



LUND UNIVERSITY

School of Economics and Management

**Master programme in Economic Growth,
Innovation and Spatial Dynamics**

ESS – The regional impact

Fredrik Andrén–Sandberg
**[Fredrik.andren-sandberg.
769@student.lu.se](mailto:Fredrik.andren-sandberg.769@student.lu.se)**

Abstract: This paper examines what the local impact of the research installation ESS might be on the region of Lund and its surroundings. Done by looking at literature concerning agglomeration and clustering, reports on large research installations and interviews with local actors. The impact of the ESS will be much dependent on whether the local actors respond correctly to the opportunities from the installation. Some effects will be due to the trickle down effects, that are relatively easy to measure, other may be in the form of an icon and inspiration for the region and future scientists, which is harder to measure the impact of.

Key words: Science centre, Regional growth, European Spallation Source

EKHR21

Master thesis (15 credits ECTS)

June 2010

Supervisor: Ola Jonsson

Examiner: Lennart Schön

ESS - THE REGIONAL IMPACT



VISION OF THE ESS SITE

Fredrik Andrén-Sandberg

Department of Economic History

Course: First Year Independent Research EKHR21

Supervisor: Ola Jonsson

Examiner: Lennart Schön

ABSTRACT: This paper examines what the local impact of the research installation ESS might be on the region of Lund and its surroundings. Done by looking at literature concerning agglomeration and clustering, reports on large research installations and interviews with local actors. The impact of the ESS will be much dependent on whether the local actors respond correctly to the opportunities from the installation. Some effects will be due to the trickle down effects, that are relatively easy to measure, other may be in the form of an icon and inspiration for the region and future scientists, which is harder to measure the impact of.

Contents

1. INTRODUCTION	1
1.1 What is the The ESS?	1
1.3 Scope	1
1.4 The research question	1
1.5 The aim of the study	1
2. THEORY	2
2.1 Clusters and Agglomeration	2
2.2 Globalisation	5
2.3 Critique	6
3. METHOD	7
3.1 Type of study and previous research	7
3.2 Data collection	7
3.3 Secondary data	7
3.4 Interviews	8
4. TECHNICAL INTRODUCTION TO THE FACILITY	10
5. LITERATURE STUDIES	12
5.1 Report from Region Skåne and PricewaterhouseCoopers	12
5.1.1 Quantitative	12
5.1.2 Growth forecasts	13
5.1.3 Growth in the property market	15

5.1.4 The office market	15
5.1.5 Hotels and meeting facilities	16
5.1.6 Communications	16
5.1.7 Energy and Telecoms	16
5.1.8 Public services	16
5.1.9 International comparison	17
5.1.10 Quantitative estimates of the economic effects from the ESS	17
5.1.11 Qualitative	19
5.1.12 Analysis	19
5.2 Assessing the Economic Impact of Science Centres on Their local Communities	19
5.2.1 Analysis	21
5.3 Big Science: Public investment in large scientific facilities	21
5.3.1 Analysis	23
5.4 University City Science Centre: An Engine of Economic Growth for Greater Philadelphia	23
5.4.1 Analysis	24
5.5 A framework of industrial knowledge spillovers in big-science centres	24
5.5.1 Analysis	26
6. INTERVIEWS	30
6.1 Setup	30
6.2 Scope	30
6.3 Results	30
7. ANALYSIS	36
7.1 Literature	36
7.2 Interviews	37

7.3 Clustering effects	38
7.4 Policy implications	39
8. CONCLUSIONS	40
8.1 Draconian task	40
9. SUMMARY	41
9.1 Short summary of the paper and the findings.	41
APPENDIX A1	42
A1.1 Questions to Invest in Skåne:	42
A1.2 Questions to AstraZeneca:	42
A1.3 Questions to LTH:	42
BIBLIOGRAPHY	43

1. INTRODUCTION

1.1 What is the The ESS?

ESS, the European Spallation Source is a Pan-European research installation that is to be built in Lund, southern Sweden. The construction process will begin around the year 2012, and is expected to be fully operational within a decade. The installation itself can be seen as a giant microscope, but one that uses neutrons instead of light to probe into matter, and will be an essential addition to the resource base of companies that produce everything from aeronautic parts to advanced medicine. The installation is not seen by the involved actors as a pure ground-research facility like much of the other big research installations built in Europe like the LHC at CERN or ITER, but rather as an instrument that will provide industry with a very important tool that no single actor itself can afford and give European industry a comparative advantage over competing companies in the US and East Asia. The cost of the installation is estimated to be around 1.4 Billion €, where the host country Sweden will provide around 30% of this sum. But the economic benefit for the region that hosts it is estimated to be a lot higher than this, since it is hoped to attract high-tech companies to the region and create thousands of well paid jobs and the accompanying tax revenues. For this reason there have been fierce competition between regions around Europe to host the facility, but Lund proved to be the most competitive region that could harvest the most economic benefits from the installation and provide European companies easy access with its well developed infrastructure, as well as well educated English-speaking workforce.

1.2 MAX-lab IV

There is also a smaller research facility being built right next to the ESS, called MAX-lab IV. This facility can also be seen as a huge microscope, but uses short wave-length X-rays to probe into matter, instead of neutrons as in the ESS. This facility is a Swedish initiative, and is one of the reasons that ESS was chosen to be located in Lund with promising synergy effects between the two facilities. MAX-labs estimated cost is 2,6 billion SEK, which is around a fifth of the ESS cost, and is seen as an early proof that one facility can lure more facilities and business opportunities to the region through the process of economic agglomeration and clustering of companies and industry. There is because of this great hope in Lund and the larger region that the clustering process will bring more prosperity to its people, and that the large investment in the facility as well as infrastructure will pay of in the future.

1.3 Scope

What I would like to examine further in this thesis is the plausibility of the belief that the installation will mean so much for the region, and to examine what the future economic impact actually might be.

1.4 The research question

What will the regional impact of the ESS be on the region of Lund and its surroundings

1.5 The aim of the study

There is a report from PricewaterhouseCoopers concerning the regional impact of the ESS, and it contained a lot of estimations concerning numbers. This study could do the same of course, but it might be better trying to get more qualitative data, with opinions and views from local companies in the region, since it can add to the knowledge on the topic in greater terms than just redoing what the other report did. The ESS can be seen as a part of the local innovation system, where the actors interact with each other can be as important as the companies themselves. There are several clusters in the region, including the Medicon Valley Biotech and the Food cluster, how they view the project might be very interesting since it is these local actors that the region depend on will make use of the ESS and to make it profitable for Sweden and the whole of Europe for that matter. They might have information concerning policy requests as well have ideas of how they can make most benefit from the ESS installation. To shed light on these viewpoints could be very useful both

for the ESS secretariat as well as in policy circles, who both wants the ESS to be as successful as possibly can since they have a lot of credibility at stake and want to show the public that the money are well spent. The challenge of the study is that it should provide information about the future. This must be done without reducing the whole thesis to a guessing game, where the speculative part take over. The best way to avoid speculations is to look back into history and see what have happened in the past, to ask people of the present, and than do a thorough analysis on the gathered information. That is what this thesis is set out to do.

2. THEORY

2.1 Clusters and Agglomeration

The economic structure of Lund is special in the case that it can be seen as a business cluster where economic actors agglomerate and become to mutual benefit to each other. A clustering of industries is defined by Ellison and Glaeser as "a non-random spatial concentration of economic activity". The reasons for that Lund have become this is impossible to say, historical facts and circumstances all weigh in of cause. But the fact that the University of Lund, which is the largest University in southern Sweden and its technical collage is located in the city may be one of the main reasons, since it produces such a large output of qualified labour as well as hosting excellent research abilities. Lund have also besides its own endowments benefitted from the well developed infrastructure in the region and its proximity to Copenhagen with its large airport which makes for easy access internationally. All these factors, and many more, have made it economically sensible for many companies to set up operations in the area, and this have in turn made it even more attractive for even more companies since the already located companies supplied economic incentives. This phenomenon called clustering, have been observed all over the globe and attracted much attention from policy makers and scholars.¹

The literature concerning agglomeration and clusters is comprehensive and it can be hard to get a grip on exactly what it is about. One scholar that gives a good overview of the lifecycle and behaviour of clusters is however Dr. Kerstin Press, with her book: "A life cycle for Clusters? The Dynamics of Agglomeration, Change, and Adaptation". In this book she not only describes what a cluster is, but tries to sum up the generalities of clusters and how they seem to behave and change over time. An interesting point about clusters that she brings up is the fact that they do not seem to last forever. There are plentiful examples in history where big and successive clusters, have been turned into a backwater of the economy and the rustbelts of America and some parts of England can even show of visible scars of this, with once mighty and important factories lies in ruins and neighbourhoods that follows.

The ideas of clusters is not new, but the scholar that brought clusters into the field of economics in its modern form was Michael Porter in the year 1990, with his book "The competitive advantage of Nations". He has written numerous articles on the subject and defines a cluster as:

*"A cluster is a critical mass of companies in a particular field in a particular location, whether it is a country, a state or region, or even a city. Clusters take varying forms depending on their depth and sophistication, but most include a group of companies, suppliers of specialised inputs, components, machinery, and services, and firms in related industries. Clusters also often include firms in downstream (e.g., channel, customer) industries, producers of complementary products, specialised infrastructure providers and other institutions that provide specialised training, education, information, research, and technical support, such as universities, think tanks, vocational training providers, and standards-setting agencies. Finally, many clusters include trade associations and other collective bodies covering cluster members."*²

¹ Kerstin Press, 2006

² Michael Porter 1998, The Adam Smith address: Location, clusters, and the "new" microeconomics of competition, p 4
Department of Economic History Fredrik Andrén-Sandberg

He shows in his work numerous examples in the real world where clustering are taking place, such as the fashion industry in northern Italy, and the wine industry in California. The reason for that clustering occurs is that it is simply beneficial for the firms contained within it, without the companies having to interact directly with each other. In the case of the California wine cluster, it contains over 680 commercial wineries, as well as thousands of wine-grape growers. There are many supporting industries in the area, such as grape stock suppliers, farm equipment suppliers, labelling services, advertising firms among many. This makes it easier to conduct business, and increase the productivity of the growers as well as the business base for the suppliers. There are also links to the Educational programs in the area, special committees in the California senate that also helps the industry to become more competitive than if it had been spread out over the whole country. The boundaries of clusters are defined as where the linkages and complementarities for the industries ends. It is not always the case that this has to be in a certain country, but can be spread across borders as in the case of the southern German chemical cluster that straddles into Switzerland.

The reason that clusters gets competitive is that the increased competition within the cluster makes the companies stronger when they face other firms in overseas markets. This also raises the pace of innovation, which is crucial to productivity growth. The pooled talent is another factor, which makes for easier access when hiring staff, and where skilled labour can move to another company if an actor faces problems. Clusters also seems to stimulate the growth of new businesses, which reenforces the cluster and makes it even more attractive for startups and investments from outside.

Because of this increased competitiveness, clusters are spread all over the globe and will continue even as globalisation should reduce the need for it when everything can be sourced globally. It seems as if there still is a need for people to interact within a certain geographical sphere, and from the viewpoint of Porter clusters will just become even more important for competitiveness in the future.³

Another authority on the subject is Örjan Sölvell, who have written numerous articles in the subject. He currently resides at Stockholm School of Economics. In one report clusters are defined in a similar way as Dr Kerstin Press:

*"Cluster consists of geographically assembled related and supportive companies and branches, but also incorporates connections to science and educational institutions, financial actors, branches of government and different kind of cooperative organisations"*⁴

The work done by Sölvell and colleges focuses on the subject from a Swedish perspective, which might make it useful to use as a framework in this paper. In a report called "Clusters and the new growth-policies", he describes how clusters come to be, and how agglomeration take place. At first they point out that not all economic activity in a country abides by clustering phenomena. Public services, natural resources extraction and local sector does not show much signs of clustering at all, and this for obvious reasons, the sectors that cluster are the ones that are often subjected to both national and international competition, and for the most part consists of private enterprises.

In a market economy, the decision on where companies locates are often dependent on where the entrepreneur just happens to live, or moves to. Where the idea itself is spawned and the talent is born are of course random in scope, but there still need to be institutions or resources that can cater to the talents need, and a creative environment can often be what creates the entrepreneur itself. There are also numerous geographical endowments that have an impact as well, especially in mineral extraction or as in the fertile soil in southern Sweden that gave rise to an efficient agricultural industry. These first signs of industry can later on attract or spawn more industry and services that cater to the need of the original growth node. In the more dense and deep clusters it is also visible that proximity to political centres, and a favourable infrastructure have played a vital role in the deepening of the agglomeration process. Today there are much talk about the favourable proximity to educational centres such as universities and colleges, or "Brain resources" as the most vital part for a clustering process to pick up speed.

³ Michael Porter, 1998

⁴ Örjan Sölvell, Clusters and the new growth-policies, 2004, p 11
Department of Economic History

All said, it is always easy to tell a good story after it happened, and point out what factors that played a role in the success of a certain cluster, it is not so easy however at beforehand point out what will be needed in the future. A good example of this is the Swedish popular music industry, which have been a successful export product. In the aftermath it is easy to see that a comprehensive musical education in the schools may have played a vital role, as well as a demanding home market and an open culture for influences from abroad. But at the point before the success had taken place, it was not intended from the government side to create a music industry by commending more musical education in school. This had more to do with a philosophical view that children needed music in their lives, and that it would make them happy, and not as way to promote growth in a sector of any sort. This shows that it is very hard to know beforehand what investments will spur growth in the future.

In Figure 1, European clusters and their location quotient are shown. A location quotient of one, means that the spread of a certain industry is the same as the nationwide average, a higher quotient indicate that some clustering of industry are happening. Sweden is highlighted but the shading applies to the other countries as well, with darker areas indicating that more clustering effects are taking place.

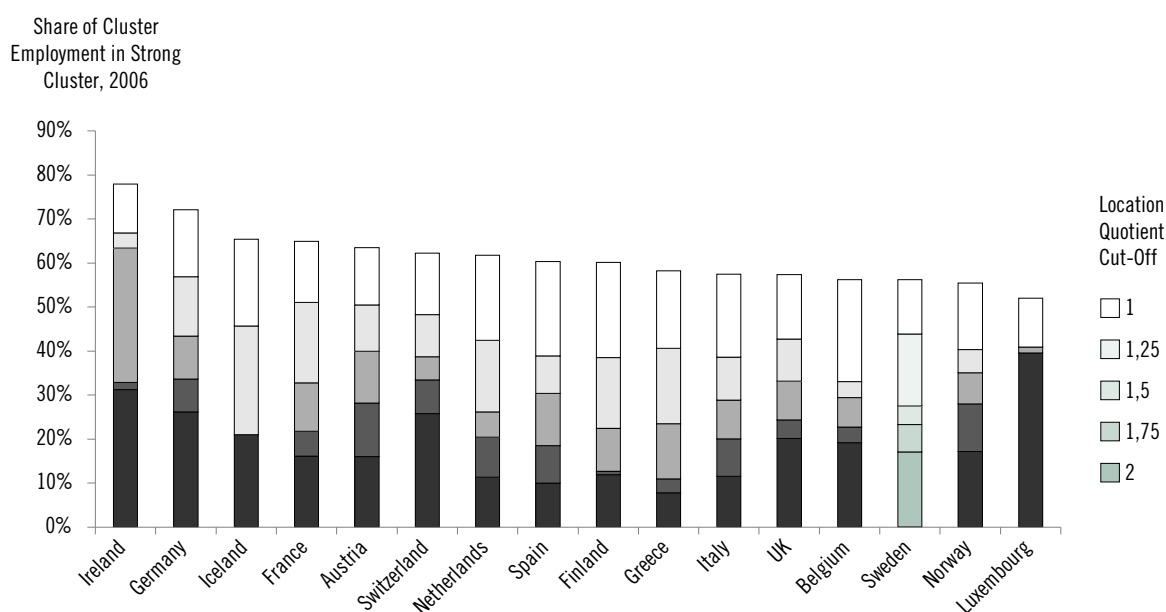


Figure 1, Strength of the National Cluster Portfolios. Source: Clusters, Cluster Policy and Swedish competitiveness in the global economy, Stockholm School of Economics.

Many cluster starts with a small number of companies that just happen to be in the same place at the same time, without much interdependence. An example of this is Hewlett Packard, and Intel that just happened to be in the area that is now called Silicon valley. The first prerequisite for creating a cluster is that this early businesses survive, and gather legitimacy and acceptance in their larger community. This first phase are characterised with a small number of entrepreneurs that become successful in their field, and spurring others to follow (The "Hero Phase" as it is called by Sölvell). Later on in stage two, a consolidation takes place and many smaller actors are bought up by the larger and more successful enterprises. This makes a case for economies of scale, and the bigger companies therefor starts to dominate the landscape, with vertical integration making them larger and ever more profitable. Specialised science and education is also growing to meet the higher demand for advanced human capital. The growth in this phase comes from both diversification and internationalisation.

In the third phase new companies come into the region and starts to compete with the existing industries for both their markets and their qualified workforce. The increased competition forces the existing companies to focus on their core business and these companies are now living next to smaller specialised actors. This phase is also characterised by many

smaller startup firms, mostly because of the qualified labour from the bigger companies are defecting and starting up enterprises of their own. Venture capital also have an increasing role in creation of new businesses.

The explained phases are not always the way that things proceed however, outside influences such as bad business climate can disturb the different stages, and if some factors are missing in a phase such as lack of venture capital or lacking infrastructure, it can derail the whole process.

2.2 Globalisation

The world is becoming ever more globalised, so is there really room for regional clusters and innovation systems? The answer is - yes according to Sölvell. It is true that capital and goods is moving at an ever greater pace, and the international competition forces companies to diversity their businesses and to put their operations wherever the comparative advantages may be. This is true for the financial and physical capital, but the human capital relative immobile in comparison, and the social capital can in the context be considered as stuck. Clusters and local innovation system may therefore not be an antagonist to globalisation, but rather a necessary local anchoring of it. If the local cluster is interwoven into the international fabric, it can act as meeting places and nodes of a more integrated world where people live, work and exchange ideas. Sölvell believes that the importance of clusters and agglomeration will only increase in the next century, and the need for region and countries to harbour there will be crucial for success in an international market.⁵

Silicon valley is one of the largest IT clusters in the world, and are highly competitive globally. Figure 2 shows a map of silicon valley with the large IT companies that are located in the region are pointed out. It clearly shows clustering, with a heavy concentration of these businesses in the area.



Figure 2, Silicon Valley; one of the most distinctive economic clusters in the world. Source: www.stanford.edu/

⁵ Örjan Sölvell, 2004

2.3 Critique

After the publication of Porters article in 1990, there has been an intense activity and research in the area with authors such as the above. There have also been however critical voices heard from other camps within the economic community, Ron Martin and Peter Sunley are two of those.

Their main critique is about the definition of a cluster that they believe is quite vague. There is no clarity of the geographical scale that clusters should be applied in. This ambiguity has led to many uses and interpretations of the term cluster, and different actors have used it for their own purpose. The result is as Ron Martin and Sunley says is conceptual end empirical confusion. There is neither a clarity of what exactly a cluster is. It is some kind of linkages by interconnected companies and associated institutions, both horizontal and vertically. There is also the social relationships and networks that are supposed to be of beneficial nature to all the firms involved. The problem with this is that it is not very easy to define a cluster, and exactly what it is. As the write in their article:

*"At what level of industrial aggregations should a cluster be defined, and what range of related industries and activities should be included? How strong do the linkages between firms have to be? How economically specialised does a local concentration of firms have to be to constitute a local cluster?"*⁶

This ambiguity have led some to refer to clusters as national groups of industries and firms, while others have claimed the term for highly specialised media firms in lower Manhattan. There are also criticism concerning how clusters have become a fashion label in policy circles, and against the cluster theory itself and how clusters are formed. They do not however seem to dispute that there seem to be certain locations of the globe where there is a higher spatial concentration of certain industries. But rather that the definition is much too vague, leading to its fashionable uses in much more contexts than can possibly be useful.⁷

⁶ Ron Martin And Peter Sunley, 2003, Deconstructing clusters: Chaotic concept or policy panacea?, p 10

⁷ Ron Martin And Peter Sunley, 2003
Department of Economic History

3. METHOD

3.1 Type of study and previous research

This thesis is foremost a literature study, where I looked into the literature concerning big research installations and their economic impact from various sources, as well as local studies of Lund and its surroundings. There have not been any academic research on the exact topic concerning ESS and Lund, but Region Skane (the county authority) have together with PricewaterhouseCoopers put forward a report on the matter. This report was however produced before the decision to place the ESS in Lund was taken, and might be a bit biased to make it look better in front of sceptics and competition with other possible locations. There have also been numerous reports and investigations from governments and private actors in Europe as well as other areas of the world. As a theoretical framework I looked into the literature concerning agglomerations and cluster building. Beside the literature study that will lay the groundwork for the paper, there were information gathered from interviews of local actors, since it provided essential information on the local conditions and the views from companies in the region.

3.2 Data collection

I foremost tried to get official documents if they were available. If they were not, I tried to get in touch with regional actors that could have relevant information and try to interview them. The interviewed persons answered a few selected questions, and afterwards spoke rather freely regarding ESS and his/her organisation under a microphone so it could later be analysed as well as cited directly. The need for this was regarding actors like the local medical giant Astrazeneca, who will surely benefit from the location of ESS in the region but may not have an official document regarding their strategies concerning it this that they wish to share. But instead had well informed people within the firms who it was interesting to get a viewpoint from. Astrazeneca was for instance a keynote speaker on an ESS industry day, and did not seem to have any problems with sharing their plans and their needs from the future ESS plant. Recent developments at Astrazeneca where they planned to shut down their operations in Lund might have altered some of their plans, and could make them less interesting in this perspective. But perhaps not since it might be interesting to hear weather the plan to shut down their Lund operations were influenced by the ESS at all, and if they still planned to use it in the future but from a smaller local operation or from another site.

Another great recourse that were to the disposal of the paper is the ESS secretariat itself. They were contacted, and set up a meeting about the thesis. They were positive about the study and wanted to contribute as much as they could to the completion of it. They ensured that they would put forward as much data and information that were requested and at their disposal, and that there could also be room for interviews on areas where there was not clear documentation or data available on the subject.

The ESS secretariat have put much effort into informing the public as well as involving industrial partners in the project, and have therefore set up a conference called the ESS industry day. This event that took place in Copenhagen in february 2010, was a meeting point for many European and local businesses and a rich information ground where it was possible to get a better idea of which kind of companies and actors that where interested in the project. This as well as an opportunity to get in contact with key persons and hear debates and other speeches were an essential opportunity to get relevant information. More than 400 delegates attended the conference, and it also provided a list of al the delegates for further contacts.

3.3 Secondary data

Since I looked into the local effects of the installation, I had to focus on what the town of Lund have planned for the surrounding areas of the facility. The city of Lund have planned a new area of the town called Lund NE (NorthEast), or Brunshög, where both the ESS and MAX-lab IV will be situated. The area that now consist mostly of farmland will be a part of the so called "information corridor" in the town, where the University and the science park IDEON will be adjacent and connected to the new facilities with convenient public transport. This as well as the numerous high tech companies in the corridor such as Ericsson, Sony Ericsson, Astrazeneca, Gambro among others, will in this new part of the

city be integrated with housing, restaurants and shops to make for a living part of the city. One that not only caters for the companies themselves but that are also designed for people to meet and exchange ideas, and thus hopefully create new opportunities and dynamics in the local economy. There have already been design plans for this part of the town, with infrastructure projects such as the light-rail, housing and a conference centre with an adjacent hotel. For the thesis to be locally anchored I needed to analyse these plans in greater detail to get a glimpse of the projected spinoff effects from the facilities, and reviewed the official documents, news paper articles and did interviews with the involved authorities in cases where the written available information is scarce.

The main part of the investigation was to review already available data, both secondary and tertiary. It was crucial for the report to only include information from credible sources, and to analyse it correctly. Quantitative data might not be so hard to analyse since it is hopefully presented in a straightforward manner, but qualitative data might be a bit trickier. Saunders et al have a method for analysing and presenting qualitative data, they propose that one should shred down the qualitative data into more definable bits, either by categories or quantifiable data, and try to present them in a diagram or spreadsheet to get a better understanding of the data at hand. This method might be very useful, since I will look into a multitude of sources and it could be hard otherwise to get an good overview of the data. Much of the presentation were however to review and compile the literature and reports individually without comparison to other reports or papers. Therefore most of the compilation is in a text format, that contains as much graphical summaries as possible. In the end of each individual literature study, there is a short summary of the information, also containing an own analysis with thoughts and critique of the reading.

When all the literature have been gone through there need to be an analysis and comparison between them. This will be done in the discussion section with the interviews combined. It will contain my own analysis and a summary of the findings as well as a short discussion of the texts.

Since there was a lot of information available on the subject, some literature had to be dispelled from the study and only the most relevant were analysed. In some cases there were interesting and good literature on the subject, but I choose to interview the author of the literature instead. This to get a condensed view on the questions that were relevant to the thesis, as well as up to date information from the person in hand. There was for instance some information about the school system, and daycare centres, that might be built as well to cater for the influx of researchers. Such as international schools and english speaking daycare centres. The tax authorities could also have been interesting to contact since they plan to increase their workforce just to cater for the ESS build, which might give a good idea as well as an example of how the local economy will be affected. Neither were however included in the study, due to the priority of other data in respect to the size limit of the study.

3.4 Interviews

The interviews were conducted on certain regional actors. They were set up in a roughly similar manner, where the interviewed person first answered a few questions under the microphone, and was than able to talk rather freely about the ESS and how it concerns their company/interest group. This recordings were later analysed and compiled as well as cited in the paper.

The problem with this approach is that there is a continuous interactions with the research subject, and the interviewer must be careful not to lead the subject towards certain answers that would bring doubt of the validity of the study. Therefore the questions and topics need to be set out beforehand and with as much monologue from the part of the interviewed person as possible. There might however be room for further questions that arises from the answers in the interview, this can move the interview towards a more unstructured form that might be useful as well. In the later analysis stage it is important that the two forms of interviews are separated even if they in reality were intertwined. The rest of the qualitative information can however be very useful, and be summarised as well as quoted for the different interest groups to support the analysis and conclusions.

It is important to realise that many of the interviewed persons may have a certain bias towards the issue, and may even have a position in their organisation where it's their job to bend the issue look in a certain way. In the analysis part it is therefore important to be aware of what these biases might be, and treat the information critically in that light.

The ethics concerning interviews are also important, that the interviewed persons integrity is respected, and that he or she are aware of what they are interviewed for and that they are recorded. To ensure this there was an email sent beforehand that explains the purpose of the study and their part of it, as well as the topics that are to be discussed. Hopefully this insured that the interviewed person were well informed and felt comfortable to answer the questions.

4. TECHNICAL INTRODUCTION TO THE FACILITY

4.1 Neutron Spallation source

The ESS facility is a so called spallation source, which will be described in this section. A problems that scientists and R&D departments face when they want to look up-close at a product that they produce is that some structures that are created today, are just too small to see with the naked eye. They can of course put their product into the microscope, but microscopes uses light as their probe and can not detect differences in the material that is smaller than the wavelength of the light. In visible light this limits the resolution to around 450 nm (nanometers), or about a millionth of a meter. Sounds small, but an atom has a size of about 0.1 nm and can thus not be seen. Neither can molecules or atomic patterns and structures in materials, which is very important to be aware of in everything from cutting edge materials, electronics, fuel-cell technologies, solar-panels or medicine to make them work better and develop new innovative products. To understand why you need smaller wavelength or probes to see smaller patterns, one can imagine bouncing basketballs at a car and see how they bounce back. You would in this case see that the basketballs bounces back somewhat different when you throw them at the windshield or the roof, but when you throw them at the rims of the tire, you would not be able to tell the difference in the "bounce back pattern" between a rim that is full of holes and one that is completely solid. To detect this difference you need something smaller to bounce back, perhaps marbles to be able to detect at these smaller structures, since they could penetrate these holes and bounce off the edges of them. The exact same principle applies to microscopy, and the rule of thumb is that you need something that is half the size of the structure that you want to measure to be able to detect it.

To see structures that are smaller than the wavelength of visible light, other kinds of microscopes have been developed with other probing materials to handle this, such as the electron microscope that uses electrons to shoot at their target and see how they bounce back. And since electrons have a smaller wavelength than light (smaller marbles) they can detect smaller patterns. The problem is however that if you want to see individual atoms, or even the inside of atoms you need something even more powerful with a smaller wavelength, such as a neutron. A neutron is a particle that are all around us, every atom (except for hydrogen) are full of them, and if you would shoot this at a target and see how it bounces back it can give back information of where every individual atom are located, and behave. Neutrons also have the novel trait that they also possess no charge, meaning that they do not interact with electrons around the atoms nucleus. This means that it is possible to see inside the atom, and to get information about for instance the magnetic charge of individual molecules and atoms, as well as differentiate between isotopes. It is also compared to other techniques very gentle, and is well suitable to look into organic matter without damaging it, which is of great importance to biotech and medical research.



Figure 3, One of the shutter rooms on the SNS (Spallation Neutron Source) at Oak Ridge National Laboratory. (Left) Source: from www.ame.com. And the Swiss Spallation Neutron Source (SINQ). (Right) Source: <http://www.psi.ch>

To generate these neutrons is exactly what the ESS is designed to do, and let researchers use them to look into their material of interest. Just as an immensely powerful microscope, or nano-scope to be more correct. To do this in the past researchers have used radioactive materials to give off the neutrons, but this is not a very efficient or good way to do it, and produces low quality (intensity) neutrons. The ESS installation will not use this technique at all, it will use non radioactive materials that it instead accelerate into at high speed along a straight tube into a large piece of metal that will then "pop out" the neutrons in all directions. These neutrons will then be led towards multiple research stations that can use them to analyse their samples and materials.

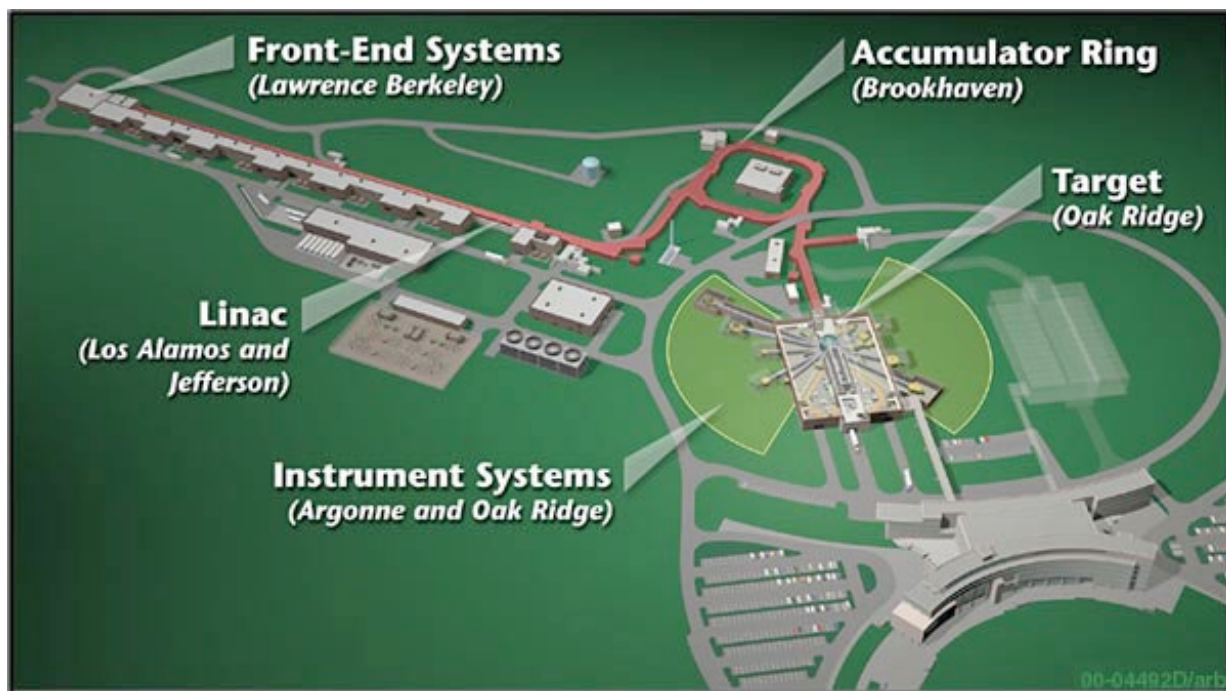


Figure 4, Conceptual drawing of the SNS site. Taken from: neutrons.ornl.gov

The problem with this process is that the non radioactive material, hydrogen, that are to be accelerated must have a high speed before it reaches its target. To do this it needs, just as a car who needs to accelerate, some distance to get it up to top speed. In the ESS this will be done in a long tube (a linac) that are surrounded with electromagnets that alternate between on and off to send the hydrogen on it its way towards the target station. This is a very complex process, and need to be very precise in order to do it correct, which is one major factor in why the ESS costs as much as it does.

There are already a similar facility in Germany operating today, but it dates to the seventies and are not at all as powerful as newer machines that are coming online today in the United States and Japan.

Europe was leading in Neutron research during the seventies and eighties, but are now loosing some of this advantage to other countries due to the fact that they are building newer and better facilities. The ESS will take around 10 years to complete, so is is therefore important for European industry to be competitive in the future that the facility is to be built today.

5. LITERATURE STUDIES

5.1 Report from Region Skåne and PricewaterhouseCoopers

Region Skåne produced together, with the consulting firm PricewaterhouseCoopers, a report on what the impact of placing the ESS might be on Lund and the broader region. The report called: "The ESS in Lund - its effects on regional development" was published in 2009 before the final decision on where to situate the ESS had taken place. PricewaterhouseCoopers who carried out the work have divided the report into two sections, with a quantitative analysis and a qualitative part, where they have gathered as much current information as possible to make an qualified guess of how the future in the region will turn out with the ESS installation place in Lund.

According to this work, OECD⁸ recommended in 1999 that a new generation of neutron sources should be built around the world, one in North America, one in Asia and one in Europe. In 2007, the Swedish government made a declaration of intent to host the facility, and in 2009 the decision to locate ESS in Lund was made among fierce competition with Hungary and Spain. The reason for this fierce competition was that it was thought that hosting the facility would give economic advantages to the host country and region.⁹

In the introduction, the report states that:

*"Having a multidisciplinary research centre based on the world's most powerful neutron source in Sweden would mean a great deal for the country as a research nation and would make Sweden in general and the Öresund Region in particular more attractive places in which to live and work. The ESS increases the attractiveness of the region which would increase the conditions for attracting world-class research workers to the region and thereby become a hub for cutting-edge research in Europe."*¹⁰

5.1.1 Quantitative

In the quantitative analysis they clearly states that the difference the ESS can make to the region are very much dependent on how well the regional actors are at harvesting the fruits that it can bring. The direct effect of the ESS itself, just as a building site and later a workplace for around 500 persons would not be higher than the invested costs, but the spinoff effects that the installation might have on the region can be huge.

To clarify this view, they have divided their estimates of the regional impact into three different scenarios that are called, Base, Vision and Max. Where the Base scenario only take into account the direct effects of the facility such as salaries and building costs, while the Max scenario envision a future where the regional actors have taken the opportunities that the ESS gave them, and where the spinoff effects have been great. The Scenario Vision is somewhere in between, and might be seen as the most plausible one.

There are several trends for the region as a whole laid out, one is that southern Sweden and the Copenhagen area are getting more and more interconnected, especially since the opening of the Öresund bridge. The growth in one side of the channel will therefore influence the other side quite a lot. The employment and population growth brought to the region will therefore be distributed between the two sides. The population growth forecasted in the region without the ESS is estimated to between 300 000- 490 000 new inhabitants in the region in the year 2045, added to the already 3.6 millions that live there already. Employment and economic growth have for the Swedish side been higher than the Swedish average for the last decade, and is thought to be at least in par with the Swedish national growth average in the coming decades. The growth rates in Denmark is estimated to be roughly the same in the coming years, with a highly positive trend. This means that it is a net-expanding and attractive region already, even without the ESS installation.

⁸ Organisation for Economic Cooperation and Development

⁹ PricewaterhouseCoopers, 2009

¹⁰ PricewaterhouseCoopers, 2009; The ESS in Lund - its effect on regional development, p 15



Summary



The report



Visions

5.1.2 Growth forecasts

The report cites the Swedish institute for Growth policy studies, that have examined the long term economic effects from investments on research infrastructure. They as well as the Copenhagen business school have conducted a report on what the siting of the ESS may result in terms of growth. Both institutions conclude that the direct effect may be negligible compared to the indirect effects that may happen if the sting leads to technical developments and high-tech business opportunities.¹¹ They state however, that these effects are very difficult to forecast and measured, and are much dependent on efficient regional innovation systems. Based on another report about the elasticity estimates for R&D and how it relates to the total productivity factor, it was estimated that the ESS will increase the R&D capital by one percent a year. Or 1 billion SEK added to the total of 96 Billion SEK invested in Swedish R&D each year. Translated to Total Factor Productivity (TFP), this would mean an increase of 0,17 percent of TFP per annum.

There are however three phases that will influence in different ways, there is the pre-construction phase that will go on from 2008 to 2011 (current information, not in the report, have moved the end date for this to 2012). In this phase there might be a lot of economic activity concerning land acquisition in the area. The land around ESS will than become more valuable, and may trigger land purchases in the attractive area surrounding the site.

The second phase, the construction period, will go on from 2011 to 2018. This phase will be of much value to the region in terms of direct wages to construction workers, their secondary spending and so on. The building cost are estimated to 13 Billion SEK, witch can be put into perspective where the gross regional product 2005 was 312 Billion SEK. Some of the money spent will not benefit the region since much equipment are bought in an international market, but around 30 percent are estimated to be spent locally.

The long term effects, defined as 2018 to 2040 are much more difficult to quantify. The running costs each year for the facility will be in the order of 1 Billion SEK, which is substantial in respect to the Total national expenditure of 96 Billion SEK.¹²

Shown in figure 1 below, is the projected investments costs for the installation over time, where it levels out to around one Billion over time as the cost to fun the facility.

¹¹ PricewaterhouseCoopers, 2009

¹² PricewaterhouseCoopers, 2009

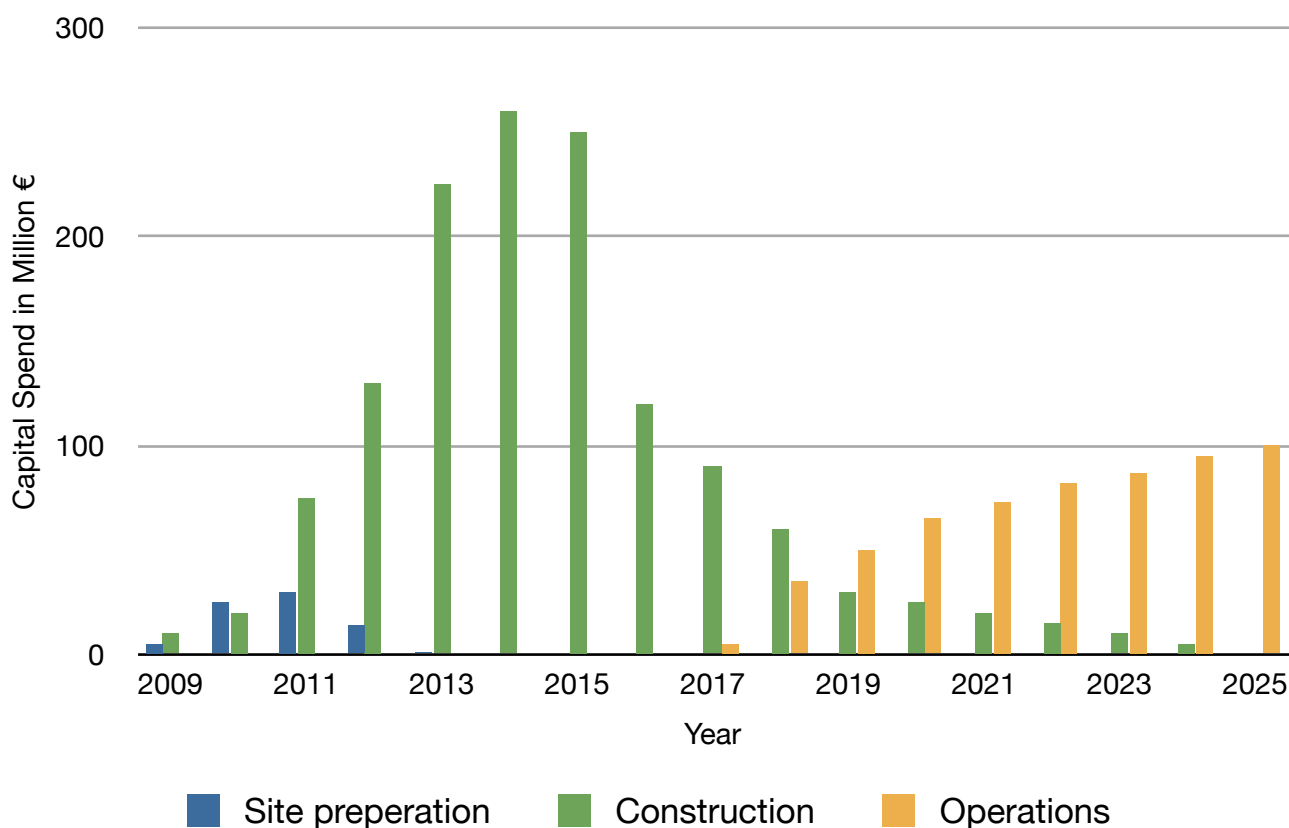


Figure 5, Capital Spend on the ESS installation. Source: "The ESS in Lund - its effect on regional development", Ch 5.

In scenario Base they estimate that the ESS will raise around 700 jobs annually on the assumption that the employment cost per person in skåne is 500 000 SEK. This means in 2040, 23 000 jobs will have been created in the region. That is without the spinoff effects included.

To get a glimpse of what the indirect effects of the installation may be, it might offer some insight to look at how LTH (Lunds faculty of engineering) and the IDEON science park, that have grown up around it as a spinoff effect, have interacted. LTH was established in 1961, and has round 7000 students and 1400 people who are directly employed. The research at the faculty has been rather successful with innovations such as bluetooth and ink-jet printers developed there. The turnover at LTH is about 1.3 Billion SEK.

IDEON Science park was set up in the proximity in 1983, with over 50 000 square meters of laboratory and office space. This area have expanded to today 100 000 square meters and the property companies that runs it plans to double this over the next ten years. Meaning over 10 000 square meters that needs to be built each year. The science park today employs around 3000 people, spread out over 250 companies. Over 700 companies have also had offices at IDEON but later moved out, and the survival rate has ben pretty high with only 4% of the companies who have closed down during the 25 year history. 76 % of the companies have had contact with the University, with the remainder benefiting from the labour supply produced there.¹³

Table 1 shows the number of people employed at IDEON today and the average annual growth rate of the numbers of employed. It also shows the number of employed at companies associated to IDEON and their respective average growth in employment.

¹³ PricewaterhouseCoopers, 2009
Department of Economic History

IDEON AND ASSOCIATED EMPLOYMENT	IDEON TODAY	AVERAGE ANNUAL GROWTH IDEON	COMPANIES ASSOCIATED WITH IDEON	AVERAGE ANNUAL GROWTH ASSOCIATED
Total employed	3000	120	5916	308
Office space m ²	10 0000	4000	8006	253900

Table 1, Employment and Office space at IDEON. Source: "The ESS in Lund - its effect on regional development", Ch 5

5.1.3 Growth in the property market

The whole Skåne region have seen an upswing of both housing prices and the construction of new dwellings. In the years leading up from 2005 there have been on average of 4700 new dwellings constructed annually, and the ESS has been estimated to increase this with another 500 each year. Thus helping the region to come in par with its construction target of 5000 new dwellings per year. This upswing can be in part explained with the excellent economic performance in the region with rising prices, and the successful integration with Copenhagen. The reason for the extra 550 dwellings per year due to the ESS are explained with the estimate that the price per square meter for housing are expected to be 4 000 SEK higher with the ESS, added to the 36 000 SEK that the average square meter are expected to cost in the year 2040. A report cited from the "Infrastructure and Urban Development in the Öresund Region" or ÖRIB, estimate that in their baseline scenario there will be around 5400 dwellings constructed each year in the region, and in their scenario competitive they raise this forecast to 8650 dwellings a year. As a backdrop of this, the ESS can be seen as having quite an impact considering that it's such a small piece of the regional economy.

To estimate the distribution for these dwellings regional wise, it makes sense to look at how today's workers in Lund are distributed. This is shown in figure 3, below.

DWELLINGS DISTRIBUTION	DISTRIBUTION FOR COMMUTING TO LUND		DISTRIBUTION ACCORDING TO WHERE SONYERICSSON EMPLOYEES LIVE TODAY	
	ABSOLUTE	PERCENTAGE	ABSOLUTE	PERCENTAGE
LUND	250	50 %	150	30 %
MALMÖ	64	13 %	150	30 %
LOMMA / BjÄRRED	18	4 %	25	5 %
KÄVLINGE	29	6 %	25	5 %
HELSINGBORG	9	2 %	20	4 %
VELLINGE	NA	NA	20	4 %
REST	132	25 %	110	22 %

Table 2, Distribution of commuters to Lund. Source: "The ESS in Lund - its effect on regional development", Ch 6

They do not however conclude how the dwellings that are constructed due to the ESS will be distributed, they just give the above indication of how similar patterns are today.

5.1.4 The office market

In Lund the percentage of office workers comprises of around 28% of the total workforce, compared to 26% and 21% in Malmö and Helsingborg respectively. The annual increase in these three biggest cities in skåne, have averaged at 2370 new office workers per year between 2000-2006. If it is assumed that each office worker need 20 square meters of office

space, this have added an additional 47 400 square meters of office space each year. If further assumed that about 50% of the new jobs created by the ESS will be conducted in offices, it means that the annual increase due to the ESS in office space will be around 7 200 additional square meters, or an increase of 15%. If estimated that 30% of this demand will be in Malmö, 50% in Lund and 20% in Helsingborg it breaks down the numbers to the following. Shown in figure 4.

OFFICE DEMAND	LUND (50%)	MALMÖ (30%)	HELSINGBORG (20%)
Office space demand m ²	3600	2200	1400

Table 3, Estimated Distribution of office space demand. Source: "The ESS in Lund - its effect on regional development", Ch 6

5.1.5 Hotels and meeting facilities

It is estimated that the ESS will contribute substantially to the demand for hotel beds as a result of visiting researcher and such. There are 5000 neutron researchers in Europe today, and the new facility will have 22 instruments stations to work at. In addition to this, there will probably be technicians and engineers coming participate as well. Based on this an estimated; 3000-4000 additional visitors will come to Lund each year, and they will need between 10 000 and 17 000 bed-nights in hotel rooms. This can be put in perspective to the annual number of hotel bed-night sold in Lund that were 177 000 in 2007, meaning that the ESS will increase the need for bed-nights of around 7%. There are already plans to alleviate some of this need by building a conference centre with adjacent hotel in close proximity to the ESS site at Brunnskög. Similar plans are under way at other parts of Lund, such as one adjacent to the big Industry Tetra Pak, as well as a new hotel in the city centre.¹⁴

5.1.6 Communications

The regions infrastructure is in general quite good. It is not believed that the siting of the ESS will influence the need for further expanding the infrastructure in the region in a big way, but instead lay out many of the already considered plans for improving the road and rail-networks. They also cite the Fehmarn bridge that will connect Copenhagen to Germany in closer way, as well as the need for an extra bridge between Sweden to Denmark at the Helsingborg-Helsingör site to alleviate the situation that are projected on the Malmö-Copenhagen bridge a few years from now. They also conclude that it is important to build out the public transportations system to have sustainable growth in the region where people can commute with a smaller impact on the environment.

5.1.7 Energy and Telecoms

Both these sectors are well developed in Skåne with no reason to believe that there will be insufficient supply of neither energy of network capacity. The ESS will however need a lot of power, around 40 MW, although it is not seen as a problem on the supply part. There is further more a vision from the secretariat side that much of this power may be reused in form of district heating to the Lund area, around 25 MW, which would limit the environmental impact of the installation. On the telecom side, the ESS may well drive the need for more bandwidth and fibre optics since there is a need for distributing the information from the experiments worldwide in a secure manner. This as well as plans to process a lot of the data in Copenhagen, at a data management centre, will probably mean an increase in the demand for high speed information highways across the straits and intraregionally. The need for securing the information gathered and distributing it may also be driving force on the development of so called eScience, which may benefit companies supplying this research and services in the region.

5.1.8 Public services

There is already an international school in Lund, as well as a private supplier of kindergarten services. If however the ESS will be sited in Lund (which is now the case) there are plans to start up a public kindergarten that can cater to english speaking children as well, and there are already a bilingual Montessori kindergarten available. There are also plans

¹⁴ PricewaterhouseCoopers, 2009
Department of Economic History

to expand one of the High schools in the area and to the double amount of students there, to cater the expected increase of international school youth following the ESS construction and the influx of scientists and their families.

5.1.9 International comparison

A look at other European facilities as well as the American Oak-ridge and Japans J-Park shows that in all the regions the research facilities are seen as a key component to attract smart people to cutting edge science. In the Oak ridge facility that are very similar to what the ESS will be, most of the staff are Europeans. Also in J-park seems to be a consensus that the facility is needed to reassure future competitiveness in a globalised world where attracting talented people are one of the key areas that governments should focus on to remain in the lead. There was also an investigation of science parks in Europe such as the Milton Park in Oxfordshire and Minatech in Grenoble. Both these parks are seen as key components to the respective economies, but it seems very hard to measure the exact economic effects from spinoffs and the knowledge created there. One concern in all countries seem to be that it is very hard to attract young people into the natural sciences, a qualified workforce that seem to getting scarcer in all of the developed world. The science facilities and science parks are seen as a way to not just attract talents from abroad, but also to inspire young people to go into the natural sciences to alleviate some of the expected shortages.

5.1.10 Quantitative estimates of the economic effects from the ESS

The last part of the quantitative section in the report gives an estimate of how much the economic growth effects of the ESS might be in the region of Skåne. They have divided the assumptions into three scenarios with the ESS and one scenario without, and gives a quantitative estimate for each of them. The results are presented in the table and graphs below.

THE EFFECTS OF THE ESS ON VARIOUS VARIABLES IN THE YEAR 2040	SCENARIO BASE WITHOUT THE ESS	SCENARIO BASE WITH ESS		
		MIN	VISION	MAX
Annual Growth in GRP in %	2.00	0.01	0.08	0.12
Difference in GRP 2040 with ESS, Billion SEK	648	1	16	26
Accumulated higher GRP with ESS, Billion SEK	15500	35	214	302
Annual increase in number of employed	2200	63	700	1100
Difference in no. employed with ESS	62000	2000	23000	35000
Annual increase in demand for dwellings	5500	50	500	760
Increase in demand for office space	-	600	7000	11500
Increase in hotel demand, bed-nights	-	-	13500	-

Table 4, Economic estimates for the ESS impact. Source: "The ESS in Lund - its effect on regional development", Ch 6

Figure 6 shows the estimated impact that the ESS will bring to the region, with three scenarios. Scenario Min only covers the direct effects of salaries and the investments made of the siting, scenario Vision includes spillover effects and the Max scenario is a more positive view than scenario Vision but with roughly the same premises. Figure 7 shows the Gross regional product, and show the marginal effect in red how much extra economic output the ESS can bring to the region

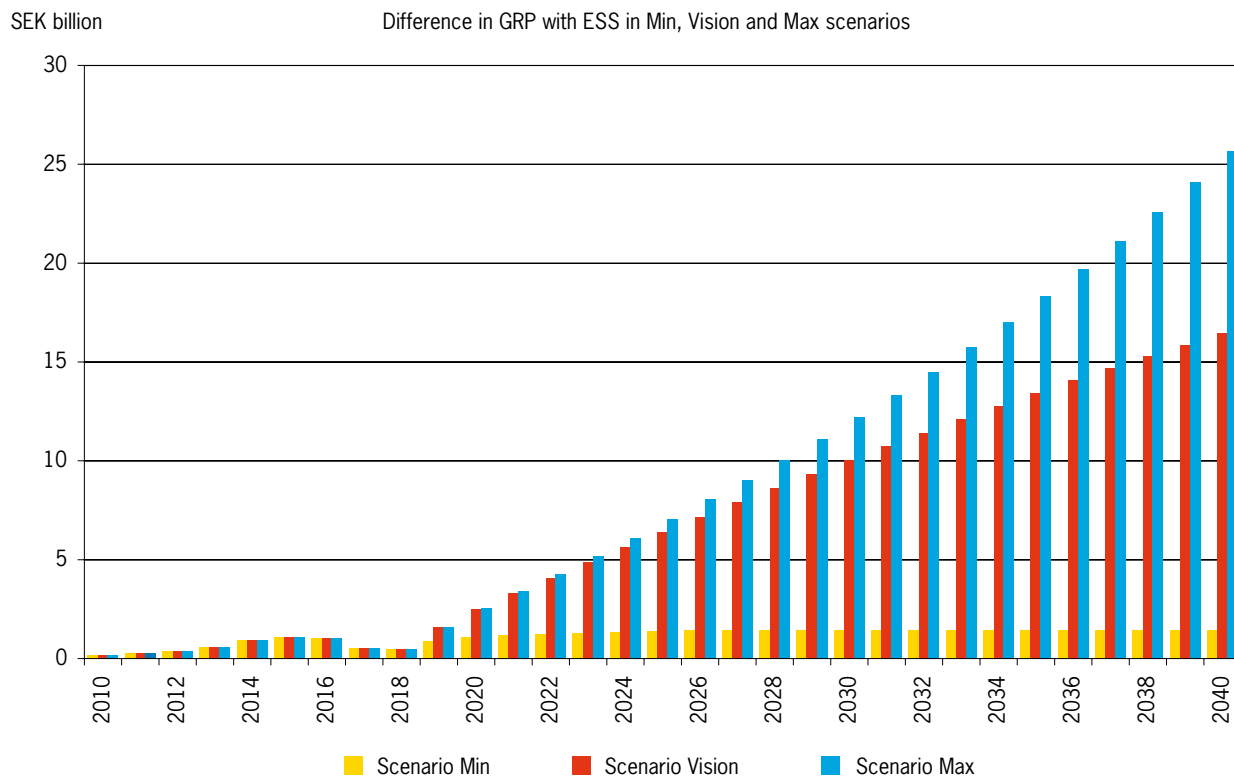


Figure 6, Shows the three different economic scenarios of the ESS impact. Source: "The ESS in Lund - its effect on regional development", p 74.

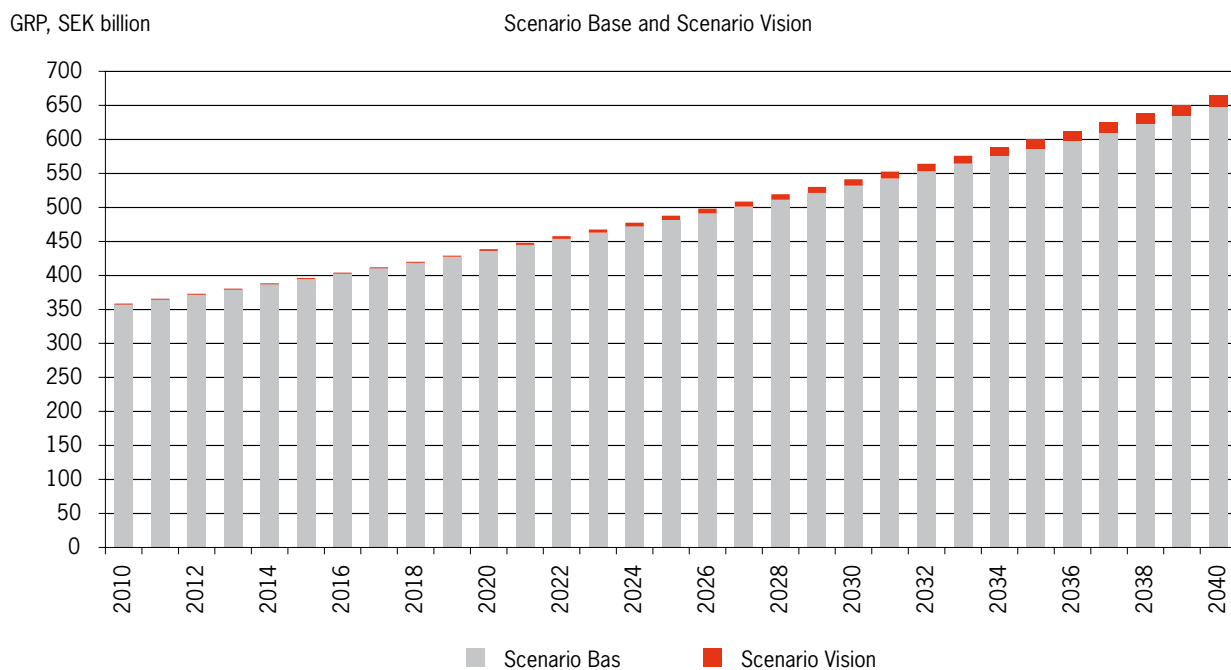


Figure 7, Shows the estimate effect of the ESS with base scenario and scenario vision. Source: "The ESS in Lund - its effect on regional development", p 74.

5.1.11 Qualitative

In the qualitative part of the report parallels with similar facilities that have been built around the globe are introduced. They state that the reason that many of these have been built have not only been due to a pure scientific need for it, but rather to act a springboard towards economic growth and to increase a regions attractiveness; to put the region on the map. The increasing competition on a global stage for talents and business opportunities give rise to the need for regions to show themselves being on the forefront of technology and opportunities, and one way to do this is to support and finance big research installations. These facilities are usually surrounded by business cluster that can take part and exploit the opportunities and research that takes place there. In Japan for instance where the J-park neutron source have been built, there is already a business cluster surrounding it that can do just this. And the Japanese government have stated as a condition for them to finance the facility, that at least 25% of the machine time must be given to industry for their applied R&D.

There are also parallels drawn to the ILL in France, where the facility have been sponsored by a number of countries, just as the ESS will be, in contrast to the J-park that is only financed by the Japanese. The problem with these type of facilities is that they can be a cut off from society, and become an International enclave that do not benefit the surrounding in a significant way. In order for the ESS to benefit the region as much as possible, there have to be an active regional innovation system in place to make use of the opportunities that presents itself.

Another science facility with surrounding research park that are used as an example is the ISIS in England. It was built in 1985 close proximity to Oxford University. Around it there is a large business park called Milton park, where thousands of workers are producing internationally competitive companies and innovations. The ISIS in this context is seen as a catalyst for this business cluster surrounding it, both in providing qualified labour and expertise to the region, but also as a monument that are putting Milton park on the map.

Other parts of the qualitative section in the report that lay out visions for the ESS, but they are largely speculative and does not so much say what the effect of the ESS will be, but rather what they wish them to be.

5.1.12 Analysis

The report clearly states that the ESS will bring economic benefits in many forms to the region. Some of the data may be speculative, but it still hold substance since they refer to other installation as well as basing their data on other investments. There are however big differences in the three scenarios that are laid out, and there is also reason to be a bit sceptic since the report was produced before the decision to locate the ESS in Lund had taken place, and may be seen as a bit biased since the purpose of the report may have been to give a positive viewpoint of the whole project.

5.2 Assessing the Economic Impact of Science Centres on Their local Communities

This report that was made by the ASTC (Association of Science-Technology Centres) and thirteen individual science centres, is a study about the impact of a multitude of research installations around the globe, and have a part that concentrates on the economic impact of these.

The main part of the study concerns museums and science centres, and not installations similar to the ESS. But some of the economic effects should however be applicable for both types of installations, since it's in both cases a matter of public investments with a scientific purpose.

In the report they divide the economic impacts into the following two, stated by the quote:

"Economic impact is made up of primary and secondary impacts:

Primary or direct economic impact refers to expenditure by the science centre itself, as in the first part of the statement cited above, plus expenditure by those visitors to the science centre who come from outside the local region in order to visit the centre.

Secondary economic impact is a combination of indirect and induced impacts.

Indirect economic impact refers to the fact that spending by the science centre and its audiences injects new money into the economy and stimulates the purchasing of goods and services to satisfy the needs of the science centre and its audiences. These are the 'supplier' effects.

Induced economic impact is the flow-on created by the combined effect of direct and indirect economic impacts. Larger total wages and increased organisational revenues are, in part, returned to the local economy through further 'consumption' spending."¹⁵

They also summarise the economic impact in a simple way:

"Science centres pay their employees, purchase supplies, contract for services, and acquire assets within the local community. These actions, in turn, support local jobs, create household income, and generate revenue to the local, state and federal governments."¹⁶

It's relatively easy to look at what some of the direct economic impacts might be, just by looking at the salaries of the employees and the orders going to local suppliers from the facility. The other direct effect that is due to the influx of people outside the region is a bit harder to measure and are estimated by looking at the number of visitors from outside the region, how many of these who came due to the facility, how long they stay and the spending patterns of these.

The secondary economic impact are estimated as larger, but not as easily measurable as the primary impact. It consists of multiplier effects on the local community, where suppliers of goods to the facility use their new input to buy from other suppliers, as well as employees purchase on the local market in successive waves that travels downstream into the economy. There are however much reservations on how to measure this, where some states that it may not be useful to try to calculate at all.¹⁷

Figure 8 shows a flow chart of how science centres impact its surroundings.

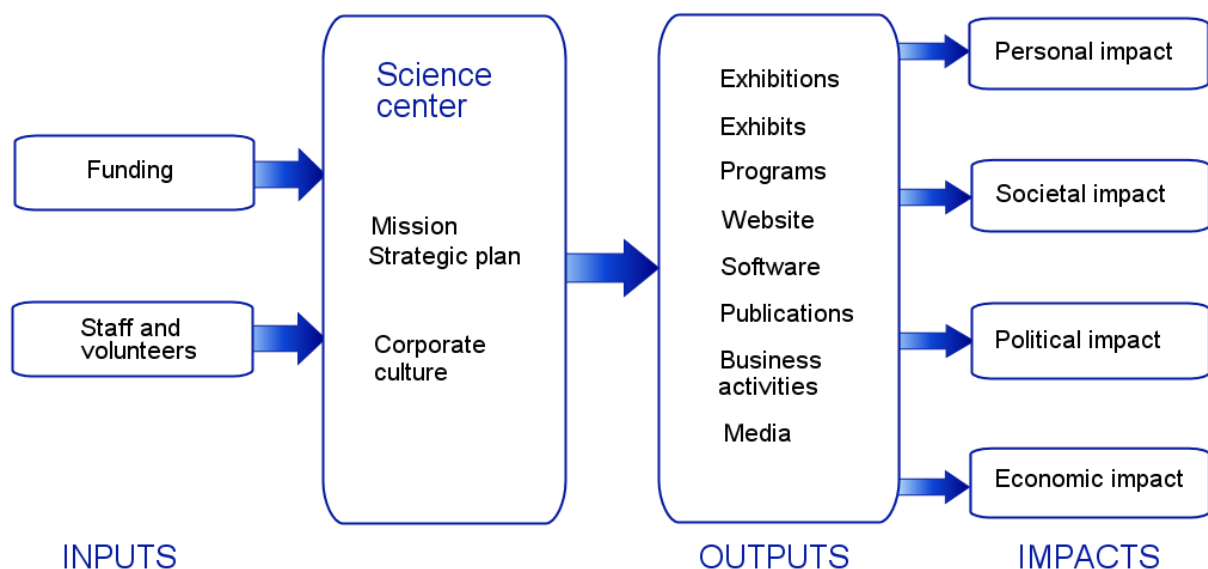


Figure 8, Model of science centre impact. Source: Assessing the Economic impact of Science Centres on Their local Communities

¹⁵ ASTC, 2005; Assessing the Economic impact of Science Centres on Their local Communities, p 11

¹⁶ ASTC, 2005; Assessing the Economic impact of Science Centres on Their local Communities, p 11

¹⁷ ASTC, 2005

Besides this the report states a long list of other economic contributions that are of a less quantitative character, but that may have an positive indirect impact. A few of them are listed below:

- *a redevelopment engine*
- *a leader in upgrading buildings and their operations to improve their performance—to reduce their energy use and their overall impact on the environment*
- *a tourist attraction in its own right*
- *a resource for science education, vocational guidance and training—providing, for example, student experiences both at the science centre and in the classroom, teacher development programs and materials, distance learning opportunities, virtual exhibits on the internet*
- *a partner with other organisations, including schools*
- *a reliable and trustworthy source of information*
- *a community asset for economic development, signalling that the community values science and mathematics*
- *a player in the transition from an industry-based economy to a knowledge-based economy*
- *the host of an incubator for new companies in the fields of information and computer technology, and the environment*
- *a facilitator of the transfer of innovation from research to new business activities*
- *a facilitator of technology transfer; for example, for the production of educational kits*
- *a supporter of teams of scientists involved in cutting-edge research, and a facilitator of interactions between the scientists and members of the public*
- *a provider of employment opportunities, particularly for students and other young people, including internships, vocational training, job guidance and start-up projects*
- *a source of opportunities for local businesses to promote their products and services through association with the science centre*
- *an organiser and host of cultural and educational events for the public, often in partnership with other community organisations*
- *Being a source of pride for the local community, a focus for generating pride in their region for local residents, resulting from the success and reputation of the science centre.¹⁸*

5.2.1 Analysis

The report states that the impacts of technology centres can be important for the local economy, and that the economic effects are much more than the direct economic impact. The rest of the report focuses on individual science centres and museums, where the economic impact of each are estimated. It is nothing however that can be generalised, and hence not be directly applicable to the ESS installation, but still offers valuable insights to what the impact on local communities of these kinds of public investments might be.

5.3 Big Science: Public investment in large scientific facilities

The British government has also put forward another report investigating the public investments in large science facilities. The report that was published in 2007, states that since the year 2000, more than 860 million pounds have been allo-

¹⁸ ASTC, 2005

cated to the construction of 10 big research facilities. Another 270 million pounds have been earmarked for another five. The report does not focus directly on the economic impact of facilities, but touches on the subject on several occasions. They state that, Quote:

*"The value of large facilities, in terms of expanding the scientific knowledge and economic benefits generated for the United Kingdom, will depend on selecting the best bids from research teams wishing to use the facilities, and on the effective exploitation of that knowledge by public policy makers and industry. Project teams have identified potential success factors for their facilities but, in most instances, these have not been specified in a way that would readily facilitate measurement"*¹⁹

One interesting aspect that they state is that there is not enough good research made on the subject of the economic impact of the facilities, and they call for these kinds of studies to be made. Especially concerning spillover effects from the research. Quote:

*"Little is known, in the UK or internationally, about the economic impact of hosting large scientific facilities. The Department and Research Councils should place greater emphasis on assessing both the immediate benefit to the local economy and the potential impact on the national pool of technical skills. The Department should track the economic impact of the current group of large-scale facilities and draw lessons for the development of future facilities"*²⁰,....

*...Local impacts, such as the effect on the local economy and local businesses during the construction phase are reasonably straightforward to measure. It is more difficult to assess the longer term economic impact of a new facility: the science is by its nature uncertain and the economic benefits can be difficult to estimate. Internationally, there have been few evaluations of the extent to which advances in scientific knowledge supported by large facilities in general, or a particular large facility, are converted into commercial innovation, or the extent to which the benefit of that innovation accrues to the country where the facility is located."*²¹

They also states that the indicators used for evaluating the success of the facilities are not sufficiently measurable or as comprehensive as they should be. This makes it hard for policy makers and scientists to learn from previous experience at future facilities. They also call for more involvement of industry in the decision of what installations that are to be built, and the importance to be able to commercialise on the research that are made. Historically the British have not been good at exploiting the business opportunities given by research, but this is beginning to change. Comparing the top 25 Universities in Britain and their business spinoffs to the United states gives a similar picture taking into account the relative size of the countries. This has had a lot to do with policy change, and the easing of patent applications and incentives for scientists. Figure 9 shows data from the ISIS facility in Britain that are similar to the ESS. On the left how much machine-time is being conducted and how many publications that follow, where the factors seem to correlate.

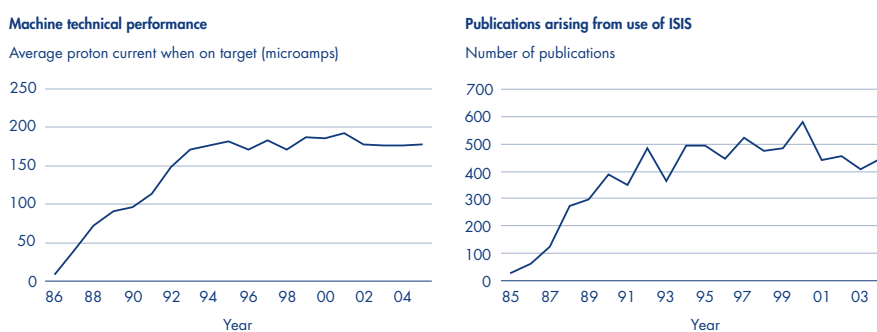


Figure 9, Data on the ISIS facility, a British spallation facility similar to the ESS. Source: Big Science: Public investment in large scientific facilities

¹⁹ House of Commons Committee of Public Accounts, 2007; Public investment in large scientific facilities, p 3

²⁰ House of Commons Committee of Public Accounts, 2007; Public investment in large scientific facilities, p 5

²¹ The National Audit Office, 2007; Big Science: Public investment in large scientific facilities, p 13

Another point made is the importance of the installations to serve as a source of inspiration for the next generation of scientists. If properly integrated into the community and the educational system, as well as television it can be big importance not measurable but still crucial for the future.²²

5.3.1 Analysis

The report shows that intelligent policies are key to harvest the economic benefits that big science centres can bring to a region. There might therefore be useful for policymakers in Sweden to look at what these policies might be, and evaluate what best policies to implement around the ESS to make it as beneficial as possible. Another interesting point the report raises is that further research on spillover effects and benefits from large science installations are needed, and that there is a shortage of comprehensive reports on the subject.

5.4 University City Science Centre: An Engine of Economic Growth for Greater Philadelphia

This report was made for the the University City Science Centre by the Economy League of Greater Philadelphia in 2009, and examines the economic impact that the research park University City Science Centre (UCSC) have had on the greater Philadelphia region in the United States. It does not examine a particular research facility like the ESS, but since the ESS is to be built close to a research park and are expected to generate an extra boost to it, it is still relevant to the subject to examine the economic impact of a successful research park.

The UCSC was established in 1963, containing labs, offices and incubators, it has since its creation spawned tens of thousands of jobs as well as hundreds of millions in earnings and billions in increased output for the local economy. Over 350 companies have moved out of the facilities to become mature companies, and of the 93 companies that currently resides there employs over 15 500 people. This employment opportunities are highly skilled, and well paid with an average wage of 89 000 USD annually per worker compared to the average regional salary of 55 000 USD, thus contributing a lot to tax revenues to the city of Philadelphia as well as the state of Pennsylvania with over 60 million USD each year. It is also estimated that each of these jobs supports an average of 1.68 more jobs in other sectors in the economy. The executive summary quote:

*"Growing yesterday's industrial manufacturing economy demanded roads, bridges, and rail to move goods and finished products. Growing today's knowledge economy demands a new sort of infrastructure to bring together the ideas and people that drive innovation"*²³

The park have also strengthened inter-organisational relationships between Hospitals, Universities and a life science companies with its active participation. This have helped the science centre to grow a life science cluster that now contributes to over 15 % of the regional economy. Since the founding of the UCSC there have been hundreds of other research parks created across the United states to spur growth and development. Initially a lot of these were just real-estate endeavours that where catering to small startup companies, but over time they have evolved into to the business and job creators that they are recognised as today with a more active participation from the resident companies.

As a public investment endeavour a recent study have shown that compared to other infrastructure projects, they have paid off relatively well. Up to 20 times as much as traditional infrastructure projects such as roads and rail networks, or around 144-216 USD cost for each incubator job created, compared to around 2920-6872 USD for each construction related jobs. Below there are a few tables that are included in the report that can give a good indication of the economic impact of the research park.²⁴

²² House of Commons Committee of Public Accounts, 2007

²³Economy League of Greater Philadelphia, 2009; The University City Science Centre: An Engine of Economic Growth for Greater Philadelphia

²⁴ Economy League of Greater Philadelphia, 2009, p 1

The impact of UCSC consists not however just the direct economic impacts, it also has a symbolic value and gives the whole community an optimistic view about the future and the prospects for the region, and have acted as a lead star in encouraging local businesses to set up operations as well as attracting partners from the outside. The region have had an industrial tradition that dates back to the early 20th century, where rail and port facilities was the key economic infrastructure needed for growth. The Science park marks a shift from this era to one where incubators and fiberoptic cables are as important as the old infrastructure, and the change into a knowledge based economy.

The benefits of the science park for the community has been boiled down into a few last points in the report:

- *To give advice, expertise, and services provided to nearby organisations(that may never actually lease space);*
- *Agglomeration effects generated when similar firms are located in close proximity;*
- *Creation of a local entrepreneurial culture;*
- *Expertise gained by serial entrepreneurs who, although their initial organisations may fail, use their expertise to start other organisations that become successful; and*
- *Philanthropic initiatives of successful entrepreneurs that benefit the community*

The reports finally ends with the conclusion:

“Just as industrial infrastructure transformed 19th and 20th century Philadelphia, so too can a robust commercialisation infrastructure now transform 21st century Philadelphia. The Science Centres’ nearly half-century of service has already contributed tens of thousands of jobs, millions in tax revenues, and billions in output to the regional economy. Now, the Science Centre is in a unique position to build upon this foundation. Greater Philadelphia has the necessary assets for global competitiveness in the new knowledge economy. The ability to bring together these assets will be a key factor in driving economic growth. The Science Centres’ synergistic resources make it a powerful engine for innovation- based economic development. Harnessing this power will ensure that Greater Philadelphia sustains its momentum and continues driving towards a world- class future.”²⁵

5.4.1 Analysis

It seems from the report that the economic benefits from Science parks can be quite large, or even a crucial part of the infrastructure in the economy of tomorrow. An important point that were mentioned where the role increased wealth can have on philanthropic activities, that can lift up the local community to an even higher level. A factor that may be overlooked, but that may have quite an impact on the social environment in a region.

5.5 A framework of industrial knowledge spillovers in big-science centres

Finnish and Swiss researchers have in a joint cooperation examined how big research centres can impact the economy through learning and cooperation activities, and produced a scientific paper on the subject. To come up with a theory of how these interactions may develop, they have produced case studies of three different companies that have acted as suppliers to the Large Hadron Collider (LHC) at CERN on the Swiss-French border region. This large installation itself, does not have much industrial value in a foreseeable future, and focuses on purely experimental research concerning elementary particles and concerns of how the Universe birth might have happened. This does not mean however that the installation does not have an positive impact on industry and the economy that it interacts with. The reason for this is that the research centre can act as a catalyst and stable a demander of innovative goods and services, and can itself interact and supply services to the supplier. One example of this is one of the three case studies, where a small startup nano-technology firm got the order to build an advanced thermometer that did not need to be calibrated, and were not ef-

²⁵ The University City Science Centre: An Engine of Economic Growth for Greater Philadelphia, 2009, p 13

ected by the harsh conditions (radiation and strong magnetic fields) that it were to be exposed to in the LHC environment. The nanotech-company itself was a spinoff from an university, and the idea was proven in the lab and in theory but had not been practically used anywhere. The LHC provided in this case a steady customer, to sell the product to, and the nanotechnology firm also got access to the CERN facilities and labs to be able to conduct research and development. There was also heavy interaction between the company and the staff at CERN, who provided much needed knowledge and expertise to the development to the team. After more than seven years of collaboration, the company supplied their first batch of thermometers, and had built up competence and a finished product that they could thereafter deliver to other potential customers.

What big science centres can supply to companies is, as in the example above, a stable customer and reliable partner that can bring the expertise needed to develop cutting edge innovations. Universities and science centres alike are usually also further in the forefront of technology and scientific discovery than the typical R&D departments at corporations. Companies that collaborate with them therefore find themselves at an advantage since they get access to cutting-edge research that are in the forefront of technological progress. Another important trait that the collaboration offers is the highly specialised workforce that are made available to the company at the science centre, who often consists of PHD and other highly educated staff that are in the forefront of technological knowhow and practice.

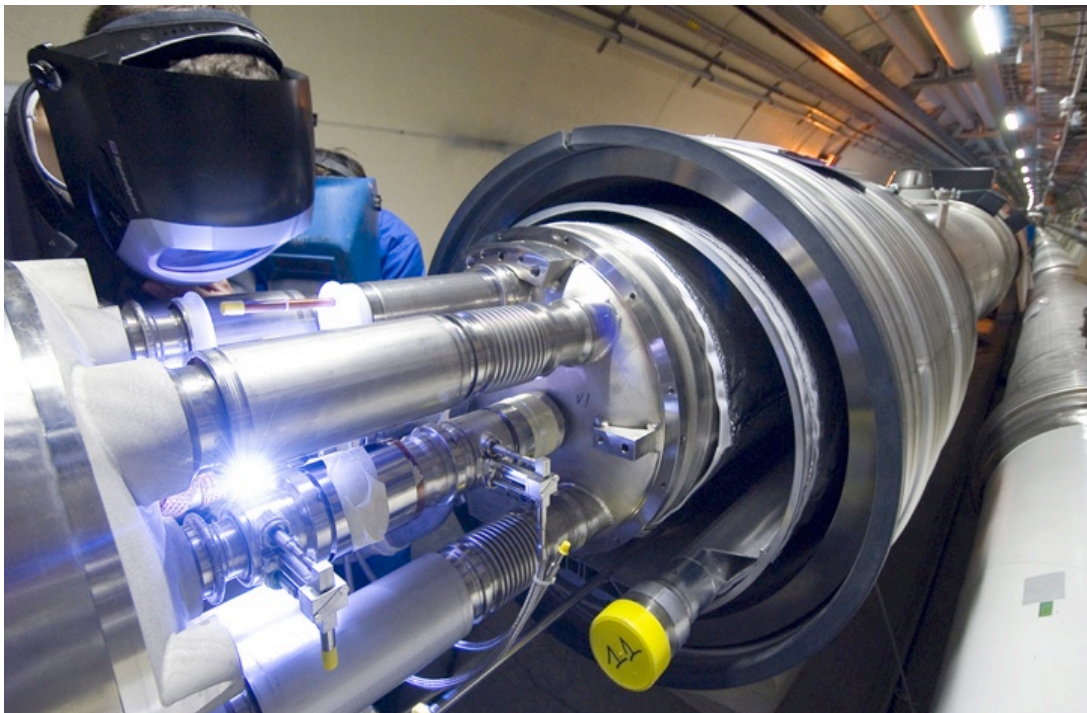


Figure 10, Welding together the massive storage ring at the LHC at CERN. Source: www.euroforum.org

Another advantage that the science centre can bring to its surrounding is its organisational know-how. A big difference between how Universities and Science centres are structured comes with the fact, that the Universities does not in general have to abide to a tight time schedule, and the teams that conduct the research are usually smaller groups of people. Where as in the case of the Science centre, there can be hundreds of people working towards a single outcome, which implies that a much more advanced organisational system must be in place to cope with. The engineering skill needed to complete the challenge of building an installation are also immense, and sometimes brings forward disruptive innovations and technologies that can have wider implications for society than just the original purpose that it was build for. The science installations are usually also public funded, and have to comply with a strict regulatory system of how it operates, in everything from how to conduct employment procedures to how quotations must be treated equally.

This organisational know how and professionally can be of much usage if it rubs of into its surrounding and partners, raising the standard of organisational knowhow and business ethics. The interactions between suppliers and science centre can also spur further improvements in the organisation skills and technology.²⁶

5.5.1 Analysis

The report goes through important aspects of how the science centre interact and benefit suppliers in the surrounding areas. It tries to lay out a framework for further studies on the subject. It emphasises the importance that the suppliers need to be as interwoven in the building process as possible, to reap as much benefit from the technological leap as they can. The report had the large hadron collider at CERN as their point of study, but the construction of the ESS facility may result in many of the same positive effects that are laid out in the report. There are however one crucial difference between the facilities that must not be forgotten, and that is that the work being conducted at the ESS when it's finished will yield economic benefits and have direct industrial applications. This in contrast to the LHC where the work done there will foremost enrich the field of particle physics and our understanding of the universe. The ESS will probably therefore have similar effects on its surrounding as the LHC, but should be even more beneficial in the long run for the economy.

5.6 City planning and the ESS

5.6.1 The local surroundings

The ESS will be built at a new part of the town of Lund called Lund North East (Lund NE) or Brunnskög. There are already well established plans for this area, with consulted private actors ready to build and a detailed city plan. The area will be an integrated part of the town and consist of 100 hectares of land, where 70% of the land dedicated to companies, university institutions, schools, shops, restaurants, hotels, and cultural premises, and the remainder 30 % will be dedicated to housing of different sorts (single- and multi-family dwellings, student accommodation). This will make for between 2 000-3 000 residential housing units, and 15 000-20 000 employed in the area. The city planners wants the new part of the town to be a an integrated place, where people work, sleep, dine, and spend leisure time, in contrast to many other areas where housing and commercial districts are widely separated.²⁷

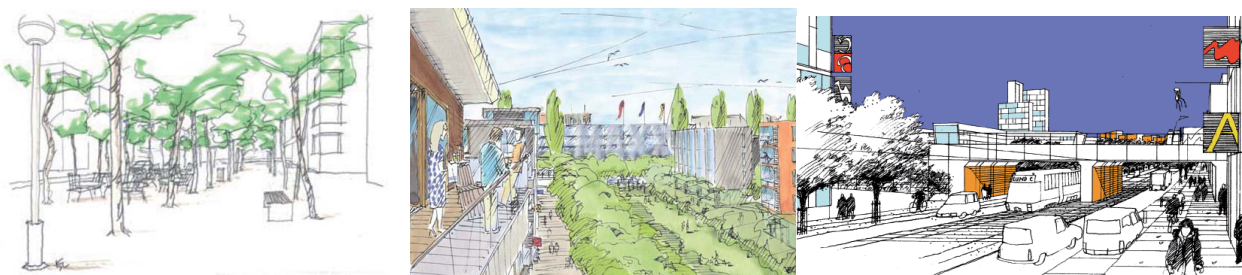


Figure 11, Visions for the new part of Lund. Source: Sketches from the information leaflet from Lunds municipality, concerning the Brunnskög area.

In the south of this area, called "The highest point" there are plans for a conference and hotel building overlooking a local square with a wide view stretching from Lund to the iconic Öresund bridge and Turning Torso in Malmö. This centre will be a easy recognisable landmark in the area, with an characteristic architecture, and a local park right next to it. The square will house shops, restaurants and have the local light-rail station that are also planned for the area. This as

²⁶ Erkkö Autio et al. 2003

²⁷ <http://www.lund.se/Bygga--bo/Stadsbyggnadsprojekt/Brunnskog/>
Department of Economic History

well as an adjacent science centre, or technology centre for the public will make it the natural meeting point for both people that visit and reside in the area. According to building plans, this area should be finished by the year 2015.²⁸

The light rail line will be a shuttle service from the central railway station in Lund up to Lund NE and the ESS, and have stations along the way at the IDEON science park and the Lund University among some. Making for easy transport and connection to the town centre. If everything runs on schedule, the link should be in service as early as 2014. There are also further plans to extend this line to nearby villages at a later stage.

The city planners have also called for this new part of town to be sustainable, and have recently been granted 1.8 M SEK from the Delegation for sustainable cities to aid in this endeavour. There are eight points that they have laid out shape this vision are:

- The connected town
- The town with the good building
- The town as a power-plant
- Intelligent material recycling
- The bicycle and strolling town
- The green-blue town
- It for a sustainable urban lifestyle
- Social life and meeting-places

The vision is that the new part of the city will be a sustainable and pleasant place to live in, and that it will act as a role model for cities and towns around the globe to follow.²⁹

There have already been interest in this area from actors both inside the region and beyond. There are requests from other Universities in Sweden to set up local branches, such as from the Engineering school Chalmers in Gothenburg and the other big university city in Sweden, Uppsala. This because they want to be close to the research being made at the new facilities, and have their own researchers doing science there in the future. It is expected that similar requests from Universities abroad will come in the future for the same reasons. There have also been an increase in interest from abroad for financing the construction of the new science park, where much of the new companies hopefully will spring into being.³⁰



Figure 12, Visionary drawing of IDEON gateway, and the area as it looks today with the IDEON area marked out. Source *IDEON and IDEON Gateway web-pages*

Right next to the new Lund NE, the science park IDEON already resides with surrounding company-hotels and other large companies offices such as Ericsson and Gambro. The IDEON science park today consists of over 110 000 square

²⁸ http://www.lund.se/Global/Förvaltningar/Stadsbyggnadskontoret/PDF-filer/Brunnshög_web.pdf?epslanguage=sv

²⁹ <http://www.lund.se/Tillbehör/Nyheter/1-8-miljoner-kronor-till-Hallbara-Lund-NEBrunnshög/>

³⁰ <http://www.sydsvenskan.se/lund/article629731/ESS-och-Max-IV-fick-fart-pa-Brunnshögplanerna.html>

meters of office space and laboratory facilities, and there are currently a lot more demand than the facilities can cater to. Because the insufficient supply there are plans to expand IDEON and its facilities with over a doubling of the office space in the coming years, and these plans were made before the decision to place ESS in Lund had taken place. Since it was decided, IDEON have seen an upswing in the already strong demand trend with many international companies already asking for office space in the region. To cater for this, there are plans to make science park more compact, with the large open parking being replaced by indoor car-parks and new offices³¹, but there will also be an expansion of the area with the most notable example being the IDEON Gateway building. This new office space will comprise of a rather tall building of European standards, one of tallest in Lund with its 18 stories, and characteristic architecture that will define IDEON and the surrounding as a landmark. It will comprise of 13 000 square meters of new office space, but will also house services that the rest of IDEON have use for such as conference centres, cafés, restaurants, boutiques and a even skybar with similar kind of view that the conference centre at the Lund NE site boasts with. This will make it the natural meeting place for all people that work in the area, and can with its close proximity to the Lund faculty of engineering, and the School of Economics be a place where entrepreneurs meet and create the jobs and companies of tomorrow.³²

Lund itself is one of two big University town in Sweden and consists of around 100 000 inhabitants, where the students comprising about a third of them. The University was 2009 ranked as the best in Sweden at Medicine, technical and natural sciences by the independent ranking agency Urank³³, and therefor attracts people from all over Sweden as well as international students. This have made Lund into a melting pot of culture, and making it easier for companies to get the talents needed for advanced applications. For this reason several big companies have large operations in the area such as Alfa Laval, Sony Ericsson, Gambro and up until recently Astrazeneca.

5.6.2 Larger region, and infrastructure

The larger region comprises of Copenhagen and the county of Skane in Sweden. Since the opening of the Öresund bridge there have been increased commerce over the straits, and a large number of people commute everyday from the swedish side to Copenhagen, taking advantage from the higher salaries in Denmark as well as the the lower prices of housing in Sweden. Many Universities resides in the area, and whole region ranks among the foremost in Europe when measuring the number of scientific papers produced each year. This have had its imprint on industry as well, with 60 % of the nordic Biotech workforce that resides in the area.

There are plans for new infrastructure being built, two bridges in particular, one over the Danish-German straits called The Fehmarn belt bridge, and another one over the Swedish-Danish straits at Helsingborg-Helsingör. The Fehmarn belt bridge that will be finished 2018, is hoped to integrate the Öresund region with the Greater Hamburg region in an information corridor that stretches from the continent towards Scandinavia. It is not yet certain when the bridge over the Danish-Swedish straits will be built, but since the Öresund Bridge is reaching maximum capacity in the coming years another crossing will be necessary. The government of Sweden stated in 2010 that it might be necessary to build another bridge with the quote that:

*"The Oresund region is one of northern Europes most dynamic growth regions, and the need for transports will only grow. The Öresund Bridge have been a success, but it wont be enough in the long run"*³⁴

There are also plans for an upgrade of the infrastructure in terms of railway and roads on the Swedish side, some in the conjunction with the ESS that might need an extra exit from the highway that passes by it.

³¹ <http://it24.idg.se/2.2275/1.276626/ideon-raknar-med-expansion>

³² <http://www.ideongateway.se/>

³³ <http://www.urank.se/ranking.html>

³⁴ <http://www.dn.se/nyheter/valet2010/mangmiljardsatsning-pa-infrastruktur-1.1070357>



Figure 13, The ÖresundRegion with iconic landmarks. Sources: Turning Torso from www.pro.se, Map from www.idk.dk, Öresund Bridge Free liecesing.

5.6.3 Analysis:

It seems as the location of the ESS in some areas have already made an impact of Lund and its surrounding. But especially locally, around the facility with the new part of Town being built, and at IDEON where they at both places already have requests nationally and abroad for office space and the will to set up branches. This can be seen as one early effect of agglomeration in the region, where these new branches will make it even more attractive for others to set up operations in the region. It is also clear that the town planners expect that the ESS and MAX-lab IV will bring job opportunities to the region.

6. INTERVIEWS

6.1 Setup

The interviews were set up in a similar manner, where the interviewed persons were asked a number of preset questions, and were encouraged to talk rather freely in between, a semi-structured interview. The questions were roughly similar to all the IPs (Interviewed persons), but differed somewhat to better fit the organisation that they represented. A sample of the questions are presented in Appendix A1.

6.2 Scope

Local players that might have had information or opinions on the ESS and how it may affect the region have been interviewed. The organisations are:

LTH and Lund University: Lunds Technical college. Different people in the organisation with different insight and role such as professors and higher administrative personal, were asked what they thought that the ESS would mean for the University, and LTH. As well as thoughts on the regional impact.

Invest in Skåne: A local investments initiative, that has as a goal to attract foreign direct investment to the region. Leaders in charge with a vital role concerning the ESS were interviewed.

Region Skåne: The county authority, provided a lot of information concerning infrastructure and initiatives to reap the benefits that the ESS might bring. Interviewed a person who worked with the establishment of the ESS for the organisation.

Research Policy Institute: A part of Lund university, have investigated the role of big research installations. And gave a political viewpoint on the project. A Ph.D that were well informed and conducted research of similar themes were interviewed.

Astrazeneca: One of the big Biotech companies in Lund, recently decided to shut down their operations in Lund. Were asked about the role for their company in the future at the ESS facility. As well as the general question about the regional impact. Interviewed one of the persons responsible for the Lund site operations.

Economic Geography department, Lund University: Senior professor with good insight was asked about the economic impact that IP thought that the ESS facility would bring to Lund and the region, and what kind of effects that would be expected. Also a larger discussion about agglomeration and clustering, as well an insight in why Sweden got the ESS.

IDEON: The Science park IDEON, Interviewed leading character in the organisation responsible for strategy and future expansion. Where asked how IDEON worked with ESS, and what IP expected the impact to be. As well as the importance of science parks as an engine for growth.

6.3 Results

All the interviewed persons were asked about the impact that they thought that the ESS would have on the region. Among the interviewed persons there were a clear consensus that the ESS would bring benefits to the region, and was generally seen as a positive thing, there were however big differences between them of how much they thought the estimated impact of the installation would be. A general trend was that the interviewed persons from the organisations directly involved in getting the ESS to Lund were a lot more optimistic about the prospects for regional growth and international investments in the area than other organisations.

The most sceptic were the ones interviewed at *LTH*, who thought that although the installation would bring benefits to the region, it would be limited and they did not think that big companies would locate in the region as a result of it. They meant that the science that would be conducted there would mostly be basic research, and that not many companies would have expertise of even use for it in their research. They gave an example of how companies interacted with *LTH*, where they were only contacted by industry in smaller projects when they had a problem of some sort that they could not solve by themselves. If the same kind of interaction would occur with the ESS, it would be much limited and not a big part of the beam time would be devoted to it. They did think however that the facility could bring spinoff effects and start up companies as a result of the research made there, and they also thought that it would be an important icon for the region and also in international science circles, where the *LTH* would benefit as well as gaining higher status and stature as a centre for science and research. It could also mean that it would be easier to recruit top scientists as well as international students to the *LTH* and the university, and become a boost to the nano-science research conducted at *LTH*.

There were also some scepticism of how well the money really were spent, with some of the equipment at *LTH* already today had a spatial resolution that were higher than the ESS. They admitted however that there were a few things that the ESS would be able to do that the current instruments could not, such as looking at materials without having to prepare them for the scan (and thus changing them), to look at living cells, and materials containing both heavy and light elements. They did not think that *LTH* and the ESS would have such a close relationship many others hoped for, and that the ESS would be a pretty enclosed and isolated part locally. There was however differences between the professors over the extension of this isolation, where one thought that there might well be people working at the ESS with Professor posts at *LTH*, and that there might be some interaction. An interesting part was that one of the professor believed that the establishment of the ESS would probably mean a new engineering track, a new program that would be devoted to material research and biology with a special focus on how to use spallation. It was also believed that the ESS would be a boost and a buildup of the Nanometer-consortium in Lund, as well as an influx of material research companies.



Figure 14, Lund University. Source: Anton Holmquist, Creative common licence

The IP at the administration of the University thought that the ESS would raise the status of the University, and make it easier to recruit world leading researchers. The interviewed emphasised the importance of building bridges from the University to the ESS, in order for the University to benefit from the establishment. If they were not successful in this, the IP believed that other Universities whom set up branches in Lund would outcompete them in recruiting the skilled labour. These bridges have already started to form, with the ESS secretariat director Colin Carlile had been given a professor seat

at the University for instance. But further efforts needed to be made, even though the timeframe for the facilities completion lies almost a decade away, they felt that they must start now and plan ahead of build more bridges between the partners. The interviewed also talked about the importance of the MAX-Lab facility that will lie in conjunction to the ESS, but would be open for operation a lot sooner. IP recognised that Sweden in general, and Lund in particular had a world leading expertise in synchrotron light facilities such as MAX-lab, but that they did not have the same international stature in spallation sources. The interviewed therefore felt that they now had to build up this new expertise by getting world class scientists to the University, and also set up educational programs for students and post docs that catered to the new field, and maybe had hands on training at the facility itself. This was something that they already had in Lund at MAX-lab III, and they want to have a similar setup with the ESS in the Future. IP did not know of any other big facility being considered for the moment in Lund beside MAX-lab IV and the ESS, but thought that smaller facilities and research labs like the nanometer laboratory might be built in increasing numbers because of the facilities. What was emphasised although were the other science centres being build in Hamburg, such as PETRA and the XFEL, that would strengthen the science corridor stretching from Northern Germany to Sweden and Norway, and that these would raise the regional advantage and perhaps lay the groundwork for even more science investments in the future.

As an end quote, one of the LTH scientists interviewed believed that the local sausage and fast-food vendor around the corner could well be one of the biggest beneficiaries in the region. This since it was the only one close by that offered food 24 hours a day, and scientists were creatures that saw time as relative, especially regarding earthly concepts such as day and night, while conducting their experiments.

The Invest in Skåne and Region Skåne, were much more positive to the affects that the installation would bring. Invest in skåne had already used the ESS as a marketing tool internationally to show off the region as a hub for science and cutting edge industries, to attract international companies to the region. They had already attracted the large Chinese ICT company Huawei (The main competitor to Ericsson that already resides in the Lund), and had a few other large International corporations that were looking into the possibility to put up operations in the region. This could not be directly attributed to the ESS of course, but it was rather part of a larger web of attractive resources that resided in the region, such as the well educated workforce and infrastructure. Furthermore they believed that companies that needed spallation sources to conduct their research and now did this at the current neutron sources, would now have incentives to move some or all of their operations to Lund instead since it offered a superior source for many experiments. They already had a number events planned such as a road show in Germany, and a special venue at the Shanghai world Expo in the spring of 2010. They expected to show of the ESS at these venues, not so much as the reason to invest in the region, but rather as a symbol and indicator of the region attractiveness that it were really competitive in a European perspective since it beat other regions for the location.

Region Skåne also had a positive view of what the facility might bring to the region. The organisation had been involved in the creation of the report from PricewaterhouseCoopers, so much of the information provided were already available in the study. What the interviewed said however was that although they had now got the ESS in Lund, the organisation did not see their job as done at all. IP believed that the positive economic effects of the ESS was very much dependent on how well it managed to market and integrate it into the regional innovation system. Meaning that if region Skåne were successful in informing the local companies and public about the opportunities that the facility can bring to them, as well as provide sufficient infrastructure (both physical and intellectual), the benefits to the region could be a lot greater than if they just sat back and hoped that the facility would bring economic prosperity by itself. IP were therefore involved in initiatives to do just this, and were informing local enterprises of how they could be part of the ESS and regional success.

The research policy institute IP were well aware of the ESS , and also had a lot of information about similar facilities. The interviewed persons view of the facility and the benefits it could bring was perhaps bit more critical than the other respondents. IP believed that the facility could well give advantages to the region, such as the direct investments itself and the effects downstream in the economy; for hotels, restaurants, barbers and such. The other spillover effects in terms of technology would be much dependent on how good the regional players were at exploiting the opportunities that the facility would bring. The interviewed furthermore said that the whole investment could well be a disaster if not well managed professionally, and pointed to other projects around the globe that had gone down this path but at the end res-

cued from disaster by government intervention. One important point IP made was that the project plan must have a financial post that dealt with uncertainties and new events that could come up well into the building process, and that actors in charge must be able to change the plan accordingly. An installation in Germany was mentioned as an example, where a large research facility was to be built. It focused mainly on material physicists and chemists as its main user groups, and only had one research station dedicated to biology where the users had to co-share the instrument with the chemists. Well into the projects was underway, new development made it evident that biology was expanding and reaching into the field big time, and that they could have much more use for the installation than just one co-shared research post. For this reason the design team changed the layout of the facility, and in the end constructed five instruments for biological purposes. The aftermath is that the installation is today a world leader in biological research, and biology have proven to be an important field in economic growth and innovation as well, with everything from advanced pharmaceuticals to bio-mimicry. This example made it clear that the ESS secretariat needs to be open to new developments in the scientific field as it builds the facility, if it wants it to become a world class science centre.

Another important point raised by the IP at the research policy institute was that what usually makes a research facility useful or not, in many cases comes down to pure resources. As in the indicated example above shows, an extra budget post that are dedicated to the unforeseen, can be vital to ensure the success of the project. It may also not be very good for the facility to save in on necessities, and the more money it get at its disposal, the better it have usually worked at other research facilities. This is however nothing that the ESS secretariat can do anything about by themselves, but rather something that policymakers and the owners (the paying states of Europe) should think about.

IP thought that the regional actors were doing pretty good in preparing for the ESS, which could be seen as an early indication of success for the build. They did however raise an important point, giving California as an example where an installation had been built and become successful in attracting talented people to the region. The point IP made, were that the reason for the influx of people had at least as much to do with the nice weather in California, and the proximity to Silicon Valley, as the quality of the actual facility. Implying that even if the ESS becomes a world class material science station, it is just one of the factors for talented people, when deciding whether to stay in the region or not.

Astrazeneca where asked if they thought that they would have use for the ESS in the future for their research. The interviewed said that they did not now use neutron spallation in their research even though it was available globally, and that they preferred and had a close partnership with the synchrotron light facility MAX-Lab for the time being. IP believed that this partnership would continue in the future with the new MAX-Lab IV (built next to the ESS). The interviewed person did however think that the ESS technology seemed very interesting for the future, since it offered a way for them to look at how cells respond to medicines in real time without destroying them, and that it might be a very important tool in the future. The problem was that since the ESS won't be fully up and running in more than a decade with probable much development in the medical industry up until then, so it was hard for them to say specifically what they might use it for.

The interviewed did not think that the ESS location in Lund would influence their decision on where to have operations in the future in any greater degree, and they clearly said that it had not been taken into a factor in the recent decision to shut down their operations in Lund. IP clarified by saying that it did not mean that they would not use the facility, but rather that they did not need to be in close proximity to be able to use it. Instead they could send their researchers to the facility when they needed to use it, or just sponsor projects on site. IP were also confident that much of the ground research being done at the facility could well be used by the company, as it always tries to make use of new discoveries being made in the life science field. The interviewed also thought that the facility might be very important for Lund, and mean a lot for the region both as an icon and for local businesses. But emphasised that it all depended on how good the region was to integrate the facility into the innovation system, whether or not it was to have a big impact.

The Economic Geography department IP had been putting forward reports on the ESS and the reason for putting it in Lund for European policy makers before the decision on the site had taken place. The interviewed believed that the main economic benefits for Lund would be in the direct economic form and the trickle down effects. Meaning that the 500 people working there and the visiting researchers and their salaries would be the main benefit to the region. They would in turn

use their money in the region and multiply the economic effect by around five times, if the system would behave as data from other sites have indicated. IP also thought that companies might be created as spin-offs from the research, but that it not necessary meant that these spin-off companies would locate in the region around Lund. The same reasoning went for large corporations that needed to use the facility, they might not need to have branches in the region to do this, but could rather come and use it whenever they liked from another location. What could happen though, was that large corporations would move close to the ESS just to be near the qualified labour pool that were "produced" there. This could be seen at other sites around the globe, where branches were set up where the talents were, if talent could be attracted that is. The ESS is only one of a myriad of reasons that a person might consider moving to Lund or its surrounding, and other factors such as the generous welfare state privileges for maternity leave, and the quality of living in the region might be as, or even more important than that the ESS provided a world class research facility to work at.



Figure 15, IKDC, (Ingvar Kamprads Design Centre) lying between LTH and IDEON Science park. Source: Fluff, Creative common licence

The interviewed further believed that the ESS would raise the status of the University in Lund, and hence the ability for them to attract world class scientists and students. IP also thought that the University would start up new programs catering to spallation, and that it might be an opportunity for educational training for the small elite workforce in the area.

One especially interesting point that the interviewed raised, was that the benefits from the facility was not something universally agreed on. The reason that Germany did not opt of the facility (initially interested, but later reconsidered) was that the German scientific board were not certain that this technology was something that they needed ten years from now (when it would be up and running), and that the money dedicated to it could be wiser spent somewhere else in science. Other scientists in Sweden agreed on this, and were afraid that it would drain away resources from other fields where Sweden had a comparative advantage, something they currently not have internationally on spallation science.

As a last remark IP said that one of the most important uses for the facility could be, not the science made there, but as an icon, a visible sign for optimism and future prospects in the region, just as the Öresund bridge. The benefits from incoming talents and other things were believed to be much in the hands of the regional actors, and that it was up to them to build the infrastructure and institutions needed to reap as much benefits from the ESS as possible.

The interviewed at IDEON thought that the ESS would be very beneficial for the region and that it would definitely mean that more companies would be attracted, and set up operations in its proximity. It would also be easier to get ven-

ture capital to the companies that currently resided at the science park, with the ESS acting as an beacon for investors. The companies would both be attracted by the influx of talented people to the installation, and the direct economic effects that will trickle down from the facility. For IDEON itself, it would no doubt mean an expansion of its operations due to the ESS, and they did think that they would not expand as aggressively if the ESS would not have been located in Lund. IDEON have had plans for acquiring new real-estate next to the the facility, but was currently considering to use the Astrazeneca site instead, since it is to be abandoned in the near future. The plans for building new offices at the Brunshög site was therefore on hold. The organisation did however have other plans for the current IDEON area, making the area more densely populated with companies, as well as making it more living part of town with restaurants and residential accommodation. As an end quote, the interviewed believed that the ESS would mean a lot for the City of Lund in the long run, but emphasised that it would not be finished for another decade, and the effects would most easily be visible 40 years from now, looking back and seeing what it have meant for the region.

7. ANALYSIS

7.1 Literature

There seems to be a consensus at least within the literature, that science centres such as the ESS do matter in terms of getting agglomerative effects to a region. There are however differences in how much, and what they believe this effect might be. It seems in the studies concerning science parks, that the science centre cannot itself bring growth to the region in any great quantity, but needs to be in conjunction with a nearby science park to be able to reap the benefits that it provides. The studies also shows the importance of having efficient policies in place to do just this, this was especially evident in the British report, where it was a big difference before and now how well the economy absorbed science from ground research and converted it into useful innovations. The scientific report on spillover effects showed how some of these effects play out in the real world, and it is not unlikely that similar effects will be seen when the ESS is being built, and afterwards. It is very important although that the secretariat and the involved actors are aware of how the economic benefits during the build phase can be harvested. If they do, it can bring new startup companies from spinoff research already during the building phase when they try to solve the numerous problems that lie before them. They must also make sure to have close contact with their suppliers, and get them as interwoven as possible in order to get the latest science out to market through these channels.

What many of the reports clearly state is that policy decisions matter; that intelligent policies such as the ones in Great Britain can make a big difference in how many new startups you can get from a research facility. Local actors should therefore look into what the effects have been at other installations, emulate the successful policies and try to avoid the ones that seemed to have a negative effect. The problem seems to be, as raised in the report from Britain, that insufficient research has been made on the subject of spillover effects from large research installations, which currently makes it hard to carry out good decision making since there is no good material to base it on. To alleviate the problem, the ESS could partner up with a University to sponsor such research. If a comprehensive study would be done on this, it would make it easier for the ESS to put policies in place to be as beneficial as possible for all involved actors, and it would also give the international community a well needed report that they can base further policies at other installations on in the future.

The reports from ASTC: "Effects from Science Centres on Their local Communities", shows that the greatest benefits from the facility is not the direct effects from the science centre itself, but rather what can be built up around it. The importance of using the ESS as an Icon and a tourist attraction just as CERN does, must not be underestimated. Building the planned science centre at Lund NE may be a first step towards this, if it houses exhibitions and information about the ESS just as a museum. Guided tours around the ESS might also be a good thing, as long as they are non intrusive for the scientists working there. This might also help with another urgent goal that some of the reports mentioned, that was to make people more interested in science. Especially the young and try to get them into the natural sciences and engineering programs in the longer run, something crucial for long term economic prosperity, and a rising problem in the whole western world. To have schoolchildren from all over the region to come to the facility for guided tours might seem as a trivial in the context. But in the long run, the external effects that it might have on the attitude towards science and the ESS in the region might turn out to be one of the most important effects the installation can bring. It would also raise the awareness in the whole region about what the ESS is, and a sense of pride that can rub off as business confidence and investments and future jobs.

The Philadelphia report shows how these future jobs can come to be, with the effects on the regional economy science parks can have. There is already a science park adjacent to where the ESS will be built, and it is not hard to imagine that it would get an extra boost to an already quite successful park. The report indicated that the science park in Philadelphia have had external positive effects for the whole region, and created jobs in many other sectors not directly connected to it. If this holds true for the Lund region as well, and the ESS would bring an extra injection to the system it would definitely mean that the region in the long run can benefit quite a bit from the siting. It all seems to depend on however, how well the regional actors are in catering the opportunities posed. It seems though from the articles about the surrounding area, and the plans from the city of Lund that they seem to be quite prepared, and have already planned much of the

new part of town with a futuristic sustainable vision of it. This bodes well for the project, and might give an early indication that the ESS is proving economic benefits to the region. It is however hard to conclude that these projects would not have gone through anyway, and to say that it is sole due to the ESS would not be accurate. But some of the effects can, such as the request from other Universities for setting up branches close to the facility, and many of the other plans will certainly not suffer from the siting and will probably make them happen faster.

7.2 Interviews

The interviews gave a fairly large spectra of opinions on the subject. Some of the interviewed were rather certain that companies would settle down in the the region to use the ESS instruments. AstraZeneca however said that they did not think that this was something that companies such as themselves would do, where the located had to do with other factors and if they wanted to use the ESS for some experiments. They could just send persons there when they needed to anyway, or sponsor the researchers already on site. This opinion was shared by a few other interviewees, and I believe that this is probably the case, despite that a few said otherwise. An LTH professor gave an insight of how their cooperation with industry were conducted; they were contacted a few times a year, and only when there was a problem, and were pretty much left to themselves to figure it out (for compensations of course). If this is the case, there would be no reason for industry to locate near the facility, they could just contact the ESS staff whenever they would need help with looking into a sample, or something else. It would also be hard for companies to employ staff in house, that were confident in using the ESS instruments since they would not have much to train on. AstraZeneca and their current cooperation with with MAX-Lab might be a reasonable model for how the interaction will look like between industry and the facility.

This said, there might however be other reasons why companies would like to locate near the ESS, such as the large pool of qualified labour that will be housed and educated there. This resource of talent is a scarce resource, and for the same reason that industry wants to cluster around Universities, they might choose to locate in the proximity to the ESS as well.

The actors in the region seem to agree on that they need to act in order to get as much benefit out from the ESS as possible. This insight bodes well for the economic prospects, and it seem like at least some actors are working actively on getting their plans into action. At the LTH staff, there seem to be a gap although, and a little bit of scepticism of how the cooperation will look like with the ESS. This is something that the administration at the University need to do something about, and make sure that the ESS will be well integrated into the technical faculty with co-shared employment opportunities working half time at either institution. To do this they need to get the LTH staff involved, and feel that they are a part of it and not sidestepped by some big installation that will steal their place in the sun.

Many of the interviewed emphasised the importance of the ESS as an icon for the region to be proud about, and something to show off abroad to attract direct investments and talents. One important point however that some mentioned, was that the ESS will not be the sole reason for anyone to move to region, it will be weighed in but the myriad of other factors such as weather, quality of living, housing etc will be of equal importance. The ambassadors of the region need to be aware of this, and to equally promote the ESS as the generous maternity leave laws in Sweden, the long paid vacation, free University education, the IDEON science park, among some. This information should be put forward to international scientists, as well as to private companies who are considering to relocating to the region, and should be contained in leaflets, facts sheets etc. Just as Berkeley does not only show off its labs, they also market the quality of living in California, the sunny weather and Silicon valley as attractive reasons for moving there. To make it even more attractive, and easy to move to Lund the promised multilingual daycare centres and schools must be materialised soon, many of the researchers that consider the region are probably in their early carrier, and children welfare quality might be an important part of their decision.

7.3 Clustering effects

There already seem to be cluster effects taking place in the region, and it is reasonable to believe that these tendencies can only be reinforced with the siting of the ESS in the region. It seems that the construction will bring in suppliers to the region, making it more attractive for companies that need the same kind of supplies as the ESS. The suppliers to the facility will in turn need their own suppliers, making it beneficial for similar companies to set up their operations in the region. There already seem to be interest from Universities from outside the region to set up branches in close proximity to the ESS, which will only add to the labour pool of talented people and increase incitements for clustering. There will furthermore be a large labour pool that will work and be educated at the ESS, and serves as another reason for companies that need these kind of people to set up business in the area. The amount of extra clustering taking place will although be much in the hands of regional actors and policymakers, and it may therefore be hard to conclude how much the ESS will contribute to the cluster effects by itself.

Another possible side-effect of the clustering is that it crowds out other industries and other actors in the region. As one of the LTH professors indicated, he was afraid that his research would get less attention and resources because of the ESS would take up all the talent and money available. This could also be the case for other industries that can not use the facility as effectively as some others. It changes the comparative advantages in the region and makes some investments more profitable than others, which in turn can make traditional ventures in the region to prove uncompetitive and prone to move somewhere else. The other reason for this to happen is that the influx of high-tech industries with well paid jobs raises the wages and land-rents to a level where some businesses simply can not afford to hire or rent office space, and will relocate at some other location, possibly nearby. If this will be the case, the economic impact can be seen as ripple effects taking place. Where the most benefits will come to Lund in terms of wage increases and economic advantage, the surrounding areas may then absorb some of Lunds less competitive industries, and move out their recently uncompetitive industries further away. From an economic standpoint it seems that everyone can benefit from this effects, but the downside is for the people employed in the industries that are moving away or shutting down their operations. They could follow the jobs of course, but it may be the case that people will be unwilling to do this. This is because there are many other things than just a job that bind people to an area. They might have a family with children that go to school and don not want to move, their spouse might still have a job and can not get it as easily in the other location. Also friends, social life, traditions etc may hinder. If these people who do not want to move can not get another job when their old workplace have been shut down or relocated, the ESS will not be a blessing at all from their point of view.

It is easy to think of these crowding out effects just happening to low skilled jobs, but it might just be the case that it is some of the high-end jobs that get affected the most. The ESS and surrounding businesses will try to absorb the most talented staff, and this could mean people currently employed at the University. The University could then find it hard to attract new labour, and decide to shut down some institutions, or relocate it to Copenhagen or Malmö instead, maybe even further away. The same logic goes for other industries that compete with high quality labour, Ericsson may face sharp wage increases to much to bare, and move their operations somewhere else, Tetrapak and Alpha Laval may face the same fate. The reasons to stay may although be more convincing than the ones to leave, the high wages could be offset by better quality of the labour, making it still profitable to base operations in Lund. The proximity to supportive industries, the networking and skill transfer possibilities from the ESS and many more advantages should weigh up the negative effects, it is clear however that not everyone will be winners from the ESS siting.

There is also a risk that the facility will be obsolete even before it is built. The construction of the ESS will take around ten years, and considering the technological innovations that took place in the same timespan from 1990 to 2000 where the Internet went from being nonexistent to invented, to a necessity. It is not hard to imagine that a similar technological pace in other areas such as neutron spallation, or microscopy could bring forward innovations that makes large spallation sources obsolete. There is also the geopolitical and economical aspect that can change immensely in just a few years. In the same timespan that mentioned before, there was the breakup of the Soviet Union and the move towards market economy in Eastern Europe as well as a strengthening of the EU. In the years ahead there could very well be a weakening of European integration and easier communications making it more sensible to partner up with East Asian states for these kinds of facilities instead. Everything about the future is speculative by definition, but looking back at history can

show us that some hints that changes can come quickly and unforeseen, and be very disruptive to old structures. Perhaps there will even be an end to clustering itself, when communications levels out the playing field and people socialize evermore online instead. This is a belief that are shared within some economic circles, and is often called the "death do distance" argument. Nicholas Crafts and Anthony Venables are two of the proponents of this world view, and have published many articles on the matter.³⁵ There are however many others economists that do not share this belief, such as Örjan Sölvell. What he means is that that globalization and better communications do not need to be an antagonist to clusters at all, but rather that people still need to have a social arena to interact and that globalization could strengthen the clustering effects. But he bases his analysis on history, and the effects on existing structures from innovations can be very disruptive. It may just be the case that these conclusions held true in a pre social-networking and gaming era, but will not be true in the future where networks will instead be the dominant form of organization. Clusters could exist in this world as well, but in cyberspace rather than of old fashion geographical space.

All this reasoning indicates is that many of the economic and scientific effects that have been envisioned for the installation may not come true at all. And that the iconic effect that it should have given the region could be replaced with a warning example that public money shouldn't be used for these kinds of gargantuan science projects. On the other hand physics do not change what we know of, and many of the best scientists believe that the facility is both urgently needed and a sound long term investment. And the economic price of not building it in terms of becoming uncompetitive on the global scene may prove to be a lot higher than the risk of building an obsolete research facility.

7.4 Policy implications

- Should make it easier for international talents to settle in the region by building up infrastructure such as bilingual schools and daycare centre
- Should promote the ESS as part of a wider scheme of benefits for moving to the region.
- In order to promote science in general and to get a positive sentiment towards the ESS in the region, an science centre with guided tours of the ESS facility should be set up. Could also be promoted as a tourist attraction.
- The University should make sure that LTH staff get involved in the project, and that there are as much integration and bridges as possible between them.
- The ESS must make sure that the building process brings forward innovations and new startups, and that the suppliers are well intertwined with the scientists so that the best available technical skills are dispersed into the economy
- The ESS should work with a University to do a comprehensive study about the spillover effects from large research installation, and what policies that matter in getting the best results. This material is sought after by more actors around the globe, so the economic burden could perhaps be shared with others.
- All concerned actors in the region should make sure to be ready for ESS, and make plans for how they can best make use for it from their point of view, and interact heavily with the ESS build to try to get their special requests, if any, through.

³⁵ Crafts & Venables, 2001

8. CONCLUSIONS

8.1 Draconian task

Much evidence points to that the ESS will bring economic good of some sort to the region, but to say exactly what it will be is not possible and depends to a large extent on how well the involved actors do in their endeavour to use the facility for their needs. If the installation become an isolated "Cathedral in the desert", it will just give of the trickle down effects of the investment itself. Even this is not a small boost to the region, but it is not much compared to the effects that could come from the spin-off effects, and the iconic value for the region to drag in direct investment and talents. This as well as the importance for inspiring the youth in the region towards the natural sciences will be impossible to quantify, at least not for now. But it may many years from now be studies that show that this effects were the most important for regional competitiveness in the long run, and that the rising percentage of students going into the natural sciences twenty years from now gave the greatest value of investment than all the others combined. It is hard to say for certain what the ESS will mean for the region. But there seem to be a consensus from the literature and interviews that there will at least be some kind of economic impact, and I believe that the extent of how positive the economic benefits will be depends heavily on good decision making from the involved actors. So the pressure is on them to get as much good out from the siting as possible, and the economic benefits for the region from the ESS I therefore declare as inconclusive and currently impossible to quantify.

9. SUMMARY

9.1 Short summary of the paper and the findings.

This paper examines what the local impact of the research installation ESS might be on the region of Lund and its surroundings. Done by looking at literature concerning agglomeration and clustering, reports on large research installations and interviews with local actors. There seems to be a consensus in the literature that research installation can bring positive economic effects to a region, exactly what these effects are, is a bit harder to pin down. In the interviews local actors in the region were asked about what they thought the ESS would mean for Lund and their organisation. The answers from this varied quite much, but there was also here a consensus that it would be good for the region. The most positive were the involved actors such as "Invest in Skåne" and "Region skåne", and the most sceptic interviewees were found in the local academia. The conclusions are that the impact of the ESS will be much dependent on whether the local actors respond correctly to the opportunities from the installation. Some effects will be due to the trickle down effects, that are relatively easy to measure, other may be in the form of an icon and inspiration for the region and future scientists, which is harder to measure the impact of but might be the largest effects for the region in the long term.

APPENDIX A1

A1.1 Questions to Invest in Skåne:

How do you believe that the siting of the ESS will affect the Lund region in the future?

Do you believe that the siting of the ESS will be a factor for companies decision to establish themselves in Lund?

Do you think that Companies in the region are well prepared for the opportunities that the siting of the ESS brings?

A1.2 Questions to AstraZeneca:

How do you believe that the siting of the ESS will affect the Lund region in the future?

Was the siting of the ESS in Lund have a factor in AstraZeneca's decision to shut down their operations in Lund?

Do you believe that AstraZeneca will use the ESS in the future, and if yes, how?

Do you think that the siting of the ESS in Lund will be a factor for future decisions on where AstraZeneca decide to conduct their operations

A1.3 Questions to LTH:

How do you believe that the siting of the ESS will affect the Lund region in the future?

Do you believe that the siting of the ESS will have an impact for LTH to conduct cutting edge research, and to attracts international talents!

Do you think that the ESS can be useful for your research, and if yes, how?

Do you think that the siting of the ESS will mean an expansion of LTH?

BIBLIOGRAPHY

- Association of Science-Technology Centres (2005) Assessing the Economic impact of Science Centres on Their local Communities
- Autio, Erkkö et al (2003) A framework of industrial knowledge spillovers in big-science centres, Research Policy
- Computer Sweden Magazine (2009)
<http://it24.idg.se/2.2275/1.276626/ideon-raknar-med-expansion>
- Dagens Nyheter, Newspaper (2010)
<http://www.dn.se/nyheter/valet2010/mangmiljardsatsning-pa-infrastruktur-1.1070357>
- House of Commons Committee of Public Accounts (2007) Big Science: Public investment in large scientific facilities
- IdonGateway (2010) <http://www.ideongateway.se/>
- Lund Municipality (2010)
<http://www.lund.se/Bygga--bo/Stadsbyggnadsprojekt/Brunnshog/>
http://www.lund.se/Global/Förvaltningar/Stadsbyggnadskontoret/PDF-filer/Brunnshög_web.pdf?epslanguage=sv
<http://www.lund.se/Tillbehör/Nyheter/1-8-miljoner-kronor-till-Hallbara-Lund-NEBrunnshog-/>
- Martin, Ron and Sunley, Peter (2003) Deconstructing clusters: Chaotic concept or policy panacea?, Journal of Economic Geography
- Porter, Michael (1998) Clusters and the new economics of competition, Harvard Business review
- Porter, Michael (1998) The Adam Smith address: Location, clusters, and the "new" microeconomics of competition, Business Economics
- Press, Kerstin (2006) A life cycle of clusters, Physica-Verlag Heidelberg New York
- Region Skåne (2009) Regional Development Department, The ESS in Lund - its effect on regional development, Pricewaterhousecoopers
- Sydsvenskan Newspaper (2010)
<http://www.sydsvenskan.se/lund/article629731/ESS-och-Max-IV-fick-fart-pa-Brunnshogsplanerna.html>
- Sölvell, Örjan (2004) Clusters and the new growth-policies, Centre for Research on Innovation and Industrial Dynamics
- The National Audit Office (2007) Big Science: Public investment in large scientific facilities
- The University City Science Centre (2009) An Engine of Economic Growth for Greater Philadelphia
- University Ranking agency (2010)
<http://www.urank.se/ranking.html>
- Venables, Anthony J & Crafts, Nicholas (2001) Globalization in History: A Geographical Perspective, Centre for Economic Performance London School of Economics and Political Science