

Trends and Risks of the European Spallation Source (ESS) Project in Lund

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ESS: Research facility or industrial facility?

- The title of this seminar: "European Spallation Source (ESS) in Lund, Sweden, for a future European nuclear waste cemetery?"

HOWEVER

- ESS is a research facility
- It cannot be turned into an industrial facility
- Such plans have never existed
- **The title of the seminar is a misunderstanding and also misleading**

Application of transmutation research

BUT THERE IS STILL A LEGITIMATE CONCERN: Can ESS be applied to transmutation research? And if so, if ESS is built in Lund, could the Øresund region end up as “the nuclear waste transmutation research capital of the world”?

- **WISE-Paris memorandum, November 2002: Double strategy in the ESS project management process concerning transmutation research**
- Transmutation experimentation has clearly been a strategic and logical orientation of the project throughout its development
- Redefinition of the project in 2001 no longer mentions transmutation. However, future adaptation of the redefined project in order to carry out transmutation experiments is both feasible without major technical challenge and economically achievable
- The reasons preventing the ESS Council from maintaining the transmutation option are **not technical, but political and financial**

Application of transmutation research

- **ESS Scandinavia and ESS Council, November 2002: ESS will not be used** for any activities linked to transmutation, partitioning or reprocessing of spent nuclear fuel or any transmutation related experiments
- **This was the first time that representatives of ESS ever publicly rejected the transmutation option**
- However, it is not contested that the **strategic core of transmutation technology**, i.e. the advanced accelerator and adapted spallation target, is present in the latest design of ESS and will **allow future developments to reintegrate transmutation**
- **7 of the 26** neutron scattering facilities around the world have **designs comparable with the ESS** and most of them are equipped with sub-critical reactors allowing transmutation studies

Defining the issues

- So, what are the most urgent issues with respect to ESS in Lund?

THEY ARE MAINLY:

- **Concerns about safety**, relating to the ESS facility's content of radioactive heavy metal
- **Spiralling of costs** to an (even more) unacceptable level, taking into account the project's science case and potential as a regional development factor
- The facility's **enormous electricity consumption**

Concerns about safety

- Seven years after Lund's bid to host ESS, there are still no risk assessments of the facility or elaboration of worst-case scenarios
- The target station(s) consist of heavy metal, which becomes radioactive during use and have to be stored in a nuclear waste repository for 3000 years after the decommissioning of the research centre
- An explosion in the ESS facility could spread radioactive heavy metal not only over the city of Lund, but the whole region

Concerns about safety

- **Impact assessments of worst case scenarios on a local and regional scale - size of population potentially at risk:**
- Larger cities near the proposed location of the ESS facility are: Lund (ESS facility 5 km from city centre, **100.000 inhabitants**), Malmö (ESS facility 25 km from city centre, **262.000 inhabitants**), Copenhagen and the Danish metropolitan region (ESS facility 40 km from city centre, **1.810.000 inhabitants**) and Helsingborg (ESS facility 50 km from city centre, **119.000 inhabitants**)

Concerns about safety

- The report *Safety and Licensing of the European Spallation Source (ESS)*, Forschungszentrum Jülich, June 2004: **Accidents may be initiated by events within the facility itself**, like loss of cooling, proton beam mismatch, leaks within target hull or moderator enclosure, or internal fire may be connected to **external events** like earthquake, airplane crash, meteorite, external fire or gas cloud explosion
- **These accidents could be very serious:** For accidents with pronounced low frequencies (so called “hypothetical” accidents) no dose limits exist in most EU countries. Here, **an emergency plan has to be worked out**, which defines details of emergency measures for protection of the public (sheltering, evacuation, relocation, food ban etc.).

Concerns about safety

SO WHAT KIND OF AND HOW MUCH RADIOACTIVE HEAVY METAL DOES ESS CONTAIN?

- **ESS Scandinavia:** The material will either be **mercury, lead, bismuth or lead/bismuth**
- In reality “heavy metal” probably means “mercury”, which is also used in the recently completed neutron scattering facilities **J-PARC** in Japan and **SNS** in the U.S
- In these facilities, which are both considerably smaller than ESS, the content of mercury in the target stations is **20 tons**

Concerns about safety

There seems to be a deliberate strategy on the part of ESS Scandinavia and the two competing consortia not to reveal the quantum of heavy metal in the facility or what it will consist of

HOWEVER, THERE ARE ALREADY SEVERAL ESTIMATES:

- Rainer Moormann, supported by Sigrid Reiche-Begemann (Ed.), Forschungszentrum Jülich, Institut für Sicherheitsforschung und Reaktortechnik, *Safety and Licensing of the European Spallation Source (ESS)*, Juni 2004 – **30 tons**
- Evert Eriksson, *Overview of Safety Aspects for European Spallation Source (ESS), for a location in Skåne*, STUDSVIK/N-05/070, 2005 – **30 tons**
- Ulla Bergström, Erik Hellsten, *Overview of aspects for safe disposal of mercury from a European Spallation Source, located in Sweden*, STUDSVIK/N-05/073 – **40 tons**
- Mattias Jönsson & Johan Rönmark, *European Spallation Source ur ett riskperspektiv*, Report 5202, Brandteknik, Lunds tekniska högskola, Lunds universitet, Lund 2006 – **30-40 tons**
- Linda Birkedal, Lunds Naturskyddsförening, *ESS – ett riskfyllt forskningsprojekt*, Præsentation Skåne Social Forum, 21. oktober 2007 – **up to 60 tons** in case of two target stations

Concerns about safety

SO, WHAT IS THE WORST-CASE SCENARIO?

- **Explosion or fire in a target station** weakens the containment, while at the same time the mercury is heated. This causes further evaporation which leads to even higher concentrations in the air. These concurrent factors could cause a **dispersal of radioactive and toxic mercury and other material over a vast area**
- ESS is a **nuclear facility**, although not a nuclear power station. If the content of radioactive heavy metal in the target station(s) is set at 30 tons, it is equivalent to **a little under half of the content of radioactive heavy metal in the Barsebaeck 2 reactor**, although the potential release of radioactive substances does not comprise the same elements

Concerns about safety

However, impact scenarios regarding a serious accident in the ESS facility in Lund, including the possible negative health, environmental and economic consequences for the Øresund region, have still not been produced

- Recently, ESS Scandinavia has stated that the final decision on the choice of heavy metal **does not have to be made before 2012**
- Nevertheless, the facility's radioactive heavy metal content is bound to be an issue during the **environmental impact assessment (IEA) procedure**, which could start as early as this year
- **The type and quantum of heavy metal will have to be revealed, as well as worst-case impact scenarios in case of a serious accident at the facility**

Concerns about safety

- If such scenarios are not included in the material for the upcoming EIA-procedure, it will probably constitute an **infringement of the European EIA-directive**
- It will then be **possible for citizens in the Øresund region and green NGOs to take legal action**
- This would **include Danish citizens and NGOs**, because the EIA-procedure, pursuant to the **ESPOO-convention**, would have to involve the Danish authorities and the Danish public

Concerns about safety

A BRIEF INTRODUCTION TO THE EIA CONCEPT:

- **Environmental considerations must be implemented at the earliest stage in decision making**
- **Transparency:** Environmental impact must be known before decision is made, environmental research required
- **Integration:** Environmental impact must take into account short and long time, direct and indirect effect on all environmental media and there interrelationship
- **Public participation** in decision making: **Public hearing**

Concerns about safety

THERE ARE FIVE STEPS IN THE EIA PROCEDURE:

- The project developer must make **sufficient research of the environmental impact of the project**
- Documentation on expected environmental impact must be **submitted in the application for the permit**
- **The competent authorities must ensure the application includes the needed documentation.** Supplementary documentation can be required
- The competent authority must organise a **public hearing** and **ask other relevant authorities and affected EU member states** for comments
- **Based on the comments, the competent authority makes its decision and publishes a reasoned decision**

Spiralling of costs

- ESS possesses all the characteristics of a typical mega-project: Long planning horizons, a multi-actor process with often conflicting interest regarding decision making, policy and planning, a project scope and ambition level that changes over time and unplanned events that are unaccounted for, leaving budget and other contingencies inadequate
- For such projects, misinformation about costs, benefits, and risks is frequently considered to be the norm
- With respect to the cost levels of the ESS project, at least **10 scenarios** have been published since the first report on ESS in 1996
- These mostly refer to a **full ESS implementation**, i.e. two target stations and 44 instruments in operation

Spiralling of costs

The current proposal for ESS in Lund is based on only half the original facility, although it is still being marketed as possessing all the qualities of a fully implemented project

- That is why the Swedish government (**February 2007**) has been able to set the construction costs as low as **1.2 billion euros**
- However, only a year later (**April 2008**), according to ESS Scandinavia itself, these costs have **increased by 50 percent** to more than **1.8 billion euros**, if decommissioning costs are included

Spiralling of costs

This estimate does not include cost overruns, which are common in large infrastructure projects

- **ESS is a nuclear installation and in some respects similar to a nuclear power reactor**
- **Construction costs for nuclear reactors have doubled since 2000 and are up 69 percent from 2005**
- **This increase is mainly caused by rises in costs for labour, materials, equipment and design and engineering**
- **There is an indication, that most if not all these increases apply to the ESS project**

Spiralling of costs

- **Furthermore:** ESS Scandinavia claims to be in full control of the project's economy and has stated its intention of **following the cost management structure of the International Thermonuclear Experimental Reactor (ITER) in France**
- This is far from reassuring, considering that the **projected construction costs of ITER are expected to double**
- **A whole new budget** for the ITER project will have to be adopted in November 2008
- **The U.S. government has withdrawn from the ITER project for the year 2008 and is taking steps to ensure that it will not be held responsible for costs overruns**

Spiralling of costs

WITH RESPECT TO ESS, THE PARALLELS TO ITER ARE OBVIOUS:

- **The Swedish Agency for Public Management, September 2005: ESS is mainly financed by contributions from OECD-countries whose neutron researchers use the facility for their research. However, there are significant uncertainties with respect to the size of the contributions that even binding agreements cannot resolve and the risk that these countries abandon these agreements is very real**

Spiralling of costs

- **The costs of ESS are generally higher than depicted in the scenarios:** In addition to share of construction and operating costs (plus or minus basic financing originating from the host country's GNP-share among the participating OECD-countries), **the host country must donate a site for the facility**
- For the most advanced version of the ESS, site requirements are **1-1.2 km²**. Working Group against ESS in Lund: **2.25 km²**

Spiralling of costs

- **Site donated free of charge** without tax payments, including access roads, infrastructures, electrical power supplies, telephone and computer links, water mains, emergency preparedness, etc.
- **Technical and administrative support** will be given by the host country during the first period of the construction phase
- **Host country covers any cost arising from site conditions deviating from the reference site specifications**
- **ESFRI Working Group on Neutron Facilities: SITE SELECTION A DECISIVE FACTOR CONCERNING COSTS OF CONSTRUCTION, MATERIALS, LABOUR, ETC.**

A Scandinavian platform to host ESS?

- In February 2007, the **Swedish government** announced that it supports locating ESS in Lund and is **willing to cover 30 percent of the project's construction costs**
- Since then, together with ESS Scandinavia it has tried to **build a Pan-Scandinavian platform to cover 45 percent of the costs**
- In April 2008, the Danish government announced that it would **actively support the location of ESS in Lund**, consider the possibility of co-hosting the facility and **possibly invest a large sum in the project**
- However, **the principals of the Danish universities rejected the idea**, arguing that Danish research funds should not be invested in the project, mainly because it would not help Denmark reach the Barcelona target of investing 3 percent of GDP in research and development by 2010
- **The decision of the Danish government has not yet been made, but could be expected at any time**

A Scandinavian platform to host ESS?

THE OBSTACLES TO A SCANDINAVIAN PLATFORM TO HOST ESS ARE MAINLY:

- **The uncontrollable cost levels:** Every investment unit put into the ESS project has to come out of other research budgets, but how many?
- **Problems with the ESS science case:** ESS rejected by the **German Science Council (GSC)** in July 2002
- In a GSC assessment of 9 large scale research infrastructure projects, **ESS is placed in the third and lowest category**
- Continued work on the scientific programmes and technical design of the facilities in this category is required
- **As regards ESS, the GSC would consider it necessary to carry out a new assessment**

A Scandinavian platform to host ESS?

- **Problems with the ESS science case:** Uncertainties with respect to the size of the Scandinavian neutron researcher community
- **ENSA survey, August 1998:** 30 Danish neutron researchers in 1997 – a figure that did not change from 1995 to 1997
- 80 Swedish neutron researchers
- 20 Norwegian researchers
- Finland: No neutron researchers in 1995 and 10 in 1997
- **TOTAL AMOUNT OF SCANDINAVIAN NEUTRON RESEARCHERS 108 IN 1995 AND 140 IN 1997**

A Scandinavian platform to host ESS?

BUT NOT ALL NEUTRON RESEARCHERS ARE EXPECTED TO APPLY THE ESS FACILITY IN THEIR RESEARCH!

- Since 1997, it is unclear whether the Scandinavian neutron researcher community has been growing or is in decline
- The Danish Science Minister in the Danish Parliament, October 2003: Only 20 Danish neutron researchers (physics, chemistry and bio-science) can apply ESS in their research. They are mainly scientists from the Risø National Laboratory and Denmark's Technical University

A Scandinavian platform to host ESS?

AND WHAT ABOUT THE OTHER SCANDINAVIAN NEUTRON RESEARCHER COMMUNITIES?

- The exact number of Swedish neutron users who can apply ESS in their research is not known
- The 2005 ESF/ENSA Survey of the Neutron Scattering Community in Europe: 4.600 neutron users in Europe, 1.650-1.700 participated in the survey
- **SWEDEN:** 22 neutron researchers participated in the survey
- **ESTONIA:** None
- **FINLAND:** 2 neutron researchers participated in the survey
- **LATVIA:** 5 neutron researchers participated in the survey
- **LITHUANIA:** None
- **NORWAY:** 49 neutron researchers participated in the survey

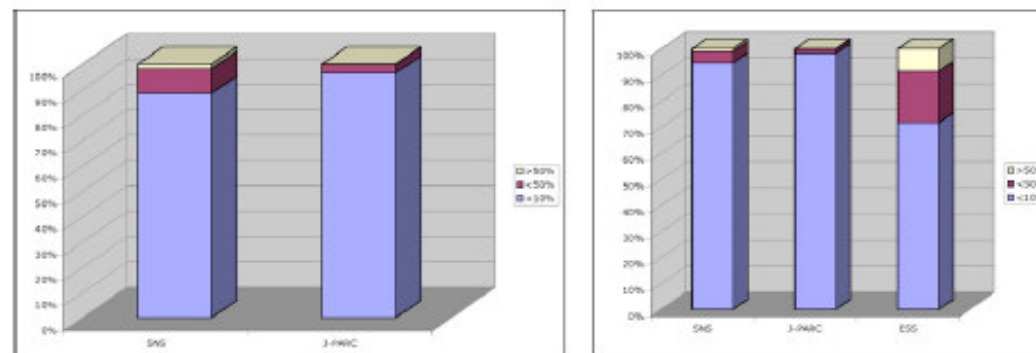
A Scandinavian platform to host ESS?

- ESS is mainly marketed as a regional development project. Hence, the number of visiting researchers is one of the most important factors
- ESS Scandinavia before the Swedish government decision to cover 30 percent of the project's construction costs: ESS facility expected to be visited by 5.000 neutron researchers annually. This roughly corresponds to the entire European neutron scattering community
- The figure also underpins the Swedish government's decision to financially support ESS in Lund
- ESS Scandinavia estimate, December 2007 (less than a year later): “The European community of researchers who use neutrons is currently ~4500. Over a 3-year period they will all use ESS”, i.e. ESS Scandinavia exaggerated the number of annually visiting researchers to ESS in Lund by a factor of 3 to get government support

A Scandinavian platform to host ESS?

- But even this number might be set to high. The following figure was published in April 2005 in a preliminary version of the ESF/ENSA survey, but cut out of the 2007 version of the survey:
- European Neutron Scattering Association (ENSA) survey, April 2005: Less than 30% of the European neutron researchers expect to use ESS (and SNS and J-Parc) in more than 10% of their research and less than 15% in more than 50% of their research, cf. Figure below

6.2 How large do you estimate the percentage of your research work done with neutrons which will be performed at SNS or J-Parc? and 6.3 How would the situation be with ESS realized during the next 12 years?



A Scandinavian platform to host ESS?

- **Questions raised about the economic sustainability of ESS:** In its position paper (September 2005), the **Swedish Agency for Public Management** doubts the ability of ESS to function as a regional development project
- **So, if there are no economic benefits in Sweden, how can there be in Denmark, Norway, Finland, etc.**

The enormous electricity consumption

- Currently, ESS in Lund is being green-washed and presented as a would-be carbon-neutral research facility, whose power supply is to originate from renewable energy sources
- The electricity need of a fully implemented ESS with two neutron sources is **120-150 MW**, which is equivalent to the consumption of a Danish city of 89.000 (120 MW) – i.e. 1.2 times the inhabitants of **Esbjerg** - and 111.000 (150 MW) inhabitants – i.e. a little less than the inhabitants of **Ålborg**
- **The current proposal** only contains one neutron source, which is equivalent to an electricity need of **40 MW**, corresponding to the power capacity of Copenhagen's **Middelgrunden offshore wind farm**, which until 2001 was the largest in the world

The enormous electricity consumption

- The facility's annual electricity consumption of **310 GW/h** is more than seven times the electricity consumption of **Copenhagen University**, an institution with more than **33.000** students and **5.500** employees
- This electricity consumption almost corresponds to the generation of **Sweden's largest offshore wind farm in Lillgrund**, off Sweden's south coast. The **110MW** installation is expected to generate about **330 GW/h** per year, enough to power about **60.000** homes
- If funds can be found for the extra neutron source, **ESS in Lund** would be back to an electricity need of **120-150 MW** again

Recommendations

THE FOLLOWING SHOULD BE CONSIDERED:

1. If Lund is elected as the ESS host site, NGOs and concerned citizens in the Øresund region **should prepare to take legal action**, if ESS Scandinavia does not include worst-case health, environmental, and economic impact scenarios in case of a serious accident at the ESS facility in the documentation presented in the EIA procedure
2. The Swedish government, possible members of a Scandinavian platform to host ESS and stakeholders in the ESS project should be asked to **clarify the moral and legal implications of the safety risks of ESS in Lund**. Such a clarification would imply taking full responsibility for health and environmental damage and economic losses in case of a serious accident at the facility

Recommendations

3. To ask the Swedish government, possible members of a Scandinavian platform to host ESS and stakeholders in the ESS project to **cap the costs of ESS**. Costs overruns beyond a certain level must be deemed unacceptable
4. **The real costs of ESS must be made public**. This would imply putting a price on the 1-1.2 km²-2.25 km² site that is donated free of charge by the host country, together with access roads, infrastructures, electrical power supplies, telephone and computer links, water mains, emergency preparedness, etc. The free technical and administrative support during the first period of the construction phase should be included in this calculation

Recommendations

5. That the necessity, legitimacy and viability of the ESS project is considered in view of its environmental and health hazards, cost levels, science case, potential as a regional development factor and enormous electricity consumption. This would imply an independent in-depth assessment of the justification, long-term orientation, environmental and social benefits and effects of the project, including an analysis of the project's local and regional safety implications as well as its role in the EU policy for sustainable development