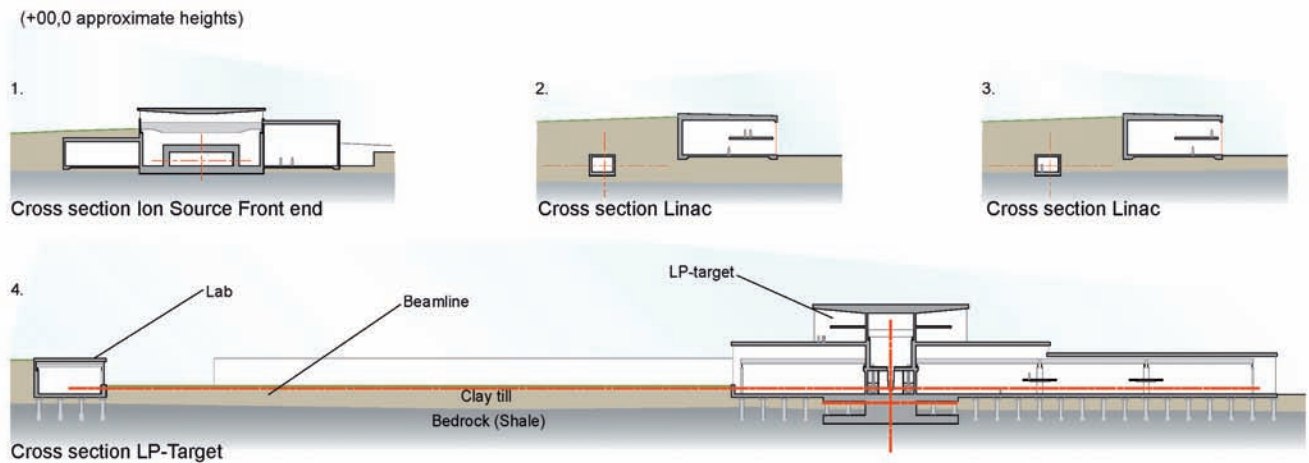


Figure F1.3: The foundation of key buildings of ESS on the site.

The seismic activity is low in this part of Sweden and the probability of severe earthquakes is extremely low. The Swedish Nuclear Fuel and Waste Management Company has made a compilation of earthquakes > 4 on the Richter scale that have occurred since the 17th century, see [Figure F1.4](#). In addition, the number of earth tremors, with a magnitude > 2, since 1976 is also found to be very low ([Ref F1.1](#)).

*It can be concluded that there is negligible seismic risk in Lund.*

The vibrational characteristics of the area of the site are found to be extremely good. Thorough studies for

the MAX IV synchrotron show that the soil layers have an attenuating effect on vibrations, and comparisons with characteristics of other sites for large scale facilities are very favourable, see [Figure F1.5](#).

The MAX IV site is very quiet and the site for ESS, which is located adjacent to MAX IV is expected to be at least as quiet.

### Hydrology and water table

The hydrology and the water table has been characterised at the site ([Ref F1.1](#)) see [Figure F1.6](#). The water table is found at a depth of a few meters; at the location of the target

station it sits at a depth of 3,7 m ([Ref F1.4](#)). The rather shallow table means, as is the standard, buildings will be fitted with a tank lining.

### Access for people and heavy equipment (roads, train, airport, port, public transport between site and residential areas)

The Öresund is a region of significant commercial and industrial activity which relies upon the efficient regular transport of goods and people from around Europe and the rest of the world. The site for ESS in Lund will benefit from this existing infrastructure and can be easily accessed from Europe by air, rail, sea and by roads and bridges. The

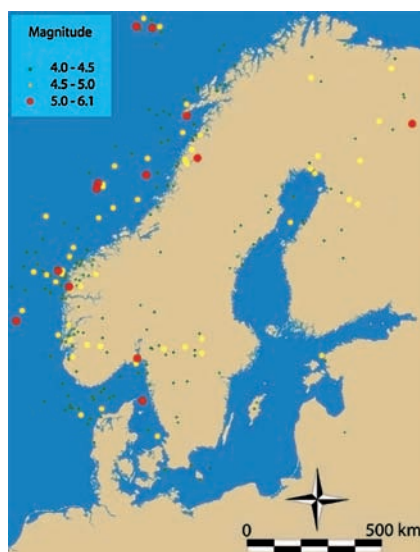


Figure F1.4: Earthquakes in Sweden with a magnitude higher than 4 since the 17th century.

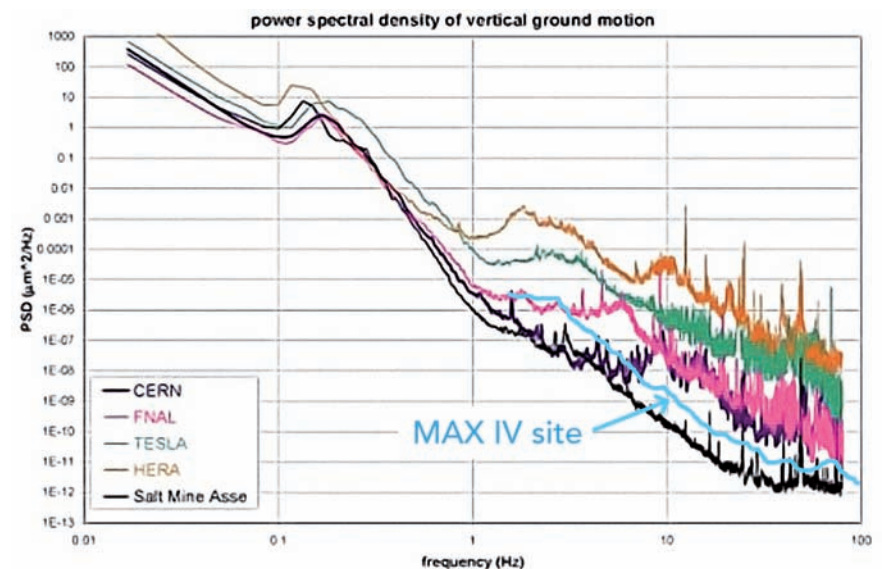


Figure F1.5: Comparison of power density spectra (PSD  $\mu\text{m}^2/\text{Hz}$ ) of the MAX IV site and sites for other large accelerator facilities.



excellent accessibility of the region from other parts of Europe has been characterised by ESPON and is illustrated in their atlas.<sup>28</sup>

There are two main access roads to the site, the E22 motorway and the state road Odarslövsvägen. Both roads are suitable for a low-loader carrying a railway wagon sized load. The roads have the highest national load classification BK1 with a maximum gross weight of 60 t (in accordance with EU regulations). Permits for special transport on these two roads, because of weight or size, is obtainable from the transport authorities. The E22 motorway is accessed from Odarslövsvägen, 1 km to the southwest of the site.

**The site is within cycling distance from all over Lund.** Using purpose-built bicycle lanes access to the ESS site will be easy and straightforward. Commuting by public transport from residential areas in Lund, Malmö,

Copenhagen and numerous villages on the extensive bus and rail network is standard practice. Already today, a well-developed rail network has, in combination with the Öresund bridge, facilitated commuting throughout the Swedish and Danish parts of the Öresund region.

The region is accessed by air mainly through Copenhagen and Malmö airports. Copenhagen airport is the major hub for the Baltic region, see **Figure F1.7**. Direct connections serve a total of 132 destinations worldwide, 19 of which are intercontinental, 84 European, 22 Nordic and 7 domestic. Almost all European destinations can be reached in less than three hours. Nearly 60 airline companies operate ~800 flights a day. The airport served 21.4 million passengers in 2007 and handled 380,000 tonnes of cargo.

When the rail tunnel being constructed under Malmö, operational in 2010, Lund will be only 30 minutes by train

from Copenhagen airport compared to 45 minutes today. Trains leave every 20 minutes for Lund and are coordinated with a bus line extending through the university area, past the IDEON Science park and the Brunnshög business area on to the sites of MAX IV and ESS. A tramline will be built to replace this bus line by 2012 with a projected transit time to ESS of 10 minutes.

Malmö Airport is located 25 km south of Lund. It is a modern domestic airport with a number of international destinations, such as London, Paris, Berlin, Warsaw, Madrid, Krakow and Budapest. The total number of passengers in 2007 was 1.9 million (0.8 million international). The airport can be reached from Lund in 30 minutes.

The Swedish side of the Öresund region can be easily reached from continental Europe by the Öresund bridge from Copenhagen to Malmö opened in 2000. The proposed bridge over the Fehmarn Belt, from Puttgarten in Germany to Rødby Denmark is now agreed and funded, and will open in 2018.<sup>29</sup> The bridges carry both train and motor traffic and will be suitable for the transport of heavy equipment.

There are a number of ports suitable for receiving heavy equipment for ESS. Southern Sweden has a history of building large vessels, and several ports with capabilities for handling bulky and heavy equipment exist. The port of Trelleborg, second largest in Sweden, is located ~ 50 km from Lund by rail or by the E6/E22 motorways, which pass the ESS site. The port of Malmö, fourth largest in Sweden, is located ~ 22 km from the site along the E22 road.



**Figure F1.7: Air transport times from Copenhagen Airport.**

28. [www.espon.eu/mmp/online/website/content/publications/98/1235/index\\_EN.html](http://www.espon.eu/mmp/online/website/content/publications/98/1235/index_EN.html)

29. [www.trm.dk/sw68728.asp](http://www.trm.dk/sw68728.asp)

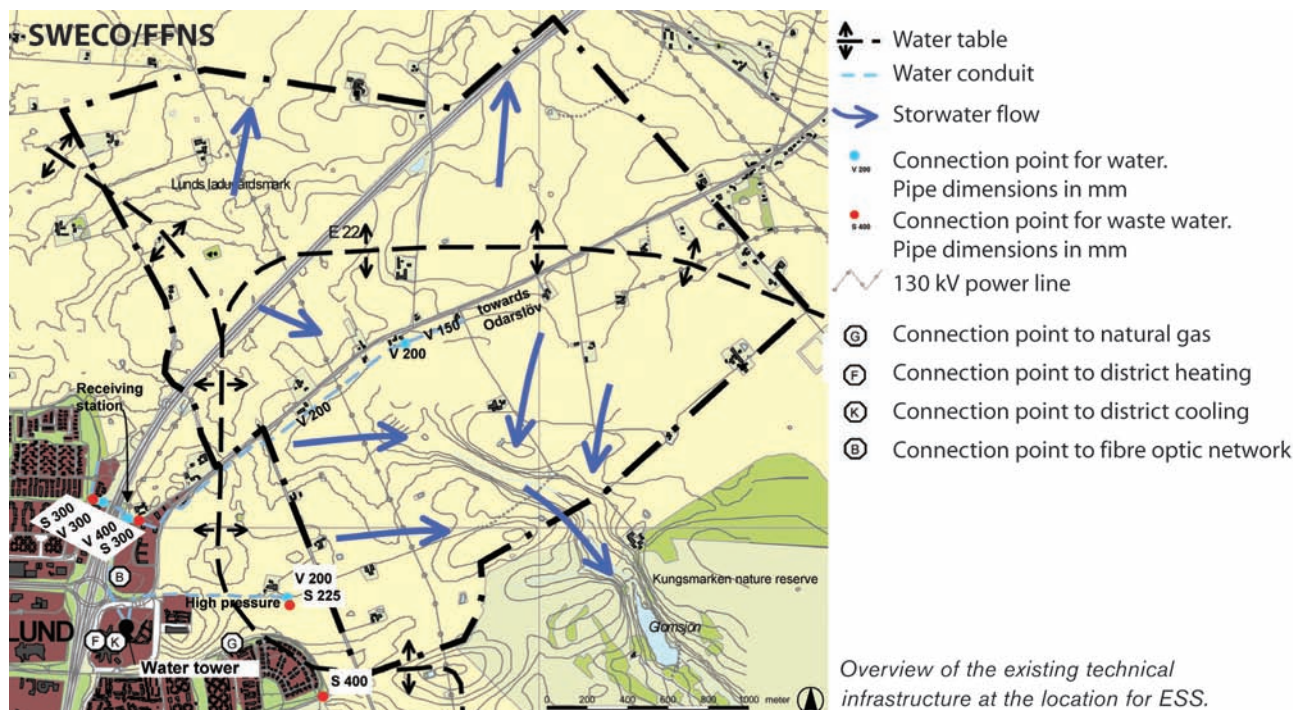


Figure F1.6: The technical infrastructure available at the site.

### Services on site [electricity, water]

There is very good access to technical infrastructure at the proposed site thanks to the proximity of access roads, power lines and the planned research and development area of Brunnsbög where electricity receiving stations, water and sewerage, district heating/cooling and fibre optic network are all available, see [Figure F1.6](#). Infrastructure already exists today with sufficient capacity to supply the ESS with the required services, implying low costs for the technical installations and connections ([Refs F1.1, F1.2](#)).

ESS Scandinavia has concluded MoUs with the energy companies Lunds Energi and Skånska Energi, both of which have concessions on the land surrounding the site. They will help to develop cost effective solutions for supplying ESS with electricity, uninterruptible power supplies and district heating and cooling as well as participating in the proposed Energy Management scheme.

The existing 130 kV power line, feeding the connection point at the Brunnsbög area, already has a spare

capacity of 50 MW, sufficient for ESS and MAX IV. The grid will be able to supply a short circuit power of at least 2,500 MVA and a stability of voltage and frequency as required by ESS. An electrical rectifier (included in the cost estimates in [Table C1.3](#)) is to be installed to protect the grid from the pulsed load of ESS and to stabilise voltage dips induced by lightning and failures.

ESS Scandinavia finds the possibility of using the tried and tested district heating and cooling system very attractive. Lunds Energi operates the system and will expand it to cover the Brunnsbög business area and the site for ESS and MAX IV. The system can receive up to a further 43 MW of hot water, and is perfectly capable of receiving hot water from ESS. Cooling water to the ESS site would be supplied at a temperature of 6°C. This arrangement provides ESS with an ecologically and economically sustainable solution for cooling needs and offers an income stream from sales of waste heat.

Systems for water supply, drainage and sewage are available at the

Brunnsbög business area adjacent to the proposed site ([Refs F1.1, F1.2](#)). The ESS Scandinavia proposal is compliant with the principles for waste water and storm water management ([Ref F1.1](#)). Water for fire fighting, can be supplied by the municipal water system, but for peak loads a reservoir of water with an associated pressurising installation may be needed.

### References

- F1.1 Expression of interest to host the European Spallation Source in Scandinavia, 2002, ESS Scandinavia Consortium.
- F2.2 Report on site selectio at the Brunnsbög area, 2002, SWECO.
- F1.3 Three dimensional geological modelling of ESS, 2008, SWECO.
- F1.4 Geotechnical prestudies (at the ESS site), 2008, SWECO.
- F1.5 Vibrational considerations for the ESS project, 2008, R. Massarsch (Resonator).

## F2 What is the local environment / infrastructure?

### Specific features and measures that make this infrastructure sustainable

Throughout Scandinavia great weight is placed upon environmental responsibility and Lund is no different. It is understood at all levels that ESS built in Lund will not only conform to Swedish standards of sustainability but will in fact set the standards for others. We will illustrate this with two specific examples; transport sustainability in the City of Lund and carbon neutrality of the ESS as a scientific facility.

### The vision for a sustainable transport system in Lund 2030

Lund is an attractive community with forward-looking environmental, economic and social development plans. Sustainable transport is a necessary part of this development, contributing to the quality of human life. Of course it can have negative consequences if it is allowed to grow in an uncontrolled manner. For this reason Lund's transport system is constantly being developed toward greater sustainability as embodied in the recently adopted action plan LundaMaTs. LundaMaTs sets a goal for a fully sustainable transport system to be achieved incrementally in the city by 2030.

The focus of LundaMaTs encompasses all three aspects of sustainability: environmental, economic, and social. Regional cooperation is emphasised.

The vision is supplemented by goals that are especially significant for the quality of life in the centre of Lund:

- Pedestrian traffic per capita will increase.
- Bicycle traffic per capita will have increased by 5% by the year 2013 and by 10% by the year 2030.
- Public transportation travel per capita will see a continuous increase.
- Motor vehicle traffic on the municipal road system will have been reduced by 2% by 2013, and 5% by 2030.
- Physical accessibility for children, the elderly and people with handicaps, will increase.
- The proportion of people who experience the traffic environment as unsafe will be reduced.



### ESS Scandinavia Energy strategy

The operating budget for ESS in Lund is estimated to be 103 M€ p.a. A significant proportion of this (22 M€) is the cost of electricity. Experience with rising energy costs over the previous decade indicates that this is a very volatile element in the operating budget of a large scientific facility, which creates a risk to the scientific output which has to be managed.

ESS Scandinavia therefore, as an integral part of its operations, is studying an Energy Management Strategy for the facility in order to minimise costs, lower the environmental impact, and factor out the variability in energy costs (Refs F2.1, F2.2 and F2.3). ESS Scandinavia has formed a company CARESSS (Caring Research with ESS Scandinavia) with partners in the energy generation industry and local government as well as Lund University. CARESSS is a partner in the Commission programme Sustainable Energy Europe.



There are a number of key elements in the Energy Management Strategy:

- Ownership of generating power by renewable means.
- The control of energy use and the implementation of an energy culture.
- The recycling of excess heat to the Lund District Heating system.

*The hallmarks of CARESSS are Renewable, Responsible and Recyclable.*

### Ownership of Generating Capacity

40 MW is the nominal maximum power load of ESS. Annual consumption is estimated to be 310 GWh. By the use of green architecture and an energy flow inventory we aim to reduce this load to ~35 MW or lower (~270 GWh p.a. or lower). An investment of ~120 M€<sub>2008</sub> will purchase sufficient wind power generating capacity to cover the integrated annual electricity use of





ESS. This will in addition yield an annual income of 5 to 6 M€ p.a. (Refs F2.1, F2.3). We are in discussion with Eon & Dong, owners of Rødsand windmill farm, on appropriate investment opportunities.

## An Energy Culture

An Energy Manager will be a member of the ESS Scandinavia Management team from the outset. Staff consciousness will be high on environmental/energy matters. The goal will be to make ESS in its entirety a carbon sink in as non-invasive a manner as possible. An energy inventory will be created and would be the central tool in this culture. This would include accounting for user and staff transport. Innovative methods in energy control will be implemented – ventilation according to air purity and not supposed occupancy; computer management of all aspects of electricity use from office needs to accelerator & instrument usage; and many other initiatives.

## Recycling of excess energy

The City of Lund benefits from a first-rate district heating and cooling network throughout the city. Much of the 32 to 35 MW “consumption” of ESS will be converted into the waste hot water derived from cooling the linac magnets. Our estimates show that ~21MW in the form of hot water, which will have a value of between 2 and 3 M€ p.a., can be recycled into the district heating system via heat exchangers. Cooling towers that would normally vent this heat into the atmosphere will not need to be built. Hot water produced in the summer will be stored in aquifers that both Lunds Energi & Skånska Energi have developed.

The use of the overall net income (~8 M€ p.a.) can either be used to reduce operating costs or used as an income stream against which capital loans from the NIB and/or EIB can be raised to offset capital needs.

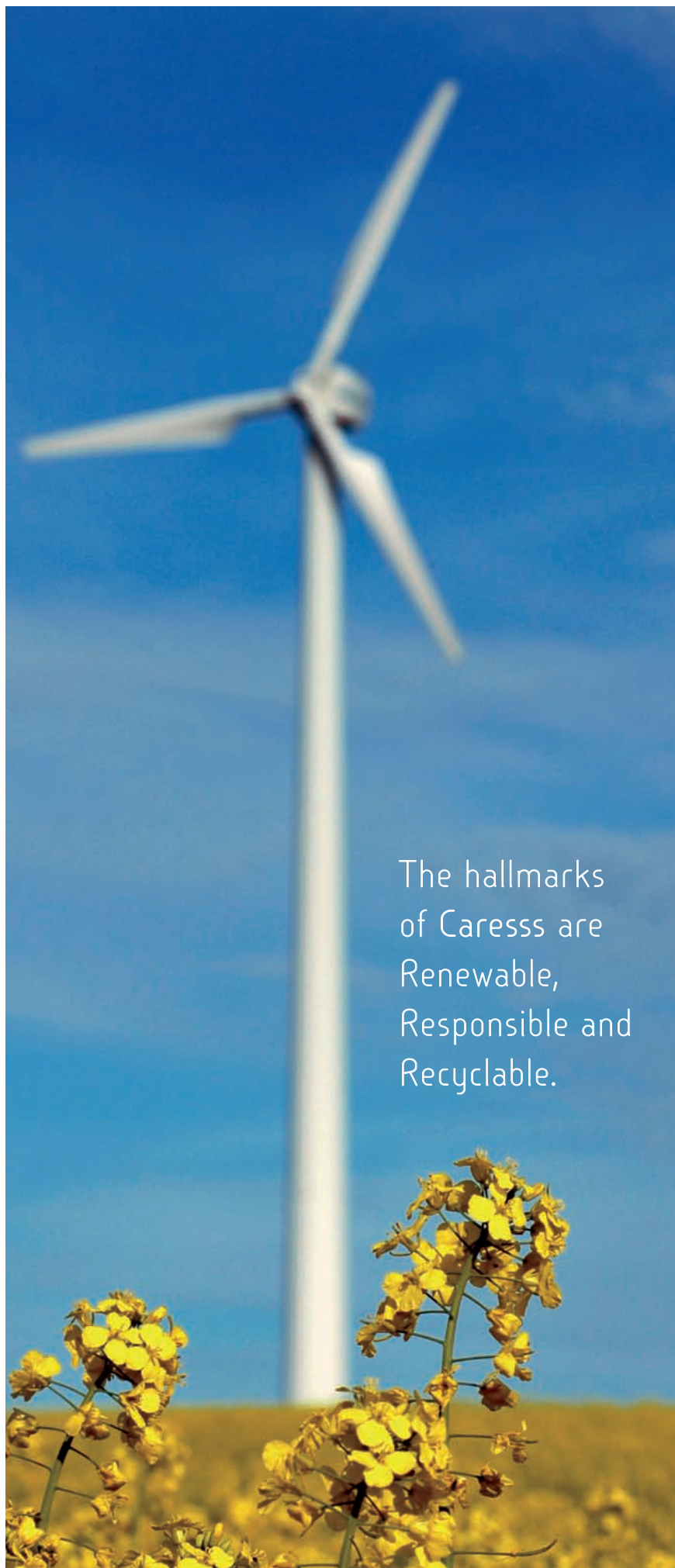


Photo: Mikael Risedal

## Existing and foreseen e-Infrastructure (communication networks, broadband connectivity)

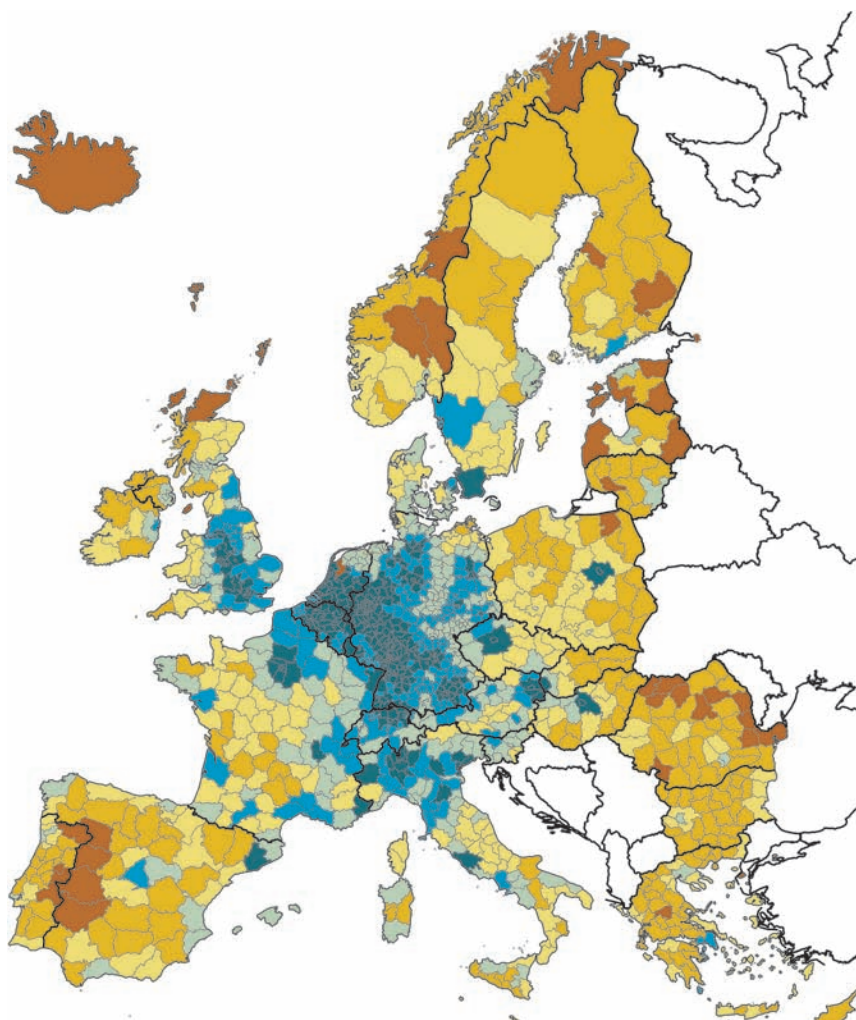
In general terms it can be said that the broadband connection to all types of premises in central Lund is 100%. There are two major suppliers of e-infrastructure in the municipality and a number of operators who provide network services. Kraftringen is the principal supplier of optical fibre in Lund, and operates in two neighbouring municipalities. The company has an open town network, providing the opportunity for several suppliers to offer their services. It is also the main supplier of the municipality intranet, which covers all civic responsibilities, such as schools, nurseries, libraries, youth centres etc. The bandwidth of this network is 100 MBps but 1 GBps is available for larger operations.

The second supplier is TeliaSonera, which formerly had the monopoly in the copper-based telephone network to all companies and households.<sup>30</sup>

In the neighbouring towns and villages, there is broadband connection (optical fibre) to all communities with more than 200 inhabitants.

The largest housing landlord in Lund is the city owned company LKF, covering about 10,000 residences.<sup>31</sup> LKF is at present expanding the optic fibre network to cover all of its properties, offering internet, TV and telephone with a bandwidth of up to 1 GBps.

There are also a number of operators offering wireless Internet connection in the form of hotspots at public places, gathering points and on public transport.



Potential accessibility (EU27 = 100)

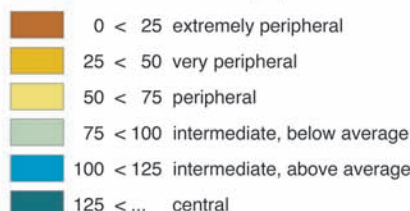


Figure F.2.2: Broadband accessibility in Europe.

Within Skåne a substantial project has been underway since 2003 to establish the optical-fibre network in a total of 270 communities. This is the work of SkåNet, a company jointly owned by the Association of Local Authorities in Skåne and Region Skåne.<sup>32</sup>

ESS will connect to the internet via the Nordic University Network NORDUnet which will provide a capacity of 40 GBps for research organisations.<sup>33</sup>



Figure F.2.1: Number of Broadband subscribers per 100 inhabitants. Source: OECD.<sup>34</sup>

30. [www.teliaSonera.se](http://www.teliaSonera.se)  
31. [www.lkf.lund.se](http://www.lkf.lund.se)

32. [www.skānet.se](http://www.skānet.se)  
33. [www.nordunet.dk](http://www.nordunet.dk)

### Local service providers (catering, cleaning, office servicing, general purpose local industries, etc)

19% of employed persons in Skåne work within the service industry. Several large-scale employers in Lund such as Lund University and the University Hospital, Astra Zeneca, Ericsson, Sony Ericsson and Tetra Pak are dependent, naturally, on a large number of local suppliers and service providers. In addition to these large employers, there are plans to build a large hotel/conference facility in the Brunnshög area adjacent to the MAX IV - ESS site into which will be integrated a Science Visitor Centre.<sup>35</sup>

An integrated public transport system exists in Lund. The use of buses and trains is encouraged, as is the use of taxis, bicycles and pedestrian access. Cars are discouraged but not stigmatised. There is no free parking in Lund city.

Shopping facilities are diverse. Within the city are small family-run shops and "Metro" versions of supermarkets. There is a lively outdoor and covered Market. Larger shopping complexes are located on the city edge. Malmö and Copenhagen offer more extensive and specialised shopping therapy. There are numerous small restaurants and cafés, catering for the lunchtime and student trade and a wide selection of good quality restaurants for evening meals. Catering companies are widespread.

Lund has two theatres and four cinemas. Malmö, 15 minutes from Lund, has an Opera and Copenhagen, 45 minutes from Lund, hosts the Danish National Opera and the Royal Danish ballet. There are numerous art galleries and studies throughout the region. The University student body is a source of much diverse entertainment. Copenhagen offers all the attractions of a capital city.

Lund is a candidate for *European Capital of Culture 2014*<sup>36</sup>

There are many gymnasia in Lund. These are well-frequented thanks partly to the Swedish government's law on reimbursement of annual gym fees by employers. Malmö has a professional football team, which regularly features in the European Champions League, and a renowned ice-hockey team. Within two years both Lund and Malmö will have new sports arenas for football, ice hockey and handball.

There are many golf courses in the region and, just 25 kilometres outside Lund, is the Barsebäck championship course, which regularly hosts the Scandinavian Masters.

Outdoor recreational activities, horse-riding, trekking, sea-bathing, and nature reserves, are a very central feature of life in Skåne.

### Local "Industry / Technology Parks" relevant to neutron scattering

Research around Lund is carried out in original settings including innovative venues where collaborations between basic research and commercial activities are promoted. Universities strive to develop excellent relationships with the commercial world, private foundations and business. Several Science Parks have developed in Skåne: IDEON, Medeon, and the Biomedical Centre. Several well-established corporate groups conduct their strategic research in Lund. Among them are companies, both small and large, dealing with drug delivery (Camurus, AstraZeneca) and medical technology (Gambro) that already make use of neutron methods for their own industrial research, specifically small angle scattering and reflectometry.

The Öresund region is often branded as Medicon Valley - one of the world's

leading biotech clusters with 280 members. This dynamic cross-border region contains a concentration of pharmaceutical companies unmatched in Europe. Thanks to the strong heritage in biological and medical research (and several Nobel Prize winners), a number of research-intensive pharmaceutical companies, such as Novo Nordisk, H. Lundbeck, Astra Zeneca and LEO Pharma, are present in the area and have also contributed significantly to the development of the region by strengthening abilities within applied research, attracting suppliers and producing spin-offs. About 10,000 researchers are working in the public and private sectors in life sciences among a workforce of 40,000 people employed in this field. Such a rich environment will bring mutual benefit thanks to the presence of ESS in Lund - already a member of the Medicon Valley Alliance.

On the industrial front, there exist a large number of facilities capable of developing and providing high technology components to ESS: departments at MAX-lab, Risø National Laboratory, and Lund University of course, but also Danfysik which specialises in instrumentation for scattering and accelerator systems.

**The presence of so many high technology companies within the region means that a large reservoir of very highly qualified people is located close at hand.**

### International schools close to the site for children from kindergarten to high school

Lund has an international high school ISLK within the renowned Katedralskolan. ISLK is a new international school for children of families living in Lund for work or study reasons, and for families returning to the country, after having spent periods abroad. The school is situated at Parkskolan, in the city

34. <http://www.oecd.org/sti/ict/broadband>

35. <http://www.ess.se/documents/symbios.pdf>

36. [www.lund2014.se](http://www.lund2014.se)



centre, and is an integrated section of Katedralskolan, which is Scandinavia's oldest school having a well-known reputation for high quality and a pleasant atmosphere.

Over the last five years the school has offered the International Baccalaureate curriculum for students between 16 and 19. In August 2006, Katedralskolan and ISLK opened its doors for children from age 6 years and upwards.

Lund also has an international school for young children, the International Pre-School of Lund (IPSL). The school is particularly intended for children whose parents are in Sweden on a temporary basis and need an English speaking pre-school with a curriculum that allows for the smooth transition of their children to and from various countries. The school's language is English. Its curriculum complies with both Swedish and international standards for pre-schools as set forth by the IBO (the International Baccalaureate Organisation).

The nurturing of children in Sweden is afforded great importance and child-care laws are very advanced.

### Attractiveness for a highly-educated workforce, opportunities for accompanying partners to find adequate and attractive jobs

The population of Skåne (1.2 million), Malmö (280,800) and Lund (105,300) has been increasing steadily for several years. Lund is considered to be a very desirable place to live.

Skåne and Malmö/Lund are part of the Danish/Swedish Öresund Region. The region has become strongly integrated in recent years with the opening of the 18 km fixed link bridge in 2000. With a travel time today of 35 minutes from

Malmö and 50 minutes from Lund to the centre of Copenhagen, the well-functioning connections between Skåne and Copenhagen, whether by road or rail, have tripled commuting since the building of the Öresund Bridge. The region is today one of the most dynamically forward-looking in Europe.

Travel links by air from Skåne to the outside world are excellent. There are a large number of direct destinations to Europe and beyond, primarily from Copenhagen but also from Malmö airport.

A large proportion of the workforce in the Öresund Region is employed in trade and communication, healthcare, research, education, finance and company services. The work distribution amongst the respective sectors in 2005 is shown in Figure F2.3.

Skåne, in relation to Sweden as a whole, is highly specialised within the area of R&D. This sector developed considerably in Skåne between 1998 and 2004, with a higher employment increase than any other sector in the region. This growth was to a very large extent concentrated in and around Lund. Almost nine out of ten job opportunities in R&D within Skåne are to be found in the southwest, the majority in Lund.

Expert tax status - a reduction of 25% - can be awarded to especially well-qualified people coming in from abroad.

English is the second language of Lund. Indeed the region can be considered to be bilingual. Barriers to employment are not high, particularly so since Sweden has a very liberal and welcoming political attitude to immigration. Job opportunities for partners are many and varied.

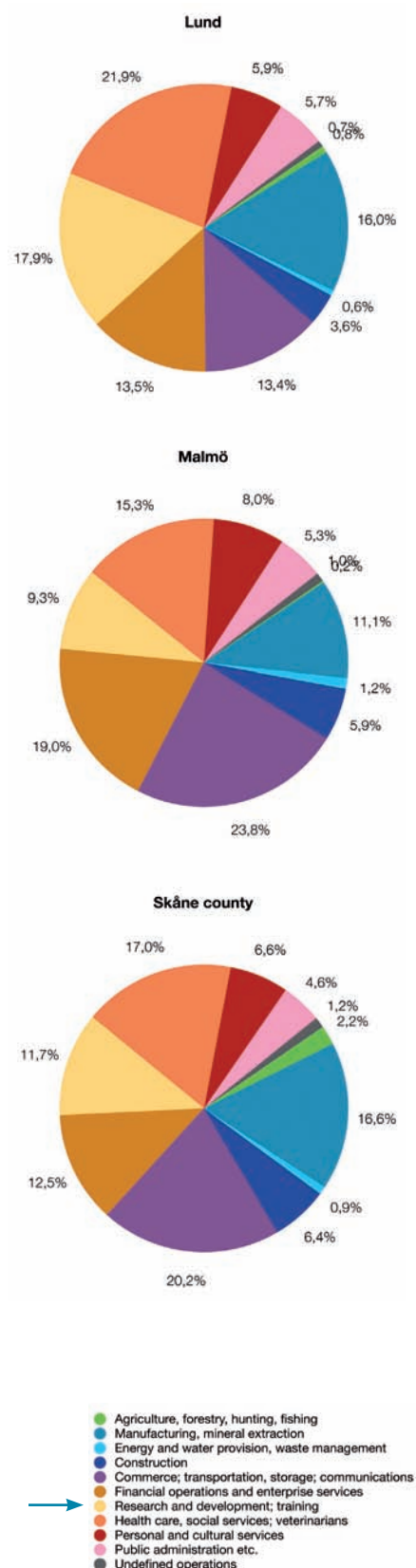


Figure F2.3: Distribution of employment categories in the region.

37. <http://lararforbundet.se/web/ws.nsf/webbIndexsida?ReadForm&index=0497808B2ABF6128C12572C80033F58F&kategoriId=00745736>

38. <http://www.imd.ch/research/publications/wcy/index.cfm?bhcp=1>

39. <http://www.fokus.se/artikelsok/>

Lund	Malmö	Skåne	Öresund region	Sweden	Denmark
56,4	31,9	28,6	29,8	27,8	27,3

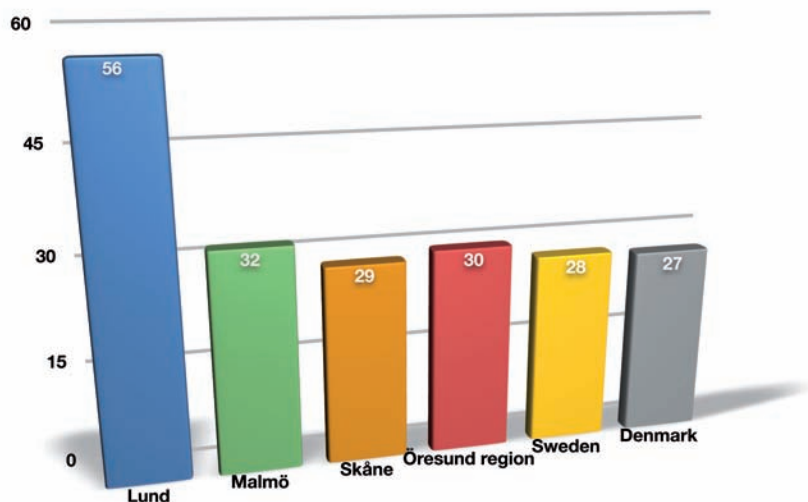


Figure: F2.4: The level of education in the Öresund Region, Skåne, Malmö and Lund.

## Level of education

Sweden allocates significant resources to education. As a proportion of GDP Sweden ranks as number 5 worldwide, just behind Denmark and Finland at around 1.8% of GDP. As a result, the proportion of the Swedish population aged between 25 to 64 who have enjoyed a university education or equivalent is close to 33 per cent.

The Öresund Region is a knowledge centre and, as such, a unique recruitment base for knowledge-intensive enterprises. The level of education in the Öresund Region, Skåne, Malmö and Lund is high see [Figure F2.4](#).

**Considering the region of Skåne, the level of education is naturally highest in Lund, where 56 percent of the population between 25 and 64 have attended university or have an equivalent level of education (2005).**

The number of young people who enrol in university is higher in Lund than anywhere else in the country; today three out of four young people here enter university or the equivalent by the age of 26 (76.3%). Since 2002, the Swedish Teachers' Union annually selects the best school municipalities in

Sweden. The award intends to motivate municipalities to invest in the people who create good schools – students, teachers and principals. *Lund has been among the five best every year.*<sup>37</sup>

*The two best-known universities, Copenhagen, which was founded in 1479, and Lund, which was founded in 1666, have both produced work within the life sciences that have resulted in the award of the Nobel Prize.*

The biggest employers in Lund are *Lund University, Tetra Pak, Sony Ericsson Mobile Communications, Astra Zeneca, Gambro Lundia, Ericsson Mobile Platforms, Alfa Laval Lund and Axis Communications.*

Language knowledge is very high in the Öresund Region. In the IMD World Competitiveness yearbook 2005,<sup>38</sup> Denmark was in third place and Sweden in seventh with regard to knowledge of languages.

Statistics show that English is the second language of 85% of Swedes. In Lund this figure is even higher. Being de facto the scientific language the ubiquity of English is an essential element in the successful operation of a large-scale scientific user facility like ESS.

## Housing situation (availability, standard, cost), recreation / culture

Lund was cited in 2007 as the "Best city to live in" by the Fokus Magazine<sup>39</sup> Lund inhabitants enjoy a high quality of life. The residents of Lund are relatively well to do. The population is rather young, a fact that can be attributed to the great number of students. The people are also generally healthy, having the third lowest number of sick inhabitants in the country.

The quality of the housing stock in Scandinavia is second to none in Europe, particular attention being paid to environmental impact and energy use. Equally well the purchasing of dwellings in Sweden is open, straightforward and efficient. Lund and Malmö both benefit from an efficient district heating system and parts of Malmö are even now carbon-neutral.

The average price of an apartment in Skåne in January 2008 was 975,000 SEK (~100 k€). The price naturally varies depending on the location within Skåne; in Lund the average price was 1,260,000 SEK (~130 k€). The average price for houses during the same period was 2,066,000 SEK (~220 k€) for Skåne and 2,882,000 SEK (~300 k€) for Lund. Lund is a desirable place to live and prices remain very stable even in downturns in the market.

Prices have increased disproportionately in recent years because of the population increase in the area. This is particularly noticeable in the southwestern corner of the region due in part to the Swedish/Danish mixing that has occurred thanks to the Öresund Bridge. Between the present day and 2015 it is planned that more than 30,000 houses and flats will be built in southwest Skåne.

## References

- F2.1 ESS Lund - A Climate Neutral Research Centre, ÅF, 2007.
- F2.2 Prestudy of Energy Use and Climate Neutrality ESSS, Sydtotal 2007.
- F2.3 Summary of current situation regarding energy aspects with ESSS, ÅF, 2007.



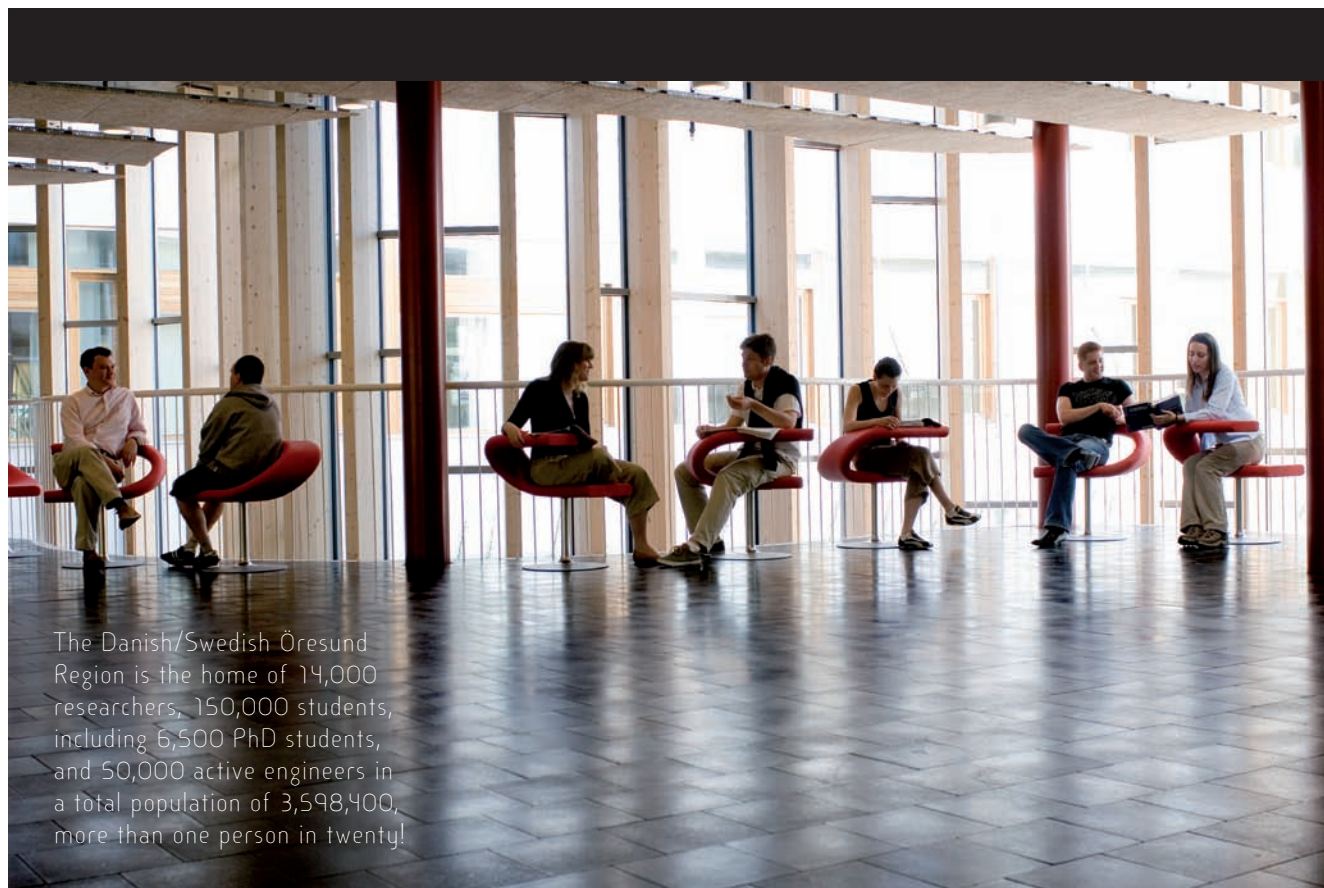


Photo: Kennet Ruona

The Danish/Swedish Öresund Region is the home of 14,000 researchers, 150,000 students, including 6,500 PhD students, and 50,000 active engineers in a total population of 3,598,400, more than one person in twenty!

Students in the Öresund University region.



Central Lund with the Cathedral and University buildings.





The ESS site is within cycling distance from all over Lund.



## The Scientific Life around the Öresund

The scientific environment in Sweden is particularly favourable to the construction of the ESS: Sweden and the Öresund Region are world leading scientific centres. Even relatively compact urban areas like Stockholm - Uppsala or Lund - Copenhagen present themselves as mega-cities when it comes to research output.

The Lund-Copenhagen Region ranks as number 15 worldwide (Ref F3.1) and is the fifth largest in Europe in terms of published scientific articles, after London, Paris, Moscow and Amsterdam (Ref F3.2); the region is ahead of renowned centres such as Berlin, Munich, Oxford, Cambridge, Grenoble, Madrid, Rome and Milan. The Öresund Region presents a growth in scientific output well above the average for research areas worldwide. Sweden is first in Europe with 3.95% of GDP being devoted to R&D, well above the 3% level set for 2010 by the Lisbon agenda. The average rate in the EU is currently 1.8% of GDP.

The region plays an important role as a node within the network of international research cooperation: the Öresund is shown to be a node as important as San Francisco, Montreal and Frankfurt or Cambridge, Los Angeles, Rome and Toronto. For the last 6 years, Sweden has been awarded the highest overall level of innovation performance of all leading countries worldwide in the European Innovation Scoreboard. Sweden performs particularly strongly on knowledge creation and on innovation and entrepreneurship.<sup>40</sup>

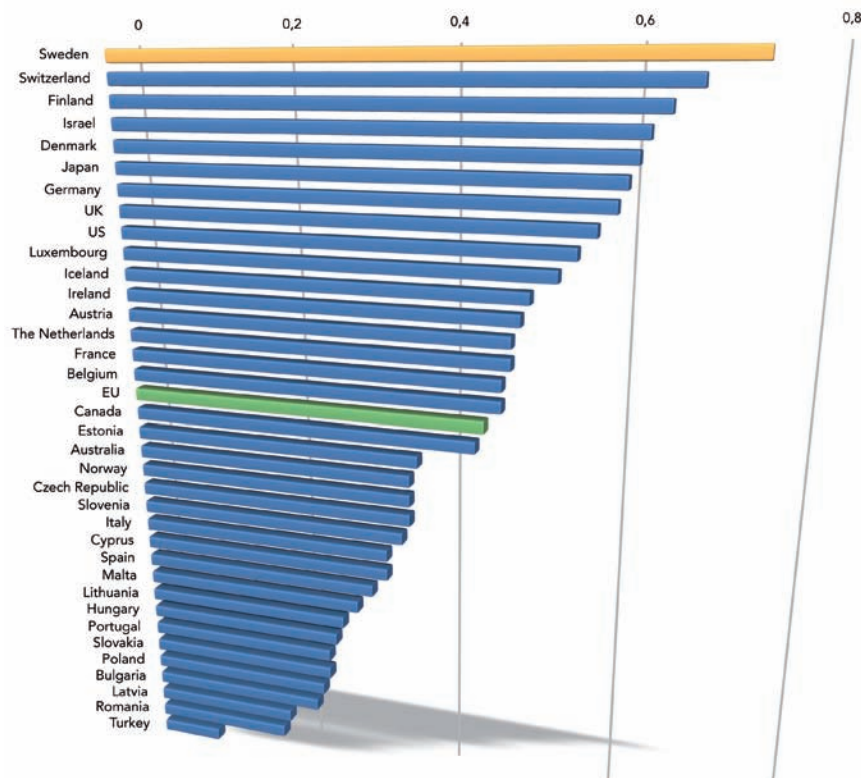


Figure F3.1: The European Innovation Scoreboard for 2007 compiled from 25 separate parameters dealing with innovation.

Early in 2008, the Öresund Region received the prestigious Regio Star award for "Clusters and Business Networks". Öresund is a model for the rest of the European Union for innovative regional projects supporting sustainable development and a knowledge-based regional economy. (Ref F3.5)

The region excels not only in medicine, biochemistry and biotechnology, but also in chemistry and physics. The scientific output (18,780 articles over the 2004-2007 period) covers biosciences and health sciences (53%), physics, natural sciences and chemistry (28%), IT & Telecommunication (7%), and environmental technology (7%).

Considerable synergies exist already between the current scientific infrastructures and the ESS project at all levels: science, instrumentation and accelerator technology. ESS in Scandinavia will benefit from the

existence of local expert research centres and very active Universities, and from the long-standing culture in neutrons science and instrumentation developed in Scandinavia and in the Öresund Region.

### Research centres

The most important research centres in Scandinavia are the synchrotron radiation centre MAX-lab in Lund, the Risø National Laboratory, the Manne Siegbahn Laboratory in Stockholm on accelerator and atomic physics, the Institute for Energy Technology in Kjeller and the Svedberg Laboratory in Uppsala on proton therapy. Moreover, many major European research infrastructures can be reached within a 300 km radius from Lund: x-ray facilities such as Doris, Petra-3, Flash and XFEL in Hamburg, and BESSY in Berlin, the neutron source at HMI Berlin, and large electron microscopes such as the FEI Titan microscope at Chalmers.

40. <http://www.proinno-europe.eu/index.cfm?fuseaction=page.display&topicID=5&parentID=51>



**We focus below on the research centres located inside the Öresund region:**

- **MAX-lab**, which is operated by Lund University, has played a key role in creating a user-oriented culture in the extremely rich scientific environment in Scandinavia: scientists from many Universities in Scandinavia have exploited facilities available at MAX-lab not only to carry out their own research but also to train students. MAX-lab consists of three accelerator rings designed to cover a wide photon energy range with 20 beam lines. MAX-lab welcomes around 600 users per year to carry out experiments in a wide variety of disciplines including surface science, semiconductor physics, materials science, atomic and molecular physics, chemistry, biology, and medicine. The MAX IV project includes two storage rings and plans for an extension into the free-electron laser field for very fast time resolved experiments. MAX IV will produce synchrotron x-ray beams with unprecedented coherence allowing for unique investigations. X-rays and neutrons are complementary tools for the study of matter in terms of relevant spatial dimensions and time scales. Having ESS and MAX IV on the same site, the world leading next generation neutron source and a world-class x-ray facility, will create an extraordinary research complex.
- **The Risø National Laboratory** has been a focal point for neutron research in Europe for 40 years; Risø scientists and university researchers collaborated in neutron scattering experimental programmes in physics, chemistry and soft matter, and also neutron instrumentation. Since 2001, neutron scattering activities in Denmark have been transferred to the spallation neutron source SINQ at the Paul Scherrer Institute in Switzerland.

## Universities

Sweden has 14 Universities, 3 Higher Education Institutes, and 22 University Colleges with a total of 18,640 post-graduate students, including to 2,740 PhD degrees delivered in 2005 (Ref F3.4); Sweden awards more than 3 PhD degrees per 10,000 inhabitants annually.

The Danish/Swedish Öresund Region hosts 12 universities, 7 science parks and 5 research laboratories; the region is the home of 14,000 researchers, 150,000 students, including 6,500 PhD students, and 50,000 active engineers in a total population of 3,598,400, more than one person in twenty! The Region is one of the most dynamic

areas in Europe: the Öresund Region is the sixth largest R&D cluster in Europe in terms of published doctoral thesis (Ref F5.3) after London, Paris, Moscow, Amsterdam and Berlin; Stockholm-Uppsala in seventh.

Nine Universities in Scandinavia were founder members of the ESS Scandinavia Consortium who together proposed Lund as a site for ESS in 2002 (Ref F3.4); today they form the scientific backbone of the Lund proposal. These universities (Lund, Chalmers, Linköping, Royal Institute of Technology in Sweden, Copenhagen and the Technical University of Denmark, Oslo and Trondheim in Norway, and the Öresund University) host over 170,000 students and 13,000 researchers. On average, they award more than 1,700 PhD degrees annually and are leaders in bio-sciences, materials sciences and information technologies.

The expertise that exists in these universities will be of critical importance when ESS is built in Lund:

- The department for Accelerator Physics at Lund University has developed expertise in accelerator techniques through MAX-lab synchrotrons. Teams from Lund University participate in many major accelerator projects around the world (LEP and LHC at CERN, HERA at DESY and RHIC at Brookhaven).
- The University of Copenhagen is a major active user of synchrotron facilities (MAX-lab, ESRF, Hasylab).
- The expertise of the Technical University of Denmark in information technology and modelling will contribute to instrument optimisation and to treatment and analysis of data generated at ESS.
- Lund University operates 27 libraries with a total of six million books and periodicals. The University hosts an electronic library with more than 500 databases, 7,000 e-books and 15,000 journals. This gold mine will be accessible to ESS and its users.

## Scientific environment in neutron scattering and fields that use neutron scattering (biology, materials sciences, engineering, etc)

More than 280 Scandinavian scientists use neutron methods regularly. Such figures amply demonstrate that neutron methods are well known and exploited in Scandinavia and Sweden. The Scandinavian National Neutron Scattering Societies have more than 200 affiliates. As mentioned above, local universities in the Öresund Region have strong programmes in many fields that exploit neutron techniques: soft matter, materials sciences and biomaterials. Regular lectures, schools and workshops are organised by Universities to discuss and promote results of scattering methods including neutrons and synchrotron x-rays (Nordic Workshops on Scattering from Soft Matter, Nordic and European School on Synchrotron Radiation).

The Science Parks such as IDEON which exist already in Lund and which involve research in soft matter, biomaterials and physics, offer a unique scientific background where ESS users will find adequate complementary methods to perform the best neutron experiments at ESS. The operation of the MAX IV synchrotron and ESS on the same site will make the ESS in Lund one of the most vibrant scientific focal points for Europe.

## Experience in neutron science and neutron scattering techniques

The Öresund Region has been a cradle of innovation in neutron scattering: the Risø National Laboratory has been at the origin of many developments in neutron methods and instrumentation. The Risø neutron scattering group has emigrated to the SINQ spallation source at PSI, Switzerland, where it contributes greatly to the instrumentation and scientific programme.



In Sweden, the Nuclear Research Laboratory in Studsvik has developed expertise in instrumentation and nuclear research, now transferred to Uppsala University where a centre for scattering techniques is currently being set up. Also Chalmers University of Technology in Göteborg has a strong user base and has recently also engaged in instrument and methods development at ISIS.

Sweden is a Scientific Member of ILL and has seen its use of the instrument suite there rise to ~2%. It is a CRG partner and is discussing a future role in FaME38. It is also a Member of ESRF. Swedish scientists have collaborated in the development of instruments on the ISIS spallation source. It should be noted that scientists (M. Karlsson, A. Steuwer) at the ESS Scandinavia Secretariat have been and still are involved with instrumentation

development and have scientific collaborations at neutron facilities in Europe (ILL and ISIS). Colin Carlike and Christian Vettier, previous Director and Science Director of ILL respectively, each with a lifetime's experience of neutron scattering science and instrumentation are leading the Lund bid.

In Norway, the Institute for Energy Technology, in Kjeller, is deeply involved with neutron research and materials technology. Within a similar distance, the Geesthacht Neutron Facility near Hamburg, Germany, has also developed expertise in neutron sciences and applications.

Furthermore, numerical simulation methods for neutron instrumentation have been developed at the Technical University of Denmark in Copenhagen in the shape of the

McSTAS suite of programmes originally used for neutron instrumentation but now being applied to the simulation of synchrotron radiation instruments.

The area around Lund has recognised expertise in instrumentation for neutron scattering and in the science that can be done by exploiting neutron methods. European experts who will build ESS will not find themselves isolated in Scandinavia!

#### References

- F3.1 Research Centres of the World 1996-2004: Location and Networks. An analysis based on bibliometric indicators, C. Wichmann Matthiesen, and A. Winkel Schwarz & S. Find, in Murayama, Y. (ed.): Cities in Global Perspective: Diversity and Transition: 131-141.
- F3.2 An Analysis of research Strength and Patterns of Specialisation based on Bibliometric Indicators, C. Wichmann Matthiesen and A. Winkel Schwarz, in Urban Studies Vol 36, No 3, 1999.
- F3.3 See footnote<sup>41</sup>
- F3.4 ESS Scandinavia Consortium



Figure F3.6: The Bio Medical Sciences Centre in Lund.

41. [http://www.proinno-europe.eu/admin/uploaded\\_documents/European\\_Innovation\\_Scoreboard\\_2007.pdf](http://www.proinno-europe.eu/admin/uploaded_documents/European_Innovation_Scoreboard_2007.pdf)

#### F4 What are the specific risks at the site (during construction / operation / decommissioning phases)?

Risks in general are very diverse in character. A facility such as ESS will be sensitive to risks associated with its owners and in particular the host country and, of course, to risks associated with its physical, political, social and economic environment. This question is understood to focus on risks in the host region and in particular for the site and we address in the following the risks which are asked for, and in addition a few others we consider to be pertinent. We consider legal risks, which to some extent have been considered in [Section E](#), to be of relevance.

#### Environmental and security (seismic activity, flooding, droughts, storms, fire, land slides, etc)

##### Seismic activity:

As described in [Section F1](#), the site is seismically quiet. It poses negligible risk.

##### Flooding:

As illustrated in [Figure F1.2](#), the site is situated on a broad crest approximately 80 m above sea level. The area in the vicinity of the site comprises the highest point in a large area. No rivers or significant lakes are in the vicinity and a watershed is crossing the site, see [Figure F1.6](#). The risk of flooding is therefore insignificant.

##### Landslides:

The soil at the site has a certain clay content and can locally have a higher water content, conditions which in combination with others could theoretically facilitate a landslide. However, since the land is characterised by only gentle slopes and the soil is very compact, land slides are according to expert opinion not an issue at all.

##### Storms, droughts and fires:

There are no extreme meteorological conditions in the region. The climate is coastal in character, precipitation is distributed rather evenly over the year, creating excellent conditions for farming; the site is farming land of class 10, the highest class of productivity there is in Sweden. Storms occur, but winds over 30 m/s are very unusual. Droughts and fires are unusual, to the extent that it is unheard of; there are no forests close to the site. Altogether, the risk for significant storms is small, but not insignificant. The risk for droughts and fires is very small.

##### Ancient remains:

The area is relatively rich in ancient remains that sometimes lie hidden underground. Known ancient remains and archaeological sites have been characterised and mapped by the County Administrative Board's register of ancient remains. No remains are known to be present on the ESS site, and since the site has been farmed and cultivated for centuries the chance, or risk, of finding significant remains is small. The County Administrative Board's cultural environment unit decides what kinds of investigations are required within the area. A preliminary investigation of the area will clarify the need for excavations at an early stage.

#### Security and stability of the supply of utilities

##### Electric power:

The electrical power grid which is relevant for the site is stable. Short voltage dips caused by lightning can be handled by the electricity system planned for ESS, see [Section F1](#). For interruptions of longer duration various solutions are being explored by ESS Scandinavia and the local energy companies Lunds Energi and Skånska Energi which have concessions on parts of the site. Should redundancy be considered necessary, ESS could be connected to the national 400 kV grid. A direct connection to the

planned Combined Heat and Power plant of 150 MW at Örtofta, only a few kilometers away, is also an option which is being explored. Altogether, the risk of a significant interruption in the supply of electrical power is small, and there are options to decrease that risk very much further if desired.

##### Cooling and heating:

The potential supplier of district heating cooling to ESS, Lunds Energi AB, has a historical reliability which is higher than 99%.

##### Water, sewage and drainage:

The infrastructure close to the site is well developed and the risk for loss of drainage or sewage is insignificant. Water for firefighting during peak loads can be handled by a reservoir.

The only possible way in which we can foresee that the security and stability of supplies of utilities would be threatened would be through conflicts on the labour market, which are infrequent in Sweden; unions and companies relations are characterised by collaboration. We do not foresee that political conflicts, or economic depressions constitute a significant threat.

#### Emissions (noise, radioactivity, gas, waste water, air pollution, etc)

There are no emissions of gas, waste water or air pollution which could be foreseen to have an effect on the ESS during any of the phases of the project. Conversely, there are no restrictions on emissions which could be foreseen to cause a problem for the construction, operation or decommissioning of ESS. The reason being that under Swedish law a Permit offers strong protection for the holder against additional environmental requirements with respect to matters which have already been examined in granting the Permit; ESS Scandinavia will therefore voluntarily take ESS through a thorough licensing procedure.



Emissions at the proposed site mainly consist of noise and exhaust emissions from vehicular traffic. The candidate area has two major roads:

- **Road E22** (motorway) with a traffic flow of about 17,000 vehicles per annual mean day.
- **Road 946, "Odarslövsvägen"** (13 m state road) with a traffic flow of about 1,300 vehicles per annual mean day.

Aside from noise and vehicle exhaust, there are no emissions of importance in the area. Just east of Brunnsbög, the area is crossed by a 130 kV regional power line owned by E-on. Next to the E22, a branch line goes to the Lunds Energi eastern receiving station. Depending on the positioning of the ESS facility within the candidate area, a minor rerouting of the line may be necessary.

There are currently no restrictions on the proposed site for the ESS due to radiological emissions from licensed or other sources. The known sources within 10 km are radiological activities at the university hospital in Lund, research departments at the University using non-nuclear sources and the synchrotron radiation facility MAX-lab, at its present location in the city, and later at its planned site neighbouring the proposed site for ESS. All of these are licensed activities and already regulated through Swedish legislation.

#### **Hazardous activities (industrial or other) that might create obstacles to the operation of the facility**

There are no hazardous activities in the area that could be foreseen to have a significant impact on the ESS site thereby creating obstacles to the construction, operation or decommissioning of the facility. Future hazardous activities which would have a significance for ESS are not foreseen since ESS as a holder of a Permit would be protected from such intrusions.

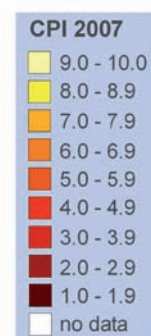
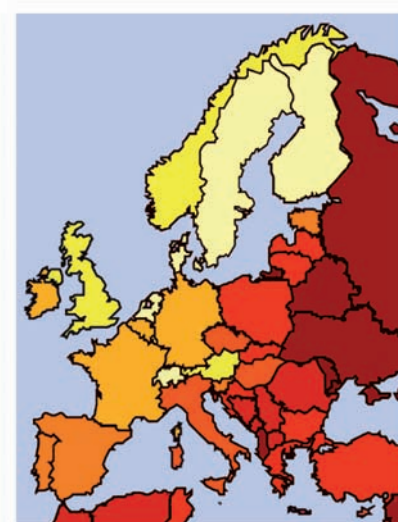
## **Political risks**

Swedish politics is characterised by transparency, cohesion and consensus. For decisions of long-term importance such as defence, energy, climate and tax, cross-parliamentary solutions are sought to provide stability. Also the area of research policy is characterised by consensus. Specifically for ESS, the political support is strong and broad; political parties having more than 90% of the mandates in the parliament support ESS. Also on a regional level and in the City of Lund, the support for ESS is cross-parliamentary and strong. A review of our proposal in 2005 – sent to more than 80 bodies such as universities, research institutes, authorities, research councils and municipalities – gave strong support to it, with only a handful of bodies recommending not to host ESS in Sweden. The risk for a change in policy which would adversely affect the hosting of ESS is considered to be very small.

A change in environmental policy leading to more restrictive laws relevant to ESS does not pose a risk to ESS or any other activity licensed in Sweden.

## **Economic and social risks**

Sweden is, at present, not a member of the European Monetary Union. This introduces an increased risk of fluctuations in cost for other countries. This risk will however be small since the Swedish economy is strongly coupled to the Eurozone economy by extensive trade and since a major share of the suppliers to ESS – during construction and operations – is expected to be in the Eurozone. It is also possible by using financial instruments to reduce this risk, should it be considered to be significant in some cases. The risk of corruption is very low in Sweden and Scandinavia, see [Figure F4.1](#).<sup>42</sup> So is the risk for crime or social and political violence, which would adversely affect the facility, the users or personnel.



**Figure F4.1: The Corruption Perceptions Index show that the degree of corruption is very low (high number) in Scandinavia.**

## **Risks associated with the physical and social environment of ESS**

The site chosen by ESS Scandinavia is in an area which, according to the ESPON study ([Section E4](#)), is characterised as having low aggregated hazards, that is an aggregation of natural hazards such as storms, droughts and floods and technical hazards such as gas, oil or chemical leakage, see [Figure F4.2](#).

## **F5 What is the socio-economic impact?**

### **Existing or foreseen studies on economic and social impact on region**

Several studies ([Refs F5.1, F5.2, F5.3, F5.4, F5.5](#)) have explored the social and economic impact of ESS in Lund. These have examined the socio-economic consequences for the local region, for the host country and for Europe. All studies distinguish the short-term direct effects related to

42. [www.transparency.org](http://www.transparency.org)



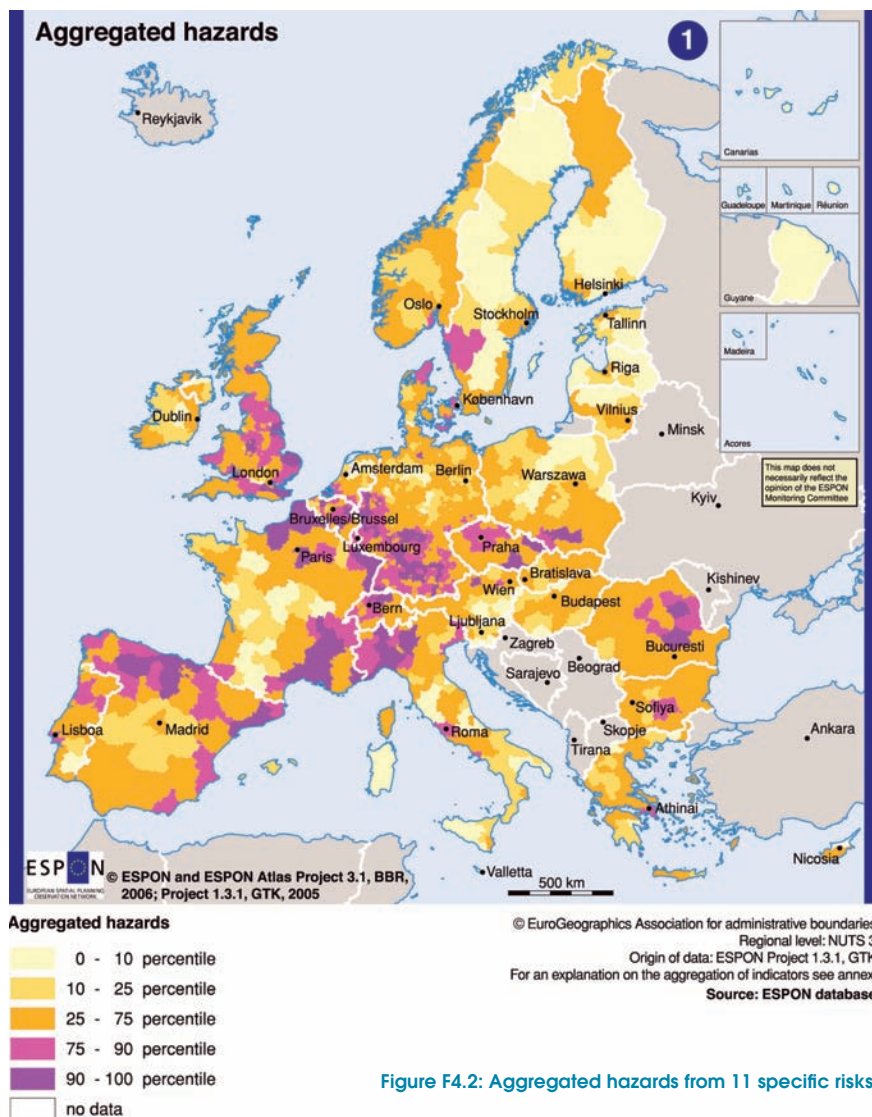


Figure F4.2: Aggregated hazards from 11 specific risks.

economic activity, mainly localised to the host region, from the long-term effects on science-driven economic growth that propagate throughout Europe.

From these studies, one can make the following general observations:

- Technological change is the only long-term driving force for economic growth [Ref F5.5].
- The long-term competitiveness of an organisation is determined by its capacity to innovate rather than by advantages in costs [Ref F5.5]. Isolated firms and organisations are rarely innovative [Ref F5.4].
- Multiplier effects boosting the local economy will be higher in a less-developed host region, but point out that ESS is not a regional development project and, in order to attract skilled personnel and scientific excellence, a well-developed and attractive region is necessary such as one finds in Grenoble [Ref F5.3].

Let us first consider the short-term localised effects. Not surprisingly, all studies confirm the benefits for the local host region, the host country and for the participating countries. Such effects have been observed for the operating costs of ILL and ESRF in Grenoble and are particularly well documented. Almost 45% of purchases are placed in the Isère Département where Grenoble is located, while 78% of purchases are placed in France. Furthermore, a large fraction (>80%) of private expenditure by ILL and ESRF staff is injected into the local economy; social charges and taxes are also paid to the French State. At that level, it is clear that "juste retour" does not work. It is expected that such a situation will prevail for ESS, more or less irrespective of the selected site provided that technical capabilities are already well-developed. The construction phase

of ESS, involving significant in-kind contributions, might lead to different return schemes.

There are also medium- and long-term effects on the host region. ESS will stimulate technical involvement in many fields, such as software development, electronics, precision mechanics, engineering and high vacuum engineering. Local schools and universities will also benefit from short-term placements and trainees at ESS. There will be student visits and joint PhD projects. All of these effects will contribute to the financial and technical spill-over from ESS.

What matters to Europe is the long-term impact. Will Europe benefit in terms of economy, social changes and competitiveness from investing in ESS? In this perspective, the capacity of the host site to absorb technological innovation and to transform it into economic growth, and the ability of the host region to disseminate knowledge around Europe and the level of communication and exchange in the area are the key factors. The socio-economic impact of ESS will strongly depend on the capacity of the host region to transfer knowledge and innovation.

It has been shown (Ref F5.5) that, in the case of an already established efficient knowledge transfer in the host region, the expected increase in GDP for the host country will be given by the annual operating costs of the ESS multiplied by an elasticity factor of 0.17 and divided by the GDP fraction dedicated to R&D in the host country. The elasticity factor increases with the capacity of technology uptake in the host country. In this model the Öresund region would see a GDP increase of roughly 400 M€ per year, whereas the increase in GDP in the rest of Europe would be at least 900 M€. Therefore, the socio-economic impact of ESS on the wider Europe will exceed the local impact and will be

enhanced provided ESS is embedded into an efficient and vibrant centre of scientific excellence and of knowledge communication. The Öresund region and the Lund-Copenhagen urban area clearly possess all the necessary ingredients to deliver such a “return” to the whole of Europe.

Finally it should be noted that a well-developed region with a scientifically rich environment will not be wholly dependent on ESS for its future prosperity and success, which will make the future moral liability to sustain the facility small for the host and participating countries.

### **Work force reservoir, local skills**

As already mentioned, Lund and the Öresund region have a strong and well-established innovation system suitable for the integration of ESS. Networks between academic research bodies and business will ensure an efficient knowledge transfer from ESS. International collaborations and

exchange of personnel in academia and business – facilitated by the good language skills and high accessibility of the region – ensure a transfer of knowledge and innovations from ESS to the wider Europe.

In Lund, the innovation system has a very strong track record, has many actors and is built around Lund University. One of the main actors, the IDEON science park, has hosted over 600 companies since it was established in 1983. More than 80% of the companies have built upon research work done at Lund University. Among the most well-known innovation companies that blossomed at IDEON is Bluetooth, which was later commercialised by Ericsson. As of today, IDEON has 275 companies with more than 2,500 employees and has become a forum for both open dialogue and informal networks between science and business. Meetings with scientists take place on a frequent and regular basis, research projects at Lund University are

enlisted, the screening of innovative ideas is organised, entrepreneurship among researchers is encouraged, entrepreneurship education is provided, and financial support and advice is provided at different stages of SME development.

Building on this experience, incubators for ideas have recently been embedded in academic departments. One example is in the modern 250 M€ BioMedical Centre, where clinical research, basic research and incubators are blended together in the same corridors – a further design criteria for the centre to allow efficient knowledge transfer was that the walking distance from the patient’s bed to the research laboratory should be less than 4 minutes.

ESS Scandinavia proposes to build further on this know-how of innovation systems already present in Lund and to fully integrate ESS in this environment. A reservoir for a highly qualified work force



Turning Torso, Malmö.

Photo: Karl McFaul, ESS



exists in the Lund area with expertise in Information Technology, bio-medical sciences, physics and engineering.

The European Spallation Source will be a European collaboration. It is foreseen that a large fraction of the expert personnel will come from the other participating countries. Thanks to the skills that are present in the region and to the high level of education, these non-Swedish experts will feel at home when moving to the Lund area.

#### References

- F5.1 Science at the Cutting Edge – The Future of the Öresund Region, G. Törnqvist, ed. Copenhagen Business School, (2002)
- F5.2 ESFRI is the same as B2.2
- F5.3 Impact on Large-Scale Research Facilities – A Socio-Economic Analysis, O. Hallonsten, et al. Lund University: Research Policy Institute, School of Economics and Management, August 2004.
- F5.4 Neutrons and Innovations, F. Valentin, Copenhagen Business School (April 2005) and available at: *See footnote*<sup>43</sup>
- F5.5 "Svenskt värdschap för ESS" (Ds 2005:20), A. Larsson (2005)

## Concluding remarks

**W**ithin these 50 pages we have attempted to present what we believe is the compelling case for locating the European Spallation Source in Lund in southern Sweden. This compact university city offers all the attributes necessary to host a world-leading scientific user facility; political commitment at all levels; surrounded by academic excellence; twinned to the highest brilliance synchrotron radiation source MAX IV; connected on all sides to proven innovation incubators; a human-scale, welcoming community, speaking English and embedded in diverse and beautiful countryside; an excellent communications infrastructure; in close proximity to a capital city; but above all located in the socially advanced society of Scandinavia where respect for the environment and for all people is strived for. In short, the Swedish principle of "lagom". The list could go on and Swedes would be too modest to continue. But these concluding remarks are written by an Englishman...

**The ESS in Lund? "The proof of the pudding is in the eating"**  
Don Quixote 1605 Miguel de Cervantes.



An architects vision of the Science City planned in the area between Max IV and ESS in Lund.

43. <http://www.biotechbusiness.dk/documents/WP02-2005.pdf>



# Advisory Bodies

## The ESS Scandinavia Supervisory Group:

- Göran Bexell, Rektor of Lund University, Professor of Ethics, Chairman.
- Lars Börjesson, Secretary General of the Committee for Research Infrastructures at the Swedish Research Council, Professor of Physics at Chalmers University of Technology.
- Henning Christophersen, Chairman of Örestad Development, former Minister for Finance in Denmark, former Vice Chairman of the European Commission.
- Lena Gustafsson, Deputy Director General of VINNOVA, Professor of Microbiology at Chalmers University of Technology.
- Hasse Johansson, Head of Research and Development at Saab-Scania.
- Pia Kinhult, Vice President of Region Skåne's Regional Council and its Board.
- Barbro Åsman, Member of the Swedish Government's Advisory Board on Research 2006-2007, Professor of Particle Physics at Stockholm University.

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- Helmut Schober, ILL, Grenoble.

## The Stakeholders Advisory Group:

- Henning Christophersen, Chairman of Örestad Development, former Minister for Finance in Denmark, former Vice Chairman of the European Commission.

## The Technical Advisory Group:

- Kurt Clausen, Director of SINQ, PSI, Zürich. Chairman.
- Roland Garoby, CERN, Accelerators.
- Werner Wagner, SINQ, PSI, Zürich, Targets.

ANTS	A centre for Advanced Neutron Technologies in Science	
BESSY	The 3rd generation synchrotron radiation facility in Berlin, Germany	<a href="http://www.bessy.de">www.bessy.de</a>
BNC	Budapest Neutron Centre, the Hungarian centre for neutron research	<a href="http://www.bnc.hu">www.bnc.hu</a>
CARESSS	Caring Research with ESS Scandinavia, a company formed by ESS in Scandinavia	
CCDTL	Cell Coupled Drift Tube Linear accelerator	
CCL	Conventional Conducting Linear accelerator	
CEA	French Atomic Energy Commission	<a href="http://www cea.fr">www cea.fr</a>
CERN	European Organisation for Nuclear Research, Geneva, Switzerland	<a href="http://public.web.cern.ch">http://public.web.cern.ch</a>
CRG	Collaborating Research Group who operates and/or partially owns a neutron instrument in exchange of access to beam time	
Day One	Day when first neutrons are produced by ESS	
DESY	Deutsches Elektronen-Synchrotron, Hamburg, Germany	<a href="http://zms.desy.de/about_desy">http://zms.desy.de/about_desy</a>
DG Research	European Union's policy maker for research and technological development	<a href="http://ec.europa.eu/research/index.cfm">http://ec.europa.eu/research/index.cfm</a>
Diamond	The UK Light Source at Rutherford Appleton Laboratory, UK	<a href="http://www.diamond.ac.uk">www.diamond.ac.uk</a>
DMC	Data Management Centre foreseen by ESS in Scandinavia to deal with data	
DORIS	4.5 GeV storage ring at DESY in Hamburg, Germany	<a href="http://doris.desy.de">http://doris.desy.de</a>
DTL	Drift Tube Linear accelerator	
EEC	European Economic Community	
EIA	Environmental Impact Assessment	
EIB	European Investment Bank	<a href="http://www.eib.org">www.eib.org</a>
EIS	European Innovation Scoreboard	<a href="http://www.proinno-europe.eu/doc/EIS2006_final.pdf">www.proinno-europe.eu/doc/EIS2006_final.pdf</a>
EMBLEM	EMBLEM is the enterprise arm of the European Molecular Biology Laboratory	<a href="http://www.embl-em.de">www.embl-em.de</a>
ESFRI	European Strategy Forum on Research Infrastructures	<a href="http://cordis.europa.eu/esfri/">http://cordis.europa.eu/esfri/</a>
ESPO	The European Spatial Planning Observation Network	<a href="http://www.espon.eu">www.espon.eu</a>
ESRF	The European Synchrotron Radiation Facility in Grenoble, France	<a href="http://www.esrf.eu">www.esrf.eu</a>
ESS	European Spallation Source	
ESSSENSE	A company to manage innovation generated by ESS	
EU	European Union	
FaME38	Facility for Materials Engineering at ILL and ESRF	<a href="http://www.ill.fr/others/FaME38">www.ill.fr/others/FaME38</a>
FLASH	Free electron LASER in Hamburg, Germany	<a href="http://flash.desy.de">http://flash.desy.de</a>
FRM-2	Research Reactor Heinz Maier-Leibnitz at Technical University Munich, Germany	<a href="http://www.frm2.tum.de">www.frm2.tum.de</a>
FZ Jülich	Forschungszentrum on interdisciplinary research in Jülich, Germany	<a href="http://www.fz-juelich.de">www.fz-juelich.de</a>
GDP	Gross Domestic Product	
HMI	The Hahn Meitner Institute in Berlin, Germany	<a href="http://www.hmi.de">www.hmi.de</a>
ILL	Institut Laue Langevin, Grenoble, France	<a href="http://www.ill.eu">www.ill.eu</a>
IMD	International Institute for Management Development in Lausanne, Switzerland	<a href="http://www.imd.ch">www.imd.ch</a>
IPR	Intellectual Property Rights	
IRI	Interfaculty Reactor Institute in Delft, The Netherlands	<a href="http://www.tudelft.nl">www.tudelft.nl</a>
ISIS	The short pulse neutron spallation source at Rutherford Appleton Laboratory, UK	<a href="http://www.isis.rl.ac.uk">www.isis.rl.ac.uk</a>
ISLK	International School of Lund - Katedralskolan	<a href="http://www.lund.se/default_28821.aspx">http://www.lund.se/default_28821.aspx</a>
ITER	The international project to design and build an experimental fusion reactor	<a href="http://www.iter.org">www.iter.org</a>
J-PARC	Japan Proton Accelerator Research Complex, Tokai-mura, Ibaraki, Japan	<a href="http://j-parc.jp">http://j-parc.jp</a>
JRR-3	Research Reactor at Tokai, Japan	<a href="http://www.issp.u-tokyo.ac.jp/labs/neutron/jrr3">www.issp.u-tokyo.ac.jp/labs/neutron/jrr3</a>
LEP	Large Electron-Positron Collider at CERN shut down to make room for the LHC	
LHC	Large Hadron Collider being built near Geneva in Switzerland and in France	<a href="http://public.web.cern.ch/public/en/LHC">http://public.web.cern.ch/public/en/LHC</a>
LKF	Housing landlord company which is owned by the City of Lund	<a href="http://www.lkf.lund.se">www.lkf.lund.se</a>
LU	Lund University	<a href="http://www.lu.se">www.lu.se</a>
Lunds Energi AB	Energy supplier company around Lund, Sweden	<a href="http://www.lundsenergi.se">www.lundsenergi.se</a>
MAX IV	High brilliance synchrotron source of soft to hard x-rays to be built in Lund	<a href="http://www.maxlab.lu.se/acc-phys/projects/max4">www.maxlab.lu.se/acc-phys/projects/max4</a>
MAX-lab	National Laboratory for Synchrotron Radiation Research, Lund University	<a href="http://www.maxlab.lu.se">www.maxlab.lu.se</a>
MeSTAS	Simulation of neutron scattering instruments and experiments at Risø and ILL	<a href="http://neutron.risoe.dk">http://neutron.risoe.dk</a>
MEGAPIE	International collaboration for liquid metal spallation target at SINQ, PSI	<a href="http://megapie.web.psi.ch">http://megapie.web.psi.ch</a>
NIB	Nordic Investment Bank	<a href="http://www.nib.int">www.nib.int</a>
NORDUnet	Nordic Internet networks in Denmark, Finland, Iceland, Norway and Sweden	<a href="http://www.nordu.net">www.nordu.net</a>
OCEM	Other Cost Estimating Method: such as Vendor Analysis, Spread Sheet	
OECD	Organisation for Economic Co-operation and Development	<a href="http://www.oecd.org">www.oecd.org</a>
Petra III	New Synchrotron Radiation Source at DESY	<a href="http://petra3.desy.de">http://petra3.desy.de</a>
PRO	Publicly-Funded Research Organisation	
PSD	Power density spectra for average displacements (vibrations)	
PSI	Paul Scherrer Institute, Villigen, Switzerland	<a href="http://www.psi.ch">www.psi.ch</a>
RFQ	Radio Frequency Quadrupole	
RHIC	The Relativistic Heavy Ion Collider at Brookhaven National Laboratory, USA	<a href="http://www.bnl.gov/rhic">www.bnl.gov/rhic</a>
RSFF	Risk Sharing Financing Facilities	<a href="http://www.eib.org">www.eib.org</a>
SANS	Small Angle Neutron Scattering	
SCL	Superconducting Linear accelerator	
SINQ	The Swiss Spallation Neutron Source at PSI	<a href="http://sinq.web.psi.ch">http://sinq.web.psi.ch</a>
Skånet AB	Provider of digital infrastructure in the whole of Skåne	<a href="http://www.skanel.se">www.skanel.se</a>
Skånska Energi	Energy supplier company around Lund, Sweden	<a href="http://www.skanska-energi.se">www.skanska-energi.se</a>
SNS	Spallation Neutron Source, Oak Ridge, Tennessee, USA	<a href="http://neutrons.ornl.gov">http://neutrons.ornl.gov</a>
STEM	The Swedish Energy Agency	<a href="http://www.swedishenergyagency.se">www.swedishenergyagency.se</a>
SWECO	A Swedish provider of consulting services in engineering, environmental technology	<a href="http://www.sweco.se">www.sweco.se</a>
TESLA	TESLA developed the superconducting accelerator technology for XFEL	<a href="http://tesla-new.desy.de">http://tesla-new.desy.de</a>
VINNOVA	Swedish Governmental Agency for Innovation Systems	<a href="http://www.vinnova.se">www.vinnova.se</a>
VR	Swedish Research Council	<a href="http://www.vr.se">www.vr.se</a>
XFEL	The European X-Ray Laser Project	<a href="http://xfel.desy.de">http://xfel.desy.de</a>

