Exploring the socio-economic impact of ESS

Full report 2013 - 2018

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Socio-economic impact assessment of the European Spallation Source ERIC:

Evaluation of the Construction Phase through 2018

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Executive summary

Europe's Research Infrastructures (RIs) enable major scientific breakthrough and incubate the discoveries that foster innovation. Given the overwhelming public consensus on the need to address the societal challenges facing Europe and the world, RIs must embrace the responsibility to create and sustain societal impact. Within this context, the European Strategy Forum for Research Infrastructures' (ESFRI) "Strategic Report on Research Infrastructures" (Roadmap 2018) recommends that European RIs establish effective means to determine their economic and wider social value, and prioritise the development of indicators and measures that help to establish causality between RIs and socio-economic impact (SEI).

Once fully operational, the European Spallation Source (ESS) ERIC will be an international, multidisciplinary research facility based on the world's most powerful neutron source. The facility is under construction in Lund, Sweden, with its Data Management and Software Centre (DMSC) located nearby in Copenhagen, Denmark.

In 2015, ESS became the first European Research Infrastructure Consortium (ERIC) established in Scandinavia. ESS is currently in the Construction Phase (2013-2025), running in parallel to the Initial Operations Phase (2019-2025).

Embedded in the ESS vision and mission statement is the goal to achieve not only scientific breakthrough, but also to generate a wide range of societal and economic impacts through research activities, public dissemination of knowledge, reinforcement and extension of scientific networks, societal outreach, promotion of economic growth in local regions, procurement of innovative technologies, and research collaborations with scientific organisations and with industry. The impacts of these activities are expected to be evident directly on the Member Countries and to extend indirectly across many additional countries and regions in the long run.

By the end of 2018, the total 654 publications since 2008 that were authored/co-authored by ESS have been cited 4,671 times, increasing by 14.6% on average every year.

Between 2013-2018, 54% of 541 publications with ESS affiliation were co-authored with partner universities, 8% with at least one industrial firm, 64% with another RI (with overlap).

ESS has worked with 194 new partners in grant projects, 16 of which are from outside of the EU.

ESS has welcomed a total of 19,465 visitors to the construction site or off-site facilities. During 2013-2018, ESS was mentioned in a total of 11,293 online media articles.

VISIT

Target Station building with its iconic oval roof

How to read this report

This report is the first, early attempt to benchmark the socio-economic impact of ESS as a civil construction project, a ground breaking scientific and technical project, and a future scientific user facility. The assessment period of 2013-2018 represents the first six years of the construction of ESS. The SEI assessment is therefore heavily weighted toward the impacts of ESS as a European infrastructure project, however, the organisation's first clear indications of scientific impact were already emerging in this period and are therefore included. ESS works with a singular focus on achieving its four strategic objectives, which serve as the structure for this report. Establishing early benchmarks for these objectives, even when based on only faint signals, is an important input to ESS' stakeholders, including those tasked with governing ESS and managing the organisation's trajectory through its planned phases of development and operation.

ESS is of course not alone in making such assessments. Establishing meaningful performance metrics across research infrastructures is a European-wide endeavour that provides the context for this report.

This ESS SEI pilot is part of an ongoing effort to establish and refine a standard set of indicators and best practices to measure and evaluate the impact of the many different types of RIs in Europe. For ESS, that process began as work within the EU project BrightnESS (2015-2018), but the primary methodological foundations for this report can be found in two 2019 reports published by the OECD and ESFRI, respectively[1]. These reports proposed the first common frameworks for the SEI assessment and performance monitoring of Europe's research infrastructures and represent the state-of-the-art. Several of the indicators used to contribute to the assessment of ESS' strategic objectives, along with the means and methods to measure them, have therefore been selected on this basis.

This report also reflects recent projects aimed at refining and expanding the complementary frameworks proposed by the OECD and ESFRI. The EU has given its support to two contemporaneous Horizon 2020 projects, ACCELERATE and RI-PATHS, whose outcomes will help to further refine how socio-economic impact should be assessed for research infrastructures like ESS. This ESS SEI report, while created under the Horizon 2020 project BrightnESS[2], has been undertaken with full awareness of, and within the context of, this parallel work. The authors of this report have made contributions to those projects, while those projects' interim findings have fed into the methodology of this report.

Finally, it is important to underscore that while this SEI pilot report recognizes the importance of aligning to the emerging standards for RI SEI assessment, it remains that those standards are sometimes an odd fit for a scientific organisation during the first years of its construction phase. As ESS matures toward steady-state operations, the applicability of certain indicators, and the strength of the data collected to measure them, will mature in parallel to the facility's and the organisation's planned phases of development and operation. For the moment, however, ESS offers this facility-side snapshot of where the organisation's SEI stands through 2018, and the impacts that can be expected to accumulate year over year.

ESS has awarded 192 contracts valued above 50 k€ – 92% of which to firms in its Member Countries.

According to the ESS Supplier Survey, 37% of 284 respondents reported experiencing increased overall profitability, and 20% having entered a new market. Among the 208 non-off-the-shelf respondents, 50% reported improved technical know-how and many derived other innovation benefits.

According to the 27 respondents of the In-Kind Partner Survey, nearly three quarters of the In-Kind Contributions require either highly customised or new and advanced products, technologies, or services.

Helium tanks in the outdoor area adjacent to Cryo-Compressor Building

[1] "Reference framework for assessing the scientific and socio-economic impact of Research Infrastructures", OECD 2019; "Monitoring of Research Infrastructures Performance", ESFRI 2019.

List of abbreviations

CERN	European Organisation for Nuclear Research
CII	Core Impact Indicator
DMSC	Data Management and Software Centre
DTU	Technical University of Denmark
ERIC	European Research Infrastructure Consortium
ESFRI	European Strategy Forum on Research Infrastructures
ESS	European Spallation Source
EU	European Union
GA	Grant Agreement
GEM	Grenoble School of Management
H2020	Horizon 2020
IKC	In-Kind Contribution
IKP	In-Kind Partner
IOP	Initial Operations Phase
KPI	Key Performance Indicator
MoU	Memorandum of Understanding
OECD	Organisation for Economic Co-operation and Development
R&D	Research and Development
RI	Research Infrastructure
SEI	Socio-economic impact
TA	Technical Annex
WoS	Web of Science
WP	Work Package

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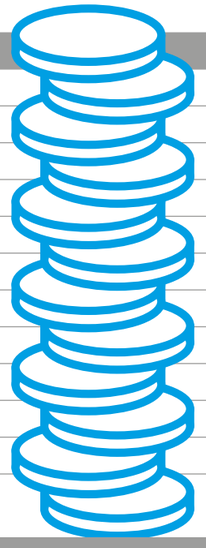
About ESS

The European Spallation Source (ESS) ERIC is a ground breaking scientific and technical project and a future international, multidisciplinary research facility based on the world's most powerful neutron source. ESS aims to advance the use of neutrons in scientific discovery, enable access to state-of-the-art instrumentation, and provide world-class support to the scientific community. Once fully operational, the facility's unique capabilities will both greatly exceed and complement those of today's leading neutron sources, enabling new opportunities for researchers across the spectrum of scientific discovery, including materials and life sciences, energy, environmental technology, cultural heritage, and fundamental physics. The facility is under construction in Lund, Sweden, with its Data Management and Software Centre (DMSC) located in Copenhagen, Denmark. In 2015, ESS became the first European Research Infrastructure Consortium (ERIC) established in Scandinavia.

The life cycle of the facility is divided into several phases. The Construction Phase started in 2013, when the ground-breaking ceremony took place in September 2014. It is currently running in parallel to the Initial Operations Phase (2019-2025). First Science is planned to begin during this period in 2025. The budget for the Construction Phase (2013-2025) is 2,120 M€ total, the Initial Operations Phase (2019-2025) is currently funded to 768 M€, and in 2015 the ESS Statutes estimated the Steady State funding requirements to be 140 M€ per year..

The ESS is a partnership of 13 Member Countries, including the two Host Countries, Sweden and Denmark. The Construction Phase to date (August 2020) has been 72% completed. The construction is financed 53.3% by its Host Countries, and the remaining 46.7% by the other 11 Member Countries. In total, around 550 M€ of the construction costs will be supplied through In-Kind Contributions (IKCs). The Member Countries have committed to cash or In-Kind towards the construction of ESS as presented in Table 1 (figures in the table are based on statutory and extra-statutory contributions).



Member Country	Contribution
Host Countries Sweden and Denmark	1,131.0 M€*
Czech Republic	41.9 M€
Estonia	5.2 M€
France	166.9 M€
Germany	209.4 M€
Hungary	20.0 M€
Italy	119.3 M€
Norway	52.3 M€
Poland	37.7 M€
Spain	57.8 M€
Switzerland	69.8 M€
United Kingdom	209.2 M€

Table 1: Member Country commitments towards construction costs (excluding pre-construction costs) of the ESS (all amounts refer to January 2013 figures)

* The split will be determined by the two Host Countries

Strategic objective 1:
ESS produces research outputs that are best-in-class both in terms of scientific quality and in terms of socio-economic impact

Strategic objective 3:
ESS is built safely, on time and on budget, operates safely, efficiently, and economically, and responds to the needs of its stakeholders, its Host Countries and Member Countries

Strategic objective 2:
ESS supports and develops its user community, fosters a scientific culture of excellence, and acts as an international scientific hub

Strategic objective 4:
ESS develops innovative ways of working, new technologies, and upgrades to capabilities needed to remain at the cutting edge

Table 2: Strategic objectives based on ESS' missions, vision, and values

Through the In-Kind model, partner institutions – on behalf of their national governments – contribute to the ESS construction in supplying equipment, design documentation, personnel or other services. These contributions are accounted for in the overall contribution from each Member Country, alongside their financial contributions. Under its In-Kind model, ESS works with more than 40 European partner institutions and nearly 130 collaborating institutions worldwide. Nearly 30% of the construction cost is expected to be supplied through IKC. An In-Kind model on the scale of ESS has never been attempted in a European Big Science project.

The construction of ESS as one of the largest Research Infrastructure projects to date is only made possible by dedicated public investment in Europe, paid by tax-payer contribution. Thus, it is central to ESS' vision and missions to generate and demonstrate its return to the society at large in the long run. ESS' vision is to "build and operate the world's most powerful neutron source, enabling scientific breakthroughs in research related to materials, energy, health and the environment, and addressing some of the most important societal challenges of our time" and its missions are reflected in its strategic objectives (see Table 2). The vision and missions of ESS indicate clearly that ESS is not only supposed to achieve scientific breakthrough, but also to generate a much wider range of societal impacts through, among others, research activities and dissemination of public knowledge, extension of scientific networks, societal outreach, economic growth in local regions, procurement of innovative technologies, industrial collaboration, and In-Kind Partnership. These impacts are the results of enabling science at ESS and are expected to bear directly on the Member Countries and to be extended indirectly on many countries and regions.

Making impact in pursuit of ESS strategic objectives: Building narratives

ESS was founded with an ambitious vision and missions because it has from its beginning put a strategic focus on making science countable and impactful for the society at large. ESS impacts its direct environment in different ways through its activities. Enabling excellence in science is expected via grant-funded research and is demonstrated by least: high quality scientific publications; promoting science to citizens; creating economic activities (e.g., via procurement); contributing to education and training; creating attractiveness for the local areas, and; through shaping scientific and economic networks (e.g., through In-Kind Partners). All these potential impacts on society, not only on science, must be taken into account and measured to show that ESS is not only an infrastructure focused on science for scientists, but also on science for society.

These intended impacts will take time to emerge and become evident, considering the developmental process of ESS. Currently, ESS is still under the Construction Phase, which runs until 2025, and moving towards the Operations Phase. This is an important context for the readers to consider when reading this report. The report aims to demonstrate some emerging evidence of ESS' socio-economic impact during the ongoing Construction Phase (the 2013-2018 assessment period), when scientific impact and technology development regarding accelerator and target have already been made evident.

In addition, this report also considers some forward-looking perspectives for the long-term impact of ESS.

Since ESS' vision is to achieve scientific breakthrough in neutron research, which in turn generates positive societal impact, it is reasonable to understand that the assessment of ESS' long-term impact of a wide range is relatively difficult when it has not yet begun its scientific user programme. However, even though still in the Construction Phase, ESS has already been engaged in various activities and has been keen on creating and demonstrating its scientific, economic, innovation, social and environmental impacts on its direct partners and stakeholders, and indirect networks in pursuit of its strategic objectives. Thus, the early evidences of socio-economic impact (SEI) of ESS demonstrated in this report are collected and organised based on narratives and impact pathways that are specifically relevant for this particular period of the Construction Phase until 2018. It is also important to note that the evident SEI of ESS shown in this report is narrated from a facility perspective, which does not necessarily cover a wide range of indirect impact taking place within Member Countries.

Following the principle of several recent EU forums, initiatives and programs, such as ESFRI (ESFRI, 2019), ACCELERATE (GA no. 731112), and RI-PATHS (GA no. 777563; Griniece, Kroll, Cvijanovic, & Reid, 2019; Griniece et al., 2020), we propose that ESS' pursuit of its strategic objectives, as defined by the ESS mission statement, will drive the socio-economic impact of ESS. This report therefore uses a mix of indicators relevant to the ongoing Construction Phase (evidence collected for the period 2013-2018) that can find their references in the prior art of EU or OECD suggestions.

In pursuit of each strategic objective, an impact narrative is developed as the rationale behind the resulted impacts being demonstrated in this report. Each impact narrative is connected to relevant indicators and measures, which will be deliberated in the next chapter. These impact narratives are not intended to make any assessment of the state of the ESS project itself.

ESS and the neighbouring MAX IV Laboratory, October 2020

Strategic objective 1: ESS produces research outputs that are best-in-class both in terms of scientific quality and in terms of socio-economic impact

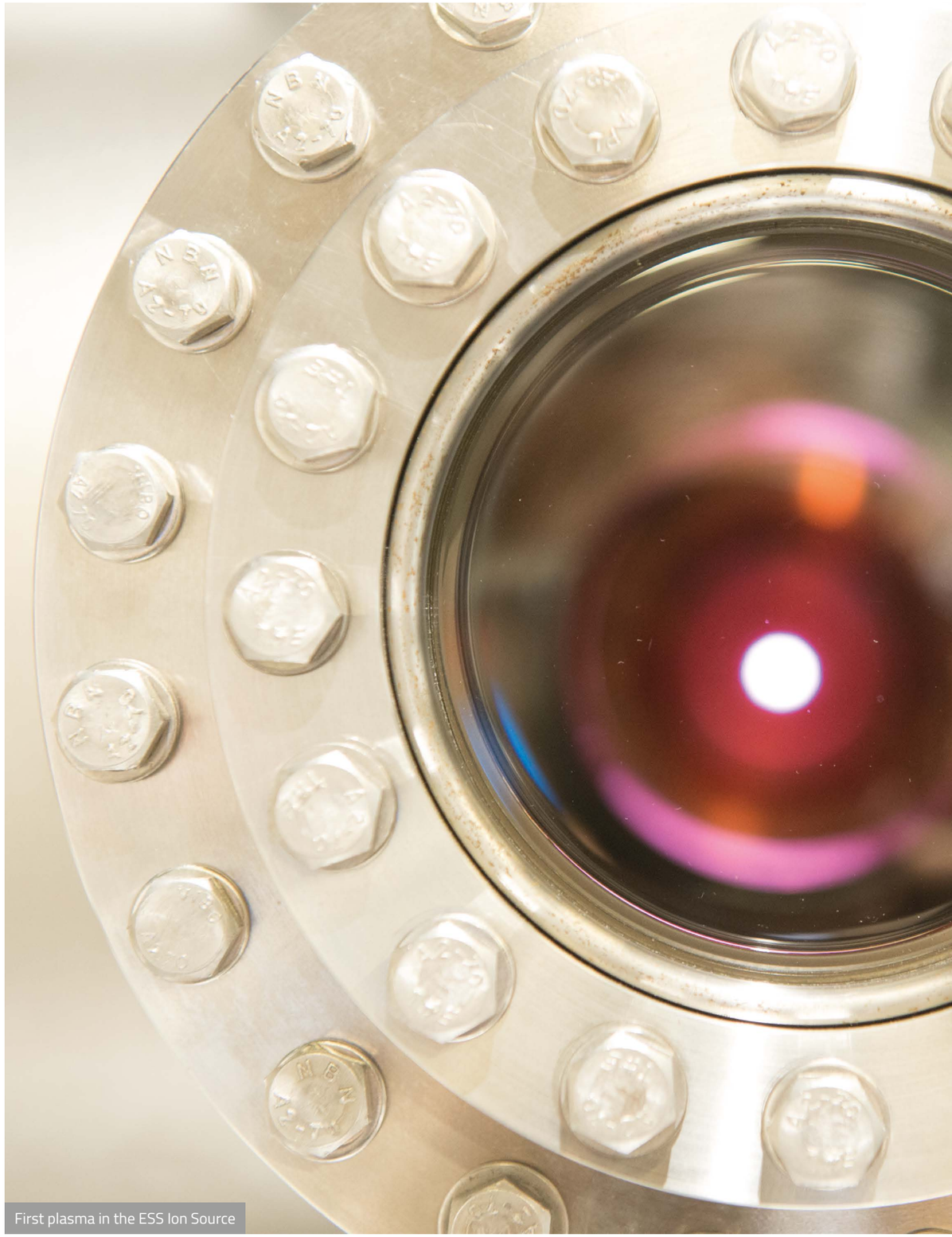
IMPACT NARRATIVE

Pathway: Publication – citation – collaboration – recognition

As a world-class scientific research facility, ESS will be the centre of numerous research activities in the relevant scientific fields in the years to come. The research outputs must be excellent in a sense of scientific value, as well as creating impact to ESS research partners within the scientific community. ESS can demonstrate already now considerable research outputs that reflect both its ambition to be the best-in-class in regard to the technology development along with the construction of ESS and its preparedness for the future scientific breakthroughs it is going to enable. Although it is not yet an operational facility, ESS has become a leading member of the scientific community regarding accelerator, target, neutron technologies (including detectors, choppers, optics, polarization, sample environment, control and data infrastructure), and neutron instrumentation and method development, demonstrated by ESS' scientific publications and collaborative research with, amongst others, many partner institutions, universities, and the industry. To achieve this strategic objective, ESS generates and disseminates enabling and impactful scientific knowledge.

Several indicators are used to demonstrate the impacts achieved in pursuit of strategic objective 1. These indicators include but are not limited to the following:

- Research activities: with and without collaboration with various partners, including several neutron source scientific networks, i.e., the League of advanced European Neutron Sources (LENS) and the European Neutron Scattering Association (ENSA).
- ESS publications: including their citations, h-index, co-authorship with partner universities, other RIs, and industry, share of publications per Member Countries, and the relationship between ESS publications and industry R&D collaboration.



First plasma in the ESS Ion Source

Participants of IKON 14 at the French In-Kind Partner, CEA

Strategic objective 2: ESS supports and develops its user community, fosters a scientific culture of excellence, and acts as an international scientific hub

IMPACT NARRATIVE

Pathway 1: Creating and shaping scientific networks and communities

It has long been understood within the science community that the long-term sustainability of ESS is dependent above all on the long-term sustainability of the existing community of European neutron scientists and facilities – the future users of ESS. For its scientific success, ESS must be directed by the scientific needs of its future users. The need for ESS long-pulse neutron source and corresponding instrument suite is the result of a bottom-up neutron-user-driven approach.

Even though it is still at the Construction Phase, ESS has been actively building its future user community and broadening its network through collaborative research supported by various activities. For instance, by leading and participating in various grant projects, ESS has the opportunity to develop relationships with new partners from other research facilities, academia and with industrial firms, within and outside of Europe, so that the status of an international scientific hub will be achieved. The role of being a scientific hub can also be demonstrated in terms of, for instance, the scientific events and user meetings organized by ESS, as well as In-Kind Partners' network benefit derived from working with ESS.

Several indicators are selected to demonstrate this impact pathway in pursuit of strategic objective 2. These indicators include but are not limited to the following, for example:

- Grant proposals: including information about granted and non-granted proposals, involvement with In-Kind Partners, industry partners, and other RIs
- Scientific events: including conferences, symposiums, and workshops with and without collaboration with various partners, including other neutron source scientific networks, i.e., LENS and ENSA
- User meetings: including meeting in collaboration with other relevant RIs
- Research collaboration with industry: including grant projects and other procured industry R&D

Pathway 2: Communication, outreach, and engagement

To foster a scientific culture around neutron source research and related fields, it is important to engage society through various public communication and outreach activities. These activities can be monitored through, for instance, site visits and online information sessions, online media channels, including social media, and involvement in various education programs. In the coming years, these efforts may also be demonstrated through public events.

Several indicators are selected to demonstrate this impact pathway in pursuit of strategic objective 2. These indicators include but are not limited to the following, for example:

- Informational visits and online sessions about ESS construction site and research
- Media exposure: including social media activities and attentions received
- Involvement in education: including contribution to partner universities' relevant educations and PhD and Postdoc programs

Strategic objective 3: ESS is built safely, on time and on budget, operates safely, efficiently, and economically, and responds to the needs of its stakeholders, its Host Countries and Member Countries

IMPACT NARRATIVE

Pathway 1: Safety – energy use – waste management – environmental impact

Throughout the construction of the facility, ESS has been built with highest consideration of safety and efficiency, and environmental impact. ESS seeks to procure goods, services and works with a reduced environmental impact throughout their life cycle. This may include, for example, the reduction of greenhouse gas emissions and air pollutants, improved energy and water efficiency, use of renewable resources, reduced hazardous waste and support for refuse and recycling. Meanwhile, the construction of ESS also responded to the needs of ESS Member Countries and its stakeholders, primarily achieved through cost-efficient procurement activities, the tendering system, and budgetary means. In later years, safety activities will be monitored by ESS.

Several indicators are selected to demonstrate this impact pathway in pursuit of strategic objective 3. For example:

- Waste volume
- Hazardous waste
- Energy consumption

Pathway 2: Employment & procurement – rendering economic benefits to Member Countries through suppliers and In-Kind Partners

First, public procurement is commonly used as a demand-side policy tool that renders economic benefits for industrial suppliers, including creating new jobs and business. These benefits are expected to be evident already during the Construction Phase of ESS for both Host Countries and Member Countries. Economic benefits cannot be expected to emerge without effective implementation of ESS procurement activities according to the European Spallation Source ERIC Procurement Rules. Second, the ESS construction project relies heavily on In-Kind Contributions for its successful execution. The ESS IKC model was chosen by the organisation's founding partners to enable a distributed effort that would both capitalise on and enhance competencies across Europe, while expediting construction. As a result, the procurement activities and the IKC model allow ESS to leverage the collective knowledge, experience, and resources of Europe's leading research institutions and industry, support the creation of jobs, strengthen the high-tech industry, and foster collaboration between key scientific stakeholders, without which it is simply impossible for ESS to be built and keep operating successfully.

It is also important to consider these impacts with regard to the way in which ESS interacts with suppliers and In-Kind Partners – where a mutually supportive relationship can foster future cooperation that leads to economic and innovation benefits. Staff diversity and mobility (such as relocations and secondments) are also being tracked. The construction and operation of ESS is not supported by an established laboratory, and therefore it is essential the project recruit skilled, mobile professionals from partner countries and other sources, and that staff are in turn able to feed back into the scientific community. Diversity goes hand in hand with recruitment goals across the ESS member countries and project stakeholders.

Several indicators are selected to demonstrate this impact pathway in pursuit of strategic objective 3. For example:

- Tenders received from and contracts awarded to Member Countries
- Number of suppliers and their perceived economic benefits
- ESS support to suppliers
- Interaction and cooperation with ESS assessed by In-Kind Partners
- ESS Industrial Liaison Officers Network (ILO) Meetings
- Employment of ESS, In-Kind Partners and Skanska during the Construction Phase
- ESS staff diversity in terms of gender and nationality

Construction work on the ESS Experimental Halls, January 2021

Strategic objective 4: ESS develops innovative ways of working, new technologies, and upgrades to capabilities needed to remain at the cutting edge

IMPACT NARRATIVE

Pathway: Technology push through procurement and In-Kind Contribution, and building innovation capacity of ESS and industry in Member Countries

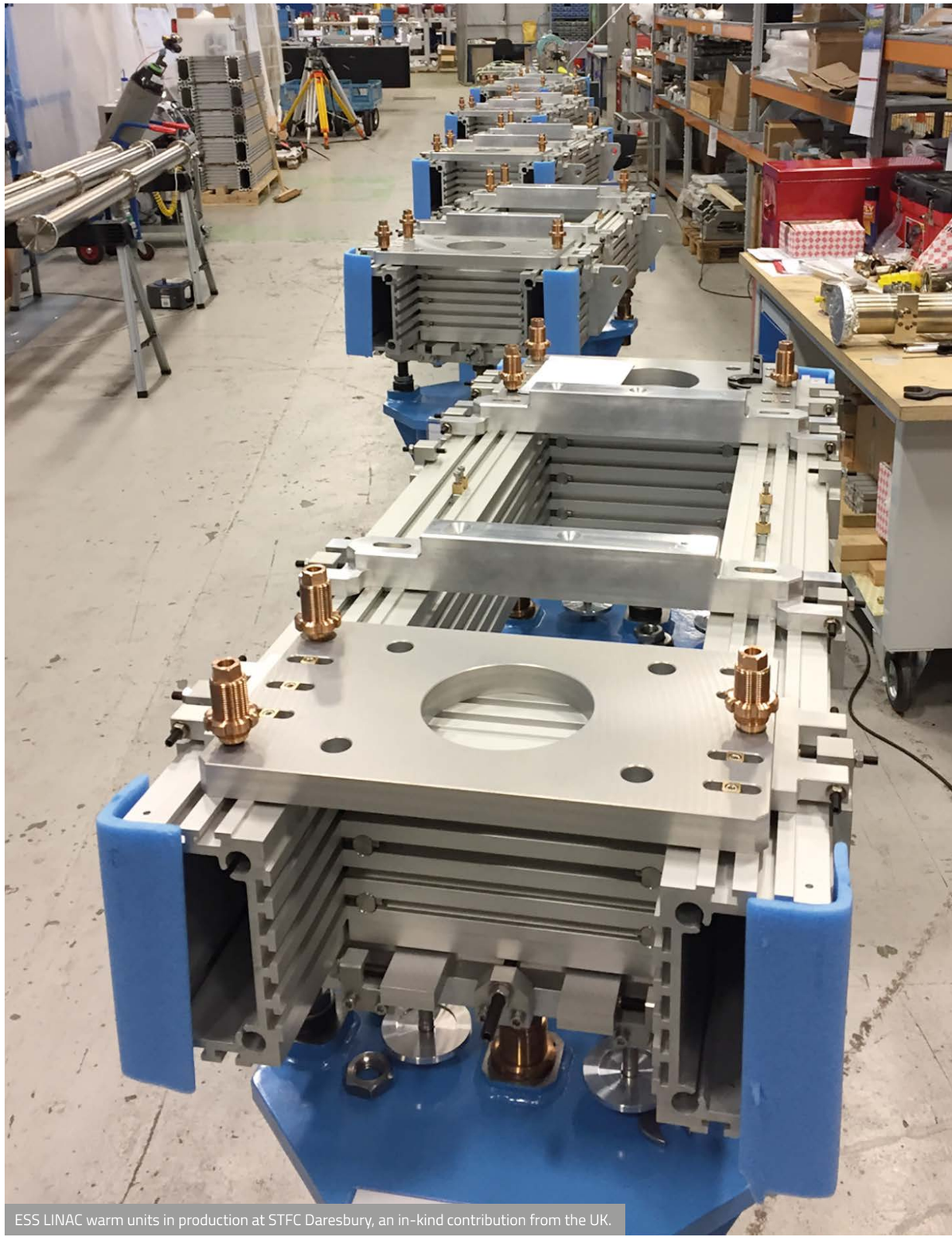
Building a neutron facility of this magnitude in size and involvement of specialised technologies requires world-class expertise, cutting-edge technologies, and innovation. That is why ESS works closely with suppliers and In-Kind Partners in the Member Countries to make technological and process innovations and build innovative capabilities within ESS and with partners. This is achieved through joint R&D via In-Kind Contributions and through specialised procurement that add innovation value to the suppliers in Member Countries. In doing so, knowledge transfer and positive spillover effects in a medium to long run will contribute to innovation capacity building among the Member Countries.

One of the ESS procurement objectives is to make sure that, in a timely and non-prescriptive manner, procurement needs are stated as outcomes, whenever possible. This is in order to maximise opportunities for innovators and suppliers, where they can present their solutions early on in their involvement, which allows for the realisation of the suppliers' full potential.

The ESS IKC model creates the opportunity to enrich knowledge and skills and to create business in each Member Country – thus benefitting from ESS membership already in the Construction Phase. The benefits are expected to exceed the direct relationship between ESS and its In-Kind Partners, through collaborative projects beyond the scope of the In-Kind Contributions. Similarly, by working with ESS, suppliers may benefit in terms of developing new technologies, products and services, and potentially extending market opportunities. Thus, in pursuit of this strategic objective, ESS makes its impact by uplifting technological innovation capacity of itself and of In-Kind Partners and industry in the Member Countries.

Several indicators are selected to demonstrate these impacts in pursuit of strategic objective 4. For example:

- In-Kind Agreements and In-Kind Technical Annexes
- Cost book value of IKC by Member Countries
- Innovation level of IKC
- Innovation benefits for suppliers
- Types of innovations supplied to ESS
- ESS patenting
- ESS technologies that address societal challenges



ESS LINAC warm units in production at STFC Daresbury, an in-kind contribution from the UK.

Socio-economic impact assessment: Prior art and ESS methodology

Socio-economic impact for RIs

As recommended by ESFRI's Strategic Report on Research Infrastructures (Roadmap 2018), RIs must set up effective means of determining their economic and wider social value. The SEI assessment of RIs has been an increasingly important topic in recent years. SEI methodologies and challenges are regularly discussed within the European RI community, whose stakeholders have developed an interest in the effects of science on society beyond scientific breakthrough.

Assessing socio-economic impact of RIs is important for four distinct categories of stakeholders: (1) RI managers who expect value for different audiences (social, economic, and scientific), (2) funders seeking economic and social returns from their investment, (3) the public at large looking for visible change in economic conditions, business and social activities, and (4) employees and users in order to enhance expertise and research capabilities through excellence.

Much progress in the field of SEI in relation to large RIs has occurred during the last two years with the development of reference frameworks and assessment protocols by a variety of significant actors, including but not limited to the OECD, ESFRI and various projects funded by the European Commission. The OECD "Reference framework for assessing the scientific and socio-economic impact of Research Infrastructures" (OECD, 2019) report was published in the spring of 2019. The reference framework is made up of a list of Core Impact Indicators (CIIs) along with a comprehensive list of standard indicators. The December 2019 ESFRI Working Group report "Monitoring of Research Infrastructures Performance" (ESFRI, 2019), provides a list of 21 proposed Key Performance Indicators (KPIs) that were developed to be used in a periodic review of ESFRI Landmarks. The EU Horizon 2020 funded projects RI-PATHS (GA no. 777563) and ACCELERATE (GA no. 731112) place a stronger focus on different pathways of RIs' impact through the use of narratives that are received as relevant for different stakeholders and supported by both quantitative and qualitative empirical evidence.

The ability to measure and evaluate socio-economic as well as scientific impact is key for an RI to make itself countable and sustainable in the long-term. Thus, during the Horizon 2020 (H2020) funded project BrightnESS (2015-2018; H2020 Grant Agreement no. 676548), ESS had put an effort into developing a pilot framework to formulate the assessment methods for the Organisation's SEI (Mangematin & Bally, 2018) together with the Grenoble School of Management (GEM) and KEDGE Business School. The BrightnESS project played a critical role in laying down the foundation early in the life cycle of ESS and setting up an overall approach to systematically measure its socio-economic impact. The BrightnESS project took a first step to outline socio-economic metrics and indicators relevant for the Construction and Operations Phases of ESS, and to collect data covering the pilot year of 2016.

To follow up with the BrightnESS project and align with the strategic priority of assessing RIs' societal impact laid down by the various initiatives in Europe mentioned above, ESS has continued its efforts in further developing and operationalising an actionable assessment framework of socio-economic impact in the BrightnESS² project for long-term use. The BrightnESS² Work Package (WP) 5, Task 5.3, aims to make the assessment of socio-economic impact of ESS a systematic annual routine of ESS. This Work Package was subcontracted with Technical University of Denmark (DTU).

In collaboration with ESS, DTU has built on the grounds laid down by BrightnESS to refine the socio-economic impact assessment framework for ESS and to collect and analyse data covering the Construction Phase until 2018. This has been done with the support of the management across several divsions of ESS, along with inputs from many of ESS' industrial suppliers and In-Kind Partners. The original metrics suggested by the BrightnESS project were mostly kept in the current framework, adapted into clear indicators and measures. In addition, some changes have been made to regroup or rephrase the items in the current framework to better align with the new EU initiatives and programmes (RI PATHS and ACCELERATE). Relevant data for measuring the majority of these indicators have been monitored and stored within ESS' internal management system already at the time of making this report.

The ESS methodology: Indicators, measures, and complementary surveys

The current SEI assessment framework consists of a series of indicators and measures, built on the prior art made by the original BrightnESS project and aligned with other EU initiatives. One distinctive approach of the current ESS SEI assessment is that it maintains a clear distinction between indicators and measures, taking pains not to equate the two. The report, therefore, uses measures—that is, data—only as the means to support the assessment of a particular indicator. For instance, "collaboration between MAX IV and ESS" is an indicator, which can be measured in different ways, among which "publications co-authored with researchers at MAX IV" is one of the measures. Many measures are further broken down into more detailed ones, e.g., per Member Country.

Additional indicators	Impact type
Cost performance index	Economic
Technology transfer	Innovation
ESS inventors	Innovation

Table 3: Newly created indicators for the BrightnESS² framework

It is a common approach recognised by several European SEI initiatives and programmes, and followed by the BrightnESS project as well, that SEI indicators can be categorised in at least the following types:

- Scientific impact
- Economic impact
- Innovation impact
- Social impact
- Environmental impact

In this report, the categorisation above is adopted and regrouped into concrete indicators or measures into these impact types. While most indicators are quantitatively measurable, some qualitative measures (stories and cases) are used as well. In addition, three new indicators were added into the SEI assessment of ESS (See Table 3).

While a full list of indicators and measures, grouped into five types can be found in Appendix 1: Indicators and measures, a summary of indicators and measures according to their relevance to the Construction Phase and Operations Phase is shown in Table 4.

To make this report, relevant data for the Construction Phase until 2018 were collected with the support from the relevant divisions across ESS who own or have access to the data. With the development of the ESS User Office, new measures have been created reflecting the User Offices' own user survey that will be much more detailed in comparison to the user survey designed by the BrightnESS project. The employee survey included in the BrightnESS framework has been replaced with new measures that are based on the biannual Employee Survey conducted by the HR division. The survey for funders and stakeholders from the BrightnESS framework may continue to be used, whenever necessary. The 2016 pilot test results were not re-used. In addition, the ESS Annual Research Reports are used in this report. A full presentation of the data collected from ESS internal sources is included in Appendix 2.

The current framework includes new data sources from two additional surveys, one for suppliers and the other for In-Kind Partners, which complement ESS internal data concerning procurement activities and In-Kind Contributions. Similar approaches have been used by CERN to investigate the economic and innovation impact on its suppliers (Sirtori et al., 2019). These two surveys provide an external perspective about the impact resulting from working with ESS on suppliers and In-Kind Partners. The surveys focused on the type of contributions these actors have made to the ESS project, the innovation level of their products and services, their perceived relationship with ESS and the effects on their networks. Suppliers were also asked about any economic benefits generated as a result of their work with ESS. Insights derived from these two surveys are unique to ESS and invaluable to probe the indirect SEI impacts that ESS may create. The Supplier Survey was sent to approximately 2,600 suppliers by e-mail (approximate number after e-mail bounce backs). Eventually, 284 respondents completed the survey in full, resulting in a nearly 11% response rate, which is satisfactory for a randomised industry survey. The In-Kind Partner Survey was sent to 69 Work Package Coordinators, across the ESS Member Countries. Some organisations opted to submit a single consolidated answer representing all Work Packages coordinated by the Organisation. As such, the survey received 27 responses from 12 Member Countries, with Spain unavailable.

Phase	Total number of indicators	of which are measured per Member Country	Total number of measures	of which are measured per Member Country
Construction only	**3**	**(1)**	**6**	**(4)**
Construction & Operations	**34**	**(8)**	**137**	**(15)**
Operations only	**21**	**(1)**	**62**	**(3)**
Total	**53**	**(10)**	**205**	**(22)**

Table 4: Number of indicators and measures per ESS project phase

Member Country	No. of respondents per Member Country	No. of responding Partner Institutes
Sweden	**1**	**1**
Denmark	**1**	**1**
Czech Republic	**1**	**1**
Estonia	**2**	**2**
France	**4**	**3**
Germany	**2**	**2**
Hungary	**1**	**1**
Italy	**5**	**3**
Norway	**4**	**3**
Poland	**1**	**1**
Switzerland	**1**	**1**
United Kingdom	**4**	**3**
Total	**27**	**22**

Table 5: IKP respondents per Member Country

Note: The Host Countries, Sweden and Denmark, do not have In-Kind Partners, but instead Partners who are making contributions in the spirit of In-Kind.

Table 5 shows the number of IKP institutes which had at least one response and the total number of responses from each country. While some IKPs had more than one response, the Spanish IKP did not manage to respond. The questions included in the Supplier Survey and the In-Kind Partner Survey are shown in appendices 3 and 4, respectively.

As the surveys were distributed during the COVID-19 global pandemic during March and April 2020, we presume that the response rate could have been higher if the disturbance of COVID-19 were absent. For this reason, ESS is confident that the response rate of these two surveys will be higher in the years to come, as they will be distributed and administrated on a regular basis. Thus, in this respect ESS is actively building data regarding the impact on industrial suppliers and In-Kind Partners.

The novelty of the ESS methodology lies in the way the indicators and measures are defined and constructed. First, the full list of indicators and measures are grouped according to the categorization made by the BrightnESS project and well respected by the current state-of-the-art. Second, each indicator can find its roots in indicators defined by either OECD or ESFRI. Third, the indicators and measures are labelled for their relevance for different phases of the ESS life cycle. Fourth, as each indicator has multiple measures, ESS managers have the flexibility to choose the most relevant and practically feasible measures to collect and report data, depending on the needs of SEI reporting. Last but not least, the combination of ESS internal data and an external survey as data sources reduces any bias that may exist within a particular RI. It is the intention of ESS to collect the internal and external data annually while maintaning the flexibility necessary to adapt the methodology of this pilot report to future scientific, economic, political, and environmental changes, and the requests of the project's stakeholders.

The next chapter reports the ESS SEI during the Construction Phase by following the narratives derived from the rationale behind the pursuit of each ESS strategic objective.

Socio-economic impacts of ESS over the first six years of the Construction Phase (2013-2018)

With 13 Member Countries, including the two Host Countries, ESS seeks to create a shared sense of ownership amongst its stakeholders – including the European scientific community, governments and funding agencies, In-Kind Partners, industrial suppliers, and society at large. This shared sense of ownership is demonstrated through the activities, outputs and impacts made throughout the first six years of the Construction Phase, 2013-2018. With this collective effort from a strong network of stakeholders, the long-term success of the ESS facility can be ensured.

Although only in its Construction Phase throughout the assessment period, ESS is already able to demonstrate its SEI in various ways. This is reflected by several indicators selected to mark its progress towards meeting its strategic objectives.

ESS broke ground on a Greenfield site in Lund in 2014

Strategic objective 1: ESS produces research outputs that are best-in-class both in terms of scientific quality and in terms of socio-economic impact

Pathway: Publication – citation – collaboration – recognition

As a future world-class scientific research institution, ESS is a central element in Europe's neutron strategy. ESS will enable and facilitate numerous research activities in scientific and technological fields related to neutron scattering. Although it is not yet an operational facility, ESS has already generated numerous research outputs of excellent scientific value. It has furthermore created impact to ESS research partners within the scientific community. To achieve the first strategic objective, ESS has become an active member of the scientific community in terms of scientific publications and collaborative research with, amongst others, partner institutions, universities, and industry to generate and disseminate new knowledge.

This report includes a selection of several indicators to show the impact created in pursuit of the first strategic objective of ESS. These indicators include ESS research activities, ESS publications and citations, h-index, co-authorship with partner universities and industry, and the positive relationship between ESS publications and collaborative R&D with industry.

First, ESS' scientific research excellence has been visible through publications authored or co-authored by ESS staff, with hundreds of peer-reviewed articles to date. Figure 1 shows the number of new publications authored or co-authored by ESS staff and the proportion of open access publications[2]. The total number of publications authored/co-authored by ESS is steadily increasing as the facility approaches First Science. Many of ESS' publications are open-access, making it easy for the research community to access and recognize. Publications to Open Access journals are increasing by roughly 4% with every year, nearing 50% of the total publications, and above 62% in 2018. The overall share of Open Access publications of ESS between the 2008-2018 period is 42%, which is lower than the Swedish national average of 47.5% and the Danish national average of 48.8% in all scientific fields over a similar period of 2009-2018. The national average of the remaining Member Countries are the following: Czech Republic: 42.7%; Estonia: 45%; France: 41.8%; Germany: 40.7%; Hungary: 49.8%; Italy: 40.4%; Norway: 47.3%; Poland: 46.6%; Spain: 44.3%; Switzerland: 51.8%; United Kingdom: 52.3%. However, when compared to the scientific fields that are relevant to ESS research only, the share of open access publications of ESS is much higher than the worldwide average (e.g., chemical engineering: 19%; chemical sciences: 19.4%; materials engineering; 19.8%; other natural sciences: 22.2%; other engineering and technologies: 23.9%; physical sciences and astronomy: 31.2%; etc.). (European Commission)

Next, citations to publications authored/co-authored by ESS since 2008 has reached 4671 by the end of 2018. With relation to the total number of publications, the rate of citations increases an average of 14.6% every year. Whereas the ESS facility is not yet in operations, and as such not much time has passed, it can be reasonably expected to see a gradual rise in the coming years leading up to First Science and the User Programme respectively. Similarly, the ESS h-index can be expected to follow a gradual increase during this phase. Figure 2 and Figure 3 show the total number of citations to and the h-index of ESS publications, respectively, during 2013-2018.

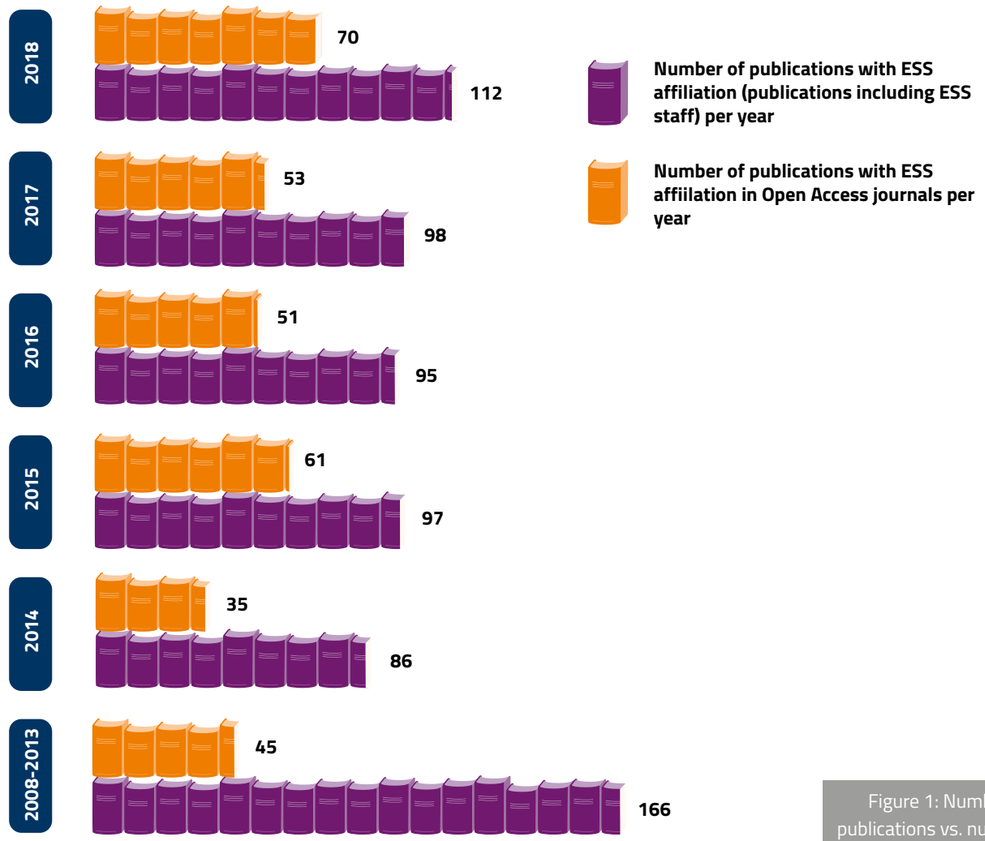


Figure 1: Number of publications vs. number of publications in Open Access journals

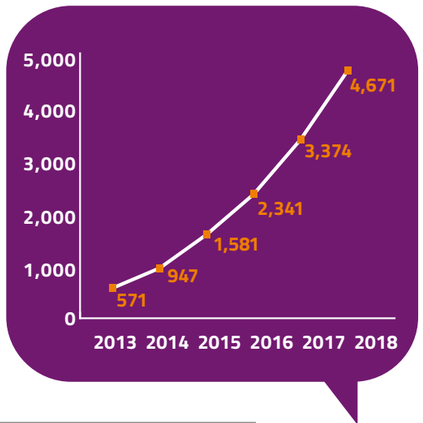


Figure 2: Total number of citations to publications of ESS

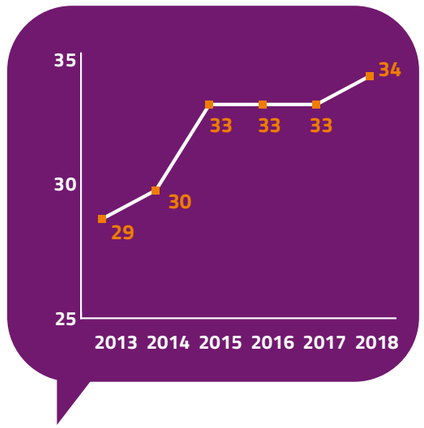


Figure 3: ESS h-index

[2]The Web of Science search results includes publications authored by ESS Scandinavia from as early as 2008. ESS Scandinavia was first established in the year 2000 to bid for the spallation source to be built in Scandinavia. As such, Figure 1 displays the accumulated total of publications between 2008 and 2013.

Next, data on ESS co-publications by Member Country reveal a detailed picture on scientific research collaborations among Member Countries. This measure is counted as a sum of shares of authors, per institute country, contributing to each publication. For example, when a publication is co-authored by one ESS author and one author from an Italian institution, ESS and Italy are each considered to have authored half a publication. Figure 4 below shows that ESS publications are consistently co-authored mostly among Swedish, Danish, German, French, UK, and Swiss institutions, with a noticeable increase of co-publications with Hungarian institutions in recent years.

Excellence in ESS scientific research also has a network effect on partner universities in the Member Countries. Universities within the hosting regions and ESS In-Kind Partner universities are strong collaborators to the research activities with ESS, as reflected by the overall co-authored publications. Among the total 541 publications of ESS published during the assessment period, 54% were co-authored with partner universities (including Lund University), indicating a significant impact of ESS on a wide range of international research communities at leading universities with respect to scientific research in the relevant fields. This

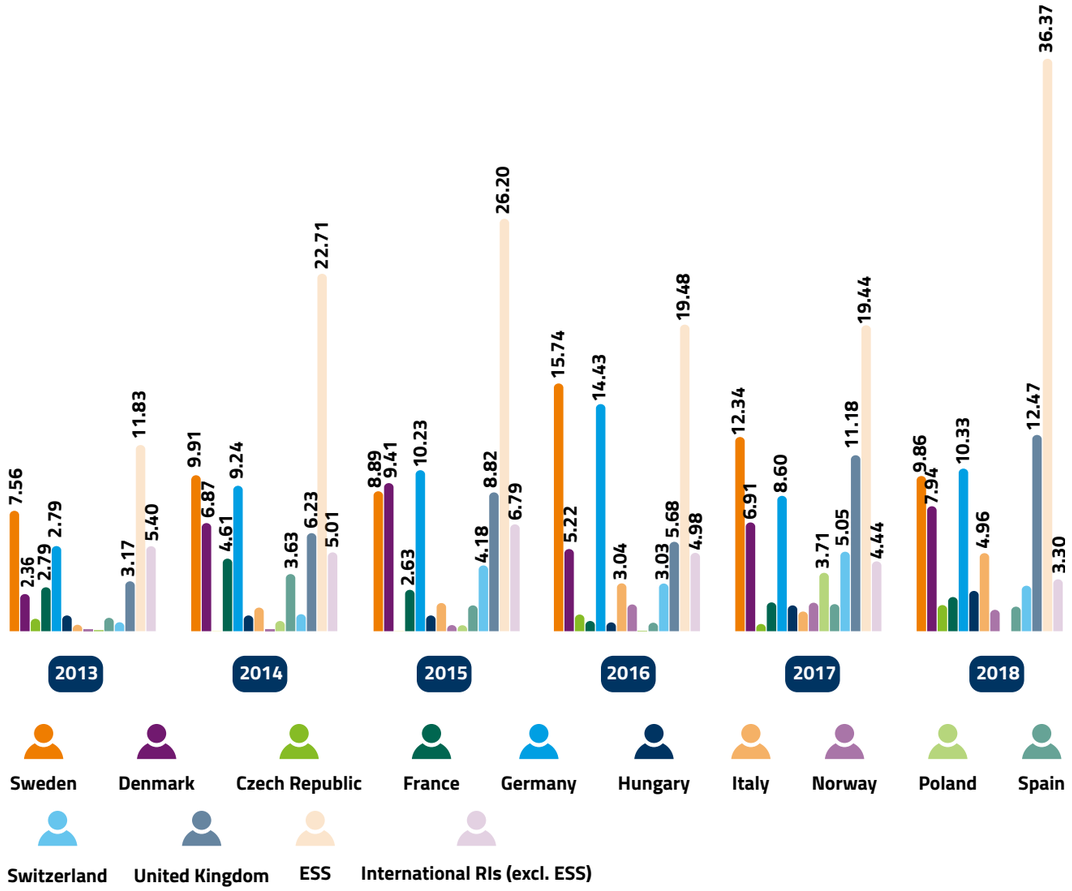


Figure 4: Number of ESS co-publications by Member Country per year (sum of shares of contributions to publications)

effect is expected to be more evident when ESS moves into the Operations Phase. Figure 5 shows the proportion of co-publications with partner universities (including Lund University) to the total number of new ESS publications during 2013-2018.

Table 6 lists the IKP universities and the actual number of their co-publications with ESS during the assessment period (NB. not as a sum of shares of contributions). It is obvious that some universities have been very active in collaborative research and publishing with ESS (e.g., Lund University, Copenhagen University, DTU, Uppsala University, and TU Munich), but there are others that ESS' research network has not managed to extend to. It is important to note that the great number of co-authorships with some universities is probably driven by the affiliation of ESS scientific staff with the universities. Therefore, the numbers presented in Table 6 could be a mix of actual collaborative research publications and the result of dual affiliation. Nevertheless, these numbers are still relevant and useful to observe the research collaboration between researchers at ESS and at the universities, because even in the case of dual affiliation, the research is also part of the university research environment, benefitting from the scientific knowledge exchange and intellectual interaction with colleagues at the university. Thus, tracing impact data as such provides ESS' scientific management with timely information.

Next, ESS also has a considerable amount of publications co-authored with industry and other RIs. These co-authorships can be traced back to 2008. Table 7 shows the number of co-authorships with industry and other RIs, along with the unique number of co-authoring industrial firms that appeared in the co-authored research. Similar to the co-authorship with universities, the co-authorship with other RIs takes a significant proportion of the total number of ESS publications, demonstrating a strong impact of ESS research in neutron science and related scientific fields within the research community. A steady number of co-authored publications with industry shows a continuous effort and result of collaborative research with industry.

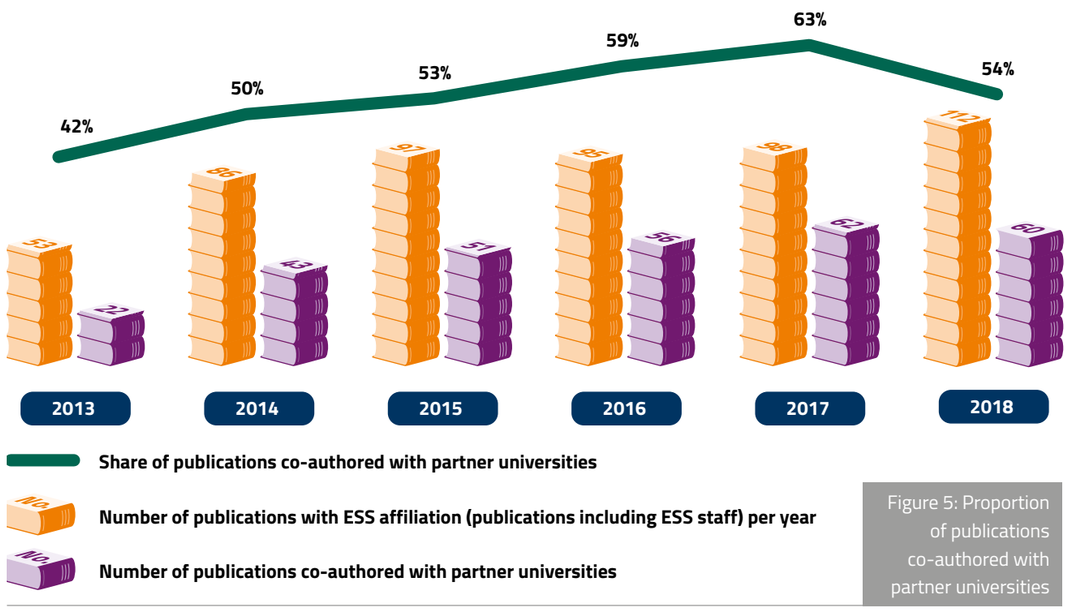


Figure 5: Proportion of publications co-authored with partner universities

University	Country	Number of co-publications with ESS
Aarhus University	DK	5
Copenhagen University	DK	73
Huddersfield University	UK	3
Lund University	SE	102
Roskilde University	DK	0
Tallinn University of Technology	EE	0
Technical University of Denmark (DTU)	DK	43
Technical University of Munich (TUM)	DE	19
University of Bergen	NO	7
University of Oslo	NO	5
University of Tartu	EE	0
Uppsala University	SE	33
Warsaw University of Technology	PL	0
Wroclaw University of Science and Technology	PL	3
ZHAW Zurich University of Applied Sciences	CH	1
Total		**294**

Table 6: Number of publications by partner universities co-authored with ESS

	2008-2012	2013	2014	2015	2016	2017	2018
Number of publications co-authored with industry	11	2	7	6	7	3	11
Number of unique co-authoring industrial firms	14	2	9	5	6	4	8
Number of publications co-authored with other RIs	80	36	48	60	64	61	79

Table 7: ESS co-authorship with industry and other RIs

The scientific impact of ESS is not limited to ESS' own publication record. Instead, the design and construction of ESS raised the interest of many researchers all over the world to focus on ESS as a subject of research. A Google Scholar search shows a result that during 2013-2018 there have been 178 scientific publications with a considerable number of citations up to 2020 about ESS, regarding its general development and progress (36 publications, 47 citations), instrument/instrumentation (71 publications, 387 citations), and design/construction (71 publications, 264 citations).

The impact of ESS scientific and technological research goes beyond scientific publication itself. One possible scenario is that scientific research documented in publications creates knowledge spillover to industry, wherever relevant to potential industrial technology development. Thus, by looking at the correlation between ESS scientific publications and R&D collaboration with industry partners, it is possible to preliminarily inspect if such an "enabling" effect exists. Figure 6 shows that the annual number of new publications of ESS is strongly associated with the number of R&D collaboration agreements that involve industry, with a very high correlation of 0.95. The interpretation of this high correlation must be cautious, because it is possible that the enabling effect of ESS scientific publication on industry R&D collaboration is lagged in time. ESS is aware of this and therefore will continue to monitor these measures to probe a more reliable indication of such an enabling effect in the years to come.

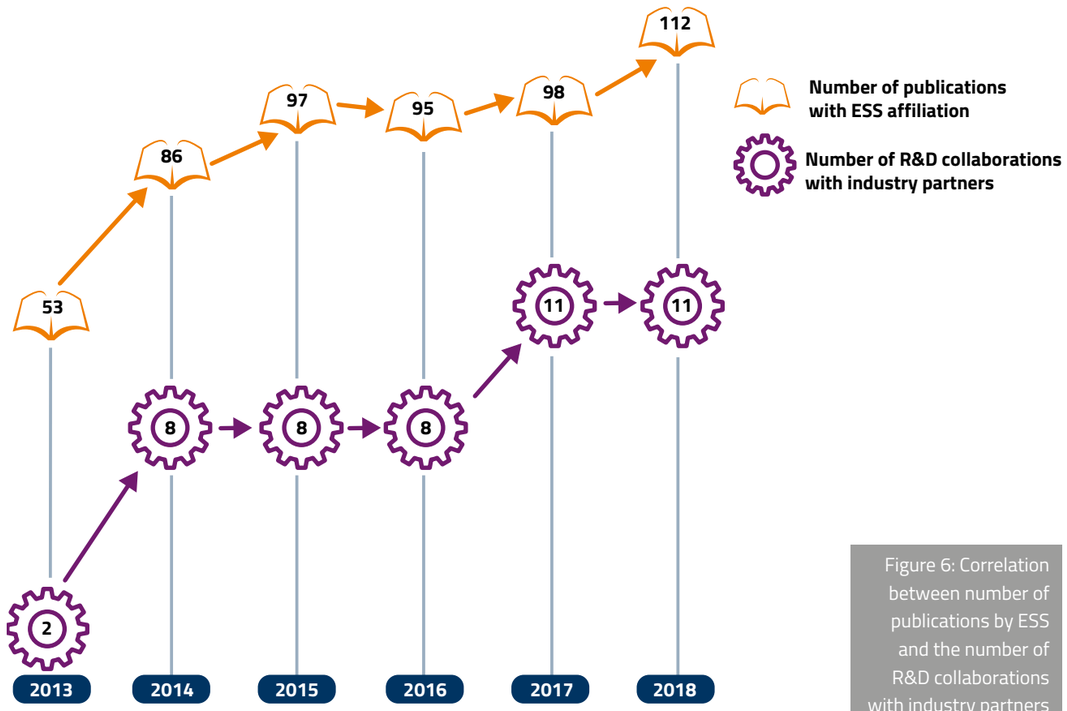


Figure 6: Correlation between number of publications by ESS and the number of R&D collaborations with industry partners

Strategic objective 2: ESS supports and develops its user community, fosters a scientific culture of excellence, and acts as an international scientific hub

Pathway 1: Creating and shaping scientific networks and communities

A robust user community is necessary to ensure the long-term sustainability of Europe's neutron sources, including a growing stream of new users. Together with Europe's other neutron sources, ESS will increasingly play a role in creating and strengthening the network of future users. In pursuit of this objective, the impact of ESS has been emerging as the results of various network activities rooted in ESS' scientific research programme. This includes the organisation of ESS science days, conferences, and user meetings; sponsoring scientific conferences, and; making several grant proposals in collaboration with In-Kind Partners, other RIs and industry. More recently, ESS has pursued a steering role together with LENS and ENSA to shape the European neutron science strategy.

In pursuit of this strategic objective, ESS actively ensures a strong user base for the Operations Phase through grant projects and R&D with a multitude of partners as well. By leading and participating in various projects, ESS has an opportunity to develop relationships with new partners from other research facilities, academia and with industrial firms, so that the status of an international scientific hub will be achieved.

First, ESS has held annual science days throughout 2015-2018, during which, chief scientists from various research partners, such as Lund University, ILL, EMBL, ESRF and the National Deuteration Facility (NDF, ANSTO, Australia), were invited to give talks on different topics, ranging from neutron work on carbohydrate binding proteins, to sample preparation and data analysis, and to lipid deuteration activities. ESS also sponsored a few scientific conferences during 2015-2018. See the numbers and names of the conferences in Table 8.

ESS-ILL Joint User Meeting

In 2018 ILL and ESS hosted their first Joint European User Meeting in Grenoble. This successful meeting reviewed the achievements of the user community, presented the status of ILL and ESS and, most importantly, looked forward to the scientific opportunities for neutron science. This was a proactive and strategic approach to navigate and manage changes in the landscape of neutron science and its user community through a collaboration building on ILL's legacy and experience. The second ESS-ILL Joint European User Meeting was held in September 2020 and the next is planned for October 2022.

Box 1: ESS-ILL Joint User Meeting 2018.

2015

- Crystallographic Methodology to Soft Matter ANSTO
- SoNS school of Neutron Scattering NBIA5
- Workshop School in Copenhagen
- SAS 2015 HZB, Berlin
- ERICE International School of Neutron Science and Instrumentation, Erice, Sicily

2016

- Funded by Interreg/MAX4ESSFUN: Synchrotron and neutron scattering in biomaterials and soft matter, Malmö
- Neutrons and Food conference, Lund
- MAX4ESSFUN research day, Lund
- The Sixth Annual Niels Bohr International Academy Workshop on ESS Science (NBIA6), Lund
- Protein Science Day 2016 – Astronomihuset, LU (co-sponsored by ESS, LU, MAX lab)

2017

- Nordic workshop on Scattering from Soft & Biological Matter, Oslo
- European Deuteration Workshop for soft matter, Oxford
- Workshop "Neutron in Structural Biology", Grenoble
- GRC and GRS in Neutron Scattering, Hong Kong

2018

- NSSM (Nordic Workshop on Scattering from Soft Matter and Biological Systems)
- Bilayers workshop (on neutron scattering for lipid-based systems) at the ILL, Grenoble
- QENS/WINS Hong Kong
- PNCMI – Polarised Neutrons for Condensed Matter Investigations, Milton Hill, Abingdon
- ESS/ILL User meeting, Grenoble
- Protein Science Day, Lund
- Wolfram-Prandl Preis 2018, Garching

Table 8: Overview of ESS-sponsored scientific conferences and events 2015-2018

Next, the number of successful grant proposals, which ESS coordinated or participated in as a part of the consortium, has been relatively consistent from 2013-2018, with an average 33% success rate. In total, 38% of successful grant applications were funded by national funding agencies. Among the 12 applications awarded by national funding agencies, 10 were awarded by Swedish agencies and two were awarded by Norwegian agencies. These success rates can be considered rather high; while not directly comparable, the eligible proposal success rate to the first three years of the Horizon 2020 program, and the entire FP7 program was 12.6% and 18.4% respectively (European Commission, 2017). Figure 7 shows the number of grant proposals awarded by all funding agencies per year to consortia that ESS led or participated in, while Figure 8 shows the proportion awarded by national funding agencies.

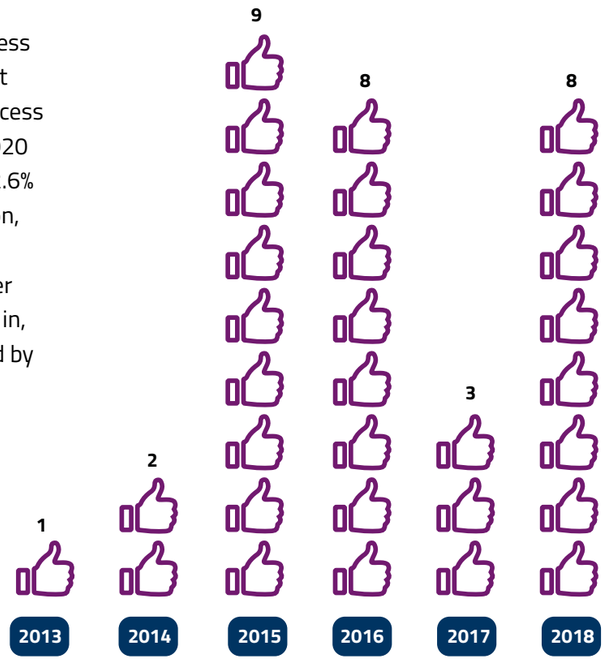


Figure 7: Number of grant proposals granted per year by all funding agencies

Figure 8: Proportion of grant proposals granted by national funding agencies

Note: ESS has limited eligibility for national funding schemes outside Sweden.

General Assembly of the EU-funded project BrightnESS², February 2020

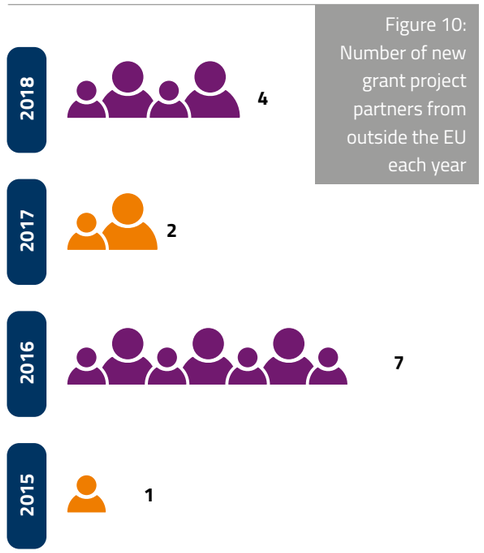


Figure 10: Number of new grant project partners from outside the EU each year

ESS has expanded its network through grant projects, by collaborating with 194 organisations for the first time since its first grant collaboration in 2011 (See Figure 9). Sixteen of these partners are based outside of the EU (See Figure 10). There were 15 grant proposals involving other RIs during 2015-2018 awarded to consortia that ESS led or participated in. The In-Kind Partners have also been frequently involved in many of these grant projects, with a combined total of €31,529,092.78 of grant funding allocated to ESS IKPs over the 2012-2019 period.

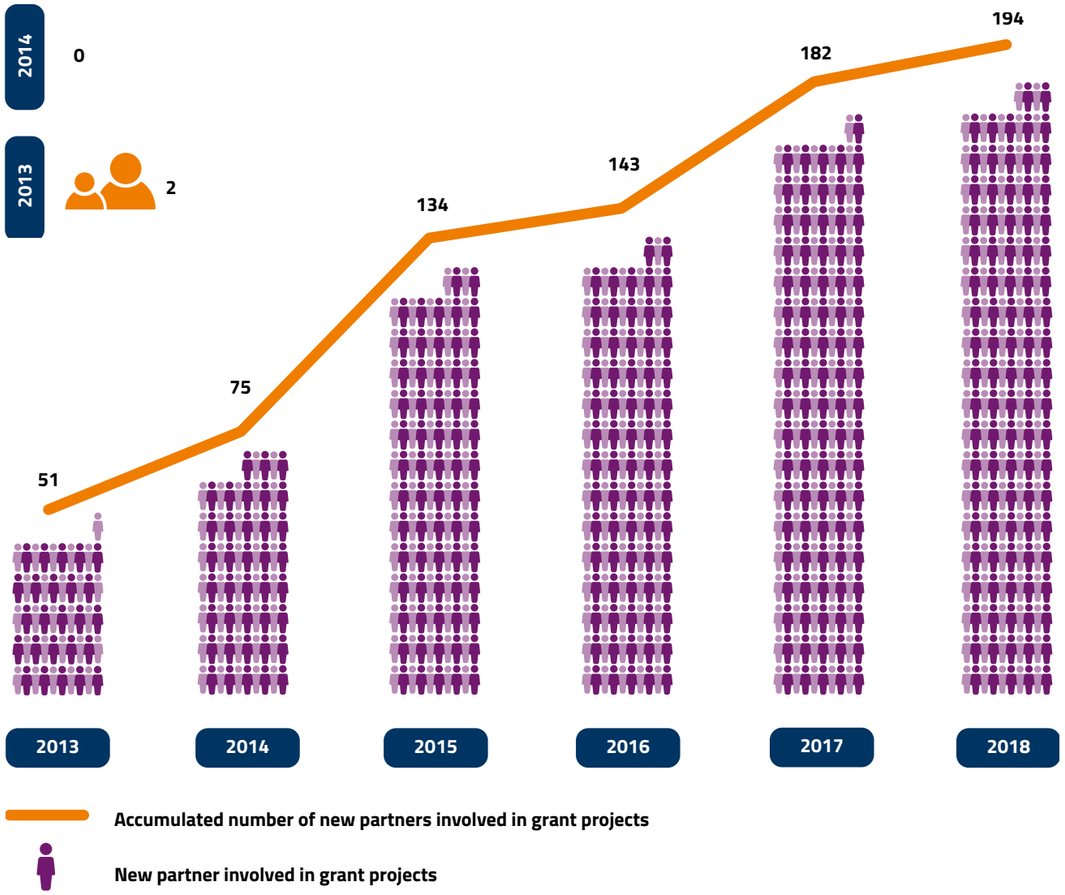


Figure 9: Accumulated number of new partners involved in grant projects

ESS Director General John Womersley welcoming His Majesty Carl XVI Gustaf, the King of Sweden, and His Excellency David Johnston, the Governor General of Canada, at ESS, February 2017

Being involved in 12 new projects during 2013-2018, the new partners from outside of the EU are located in eight countries:

2013: Russia, Switzerland
2014: Israel, Serbia
2015: Israel, Norway, Russia, Switzerland
2016: Norway
2018: New Zealand, Turkey, South Africa

The effect of extending and supporting the user community goes beyond the direct In-Kind Partner network. According to the In-Kind Partner Survey, the In-Kind Partners are expanding their own networks by developing new partners for the first time as a result of collaborating with ESS. Figure 11 below shows the percentage of responses with regard to new partner development by the In-Kind Partners: 48% of the responding partners managed to establish collaboration with universities or research institutes that they have never worked with before as a result of the In-Kind Contributions. 22% of the responses confirmed that due to the work with ESS, they established collaboration with universities or research institutes that they have never worked with before, on other projects unrelated to the In-Kind Contributions.

The overall number of grant partner organisations also included potential future users from industry, which needs to be fostered and nurtured by ESS even during its Construction Phase. Thus, ESS has collaborated with industrial firms through various grant projects. Figure 12 displays the number of ongoing grants each year per Member Country with at least one industrial partner from the respective country involved in a grant. In addition, there are various collaboration R&D projects procured from industrial firms, so far involving 11 of the 13 Member Countries during 2013-2018 (see Figure 13).

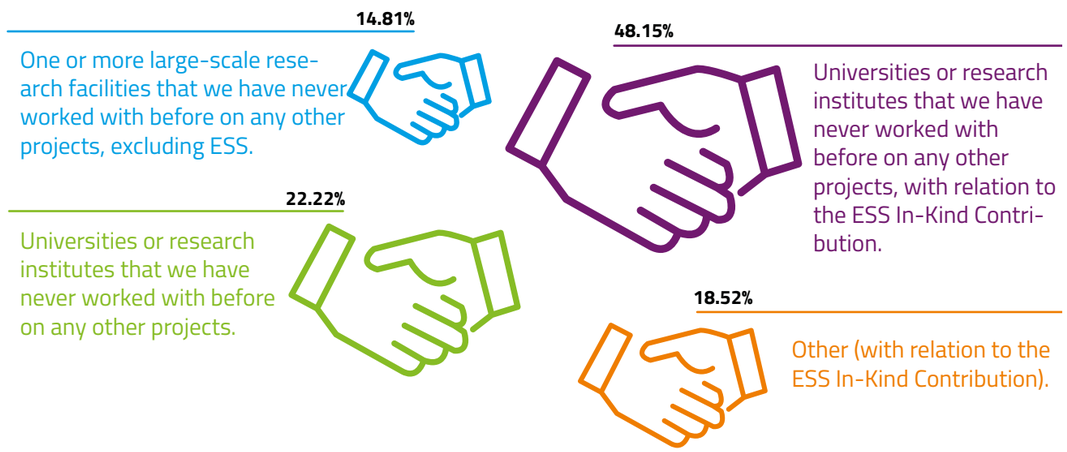


Figure 11: In-Kind Partners' first-time collaborations with new partners

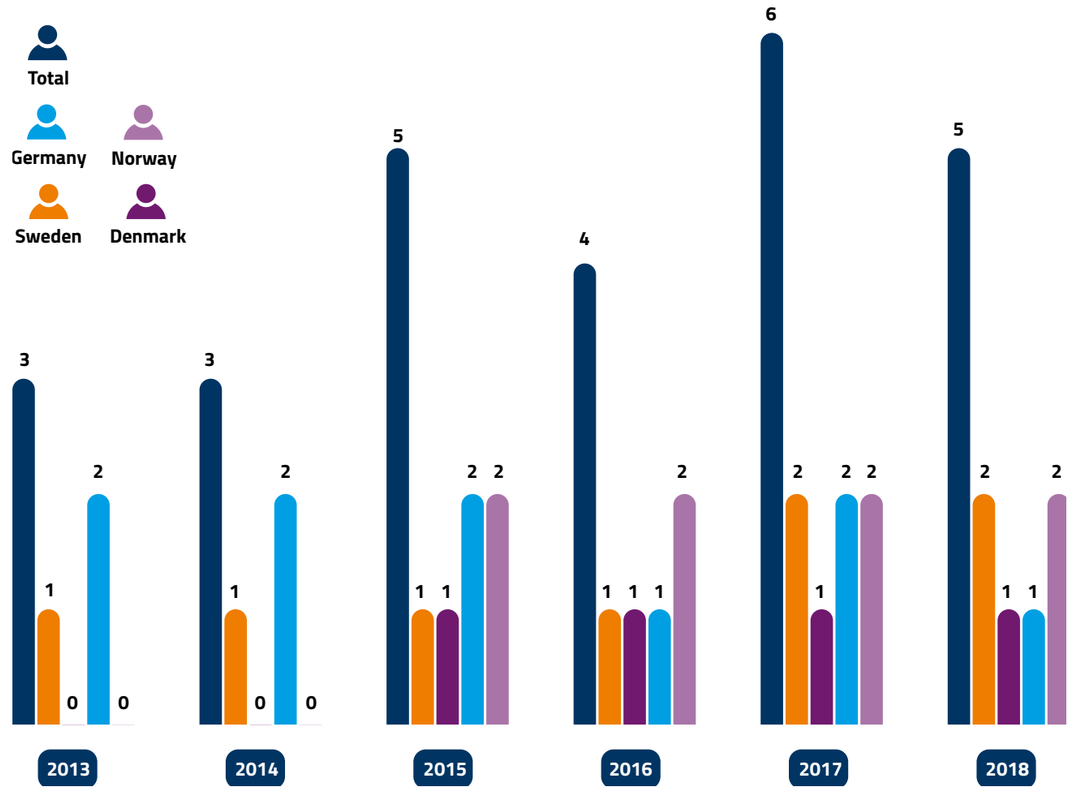


Figure 12: Number of ongoing grant projects involving industrial partners from Member Countries

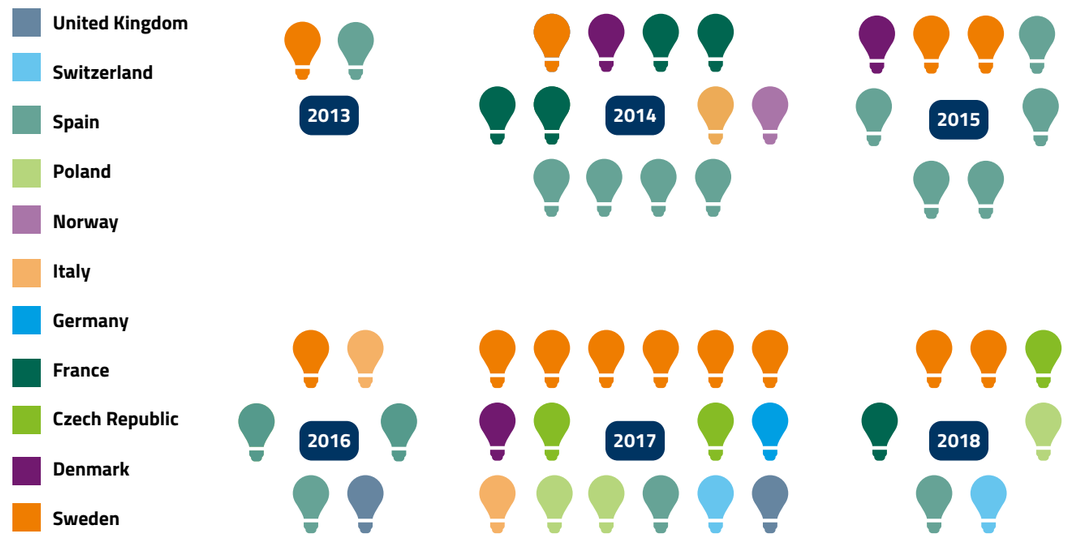


Figure 13: Number of R&D projects involving industry from Member Countries

Looking forward, the European neutron science community is facing a challenge: there is a need for more beam time, which has become increasingly scarce. A shrinking user base, which is most strongly correlated with decreased access, is the outcome Europe must avoid at all costs. The context of ESS' socio-economic impact is as a facility among several that, working together, ensure the health and long-term stability of European neutron science. ESS plays an active role in the neutron network organisation, LENS, and works together with the neutron user community, via ENSA, to define, shape and implement a European strategy for neutron science. Within the framework of the BrightnESS² project, Europe's neutron sources collaborated to bring LENS together with another major umbrella organisation for European large-scale analytic facilities— the League of European Accelerator-Based Photon Sources (LEAPS), which collectively represents 25 facilities used by some 30,000 researchers. The cooperation between LENS and LEAPS has the potential to align European RIs' efforts toward European-wide mission- and challenge-led approaches designed to find solutions for society's grand challenges.

BIR2Gain

In 2016 the "BIR2Gain project" was granted by Vinnova with an objective to familiarise Swedish metallic industry with large scale facilities (such as MAX IV and ESS). Partners involved in the project include LTH, MAX IV, ESS, Swerea and Jernkontoret (the coordinator). Even though the grant amount is relatively small, the partners were actively involved. Since the project kick-started in 2017, they have organised several workshops to introduce the demand of ESS as potentials for the industry; developed industry contacts and beamtime preparations through the DTU Industry Portal, and; participated in the Swedish Metalliska Material Industry meeting for ESS presentation and workshop. In 2018, the project started negotiation with SSAB partner about the possibility to support the GLEEBLE physical simulator sample environment to be installed on the instrument BEER at ESS. Further preparation for a new application to Vinnova together with SSAB was initiated as well.

Box 2: An example of grant collaboration with industry and RIs.

Pathway 2: Communication, outreach, and engagement

To foster a scientific culture of excellence and act as an international scientific hub, ESS also actively engages in reaching out to the general public by sharing its development with respect to science and technology with a wide range of stakeholders and future generations. The impacts are visible when looking at the site visits and online information sessions, media exposure, social media, and involvement in partner universities' education.

In 2015, the ESS construction site opened to visitors for informational tours or presentations, business meetings, or high-level events. By the end of 2018, ESS welcomed a total of 19,465 visitors to the construction site or off-site facilities. Nearly 40% of these visitors came for informational purposes – that is to learn more about ESS in a general and non-technical sense – as shown in Figure 14. These visitors include, for instance, local associations, schools, and student groups.

Figure 14: Number of visitors to ESS vs. number of informational visitors to ESS

News of the ESS facility has travelled far and wide through online media articles combined with a strong social media presence. During 2016-2018, 1,390 articles specifically about ESS were published online. On average, 64% of publications are from Swedish sources, 8% are from Danish sources and the remaining 28% are from all over the world. These articles combined have had a potential reach of 7,074.4 million readers. In addition, during 2013-2018, ESS was mentioned in a total of 11,293 online media articles (see Figure 15).

ESS has various social media accounts, including Twitter (Swedish and English accounts), Facebook (Swedish and English accounts), LinkedIn and more recently Instagram. Most of these accounts having been created throughout the 2013-2018 period. All accounts remain active with hundreds or thousands of followers for each account. The ESS Facebook page has 2,926 followers and 2,786 likes (where ESRF has 5,173 followers and 4,874 likes and ILL has 1,258 followers and 1,444 likes). The ESS LinkedIn page has 9,187 followers and 524 linked employees (where ESRF has 6,839 followers and 401 linked employees, ILL has 4,836 followers and 337 linked employees and Paul Scherrer Institut (PSI) has 10,403 followers and 1,193 linked employees, respectively). ESS actively uses social media to post news about the site construction process, scientific research breakthrough and policy updates. ESS also uses LinkedIn Job service to recruit talented researchers and administrative staff. Figure 16 below shows the number of followers and impressions on Twitter during 2016-2018 (in August 2020, ESRF has 7,490 followers, ILL has 4,786 followers and PSI has 2,995 followers).

ESS has also put a premium on outreach and engagement through contribution to partner universities' education. For example, ESS has been actively involved in the co-supervision of 33 PhD students enrolled in several partner universities with and without financial support of ESS during 2015-2018. In cooperation with ESS

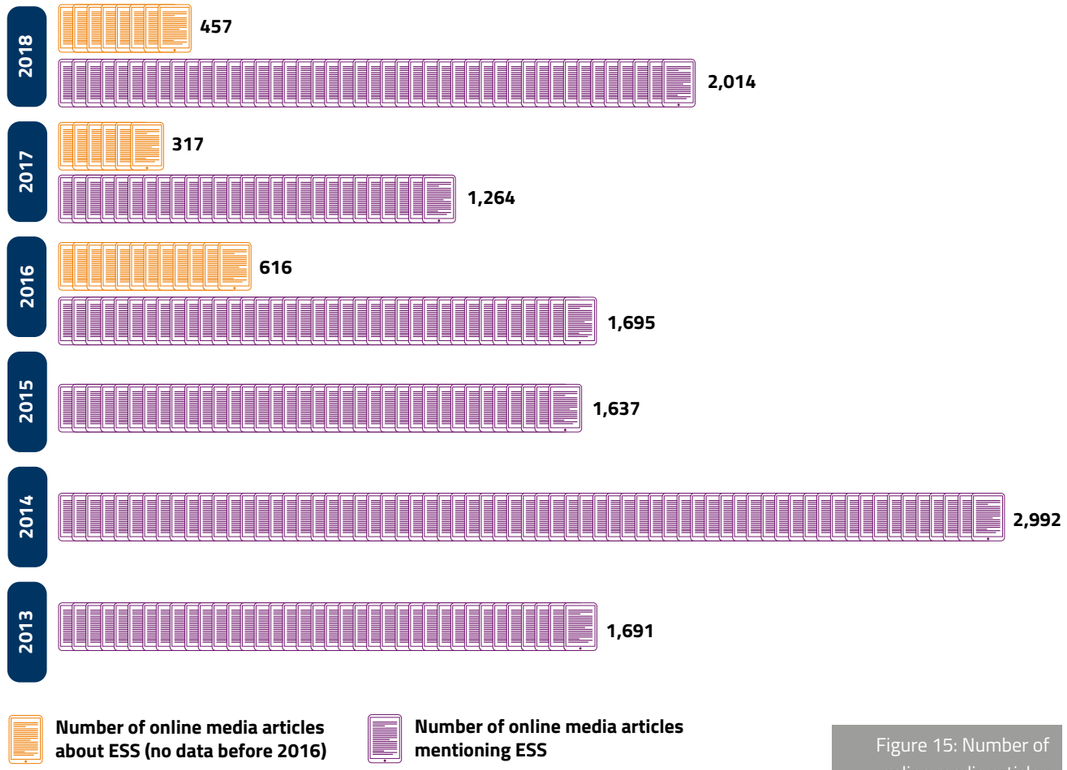


Figure 15: Number of online media articles about ESS and mentions

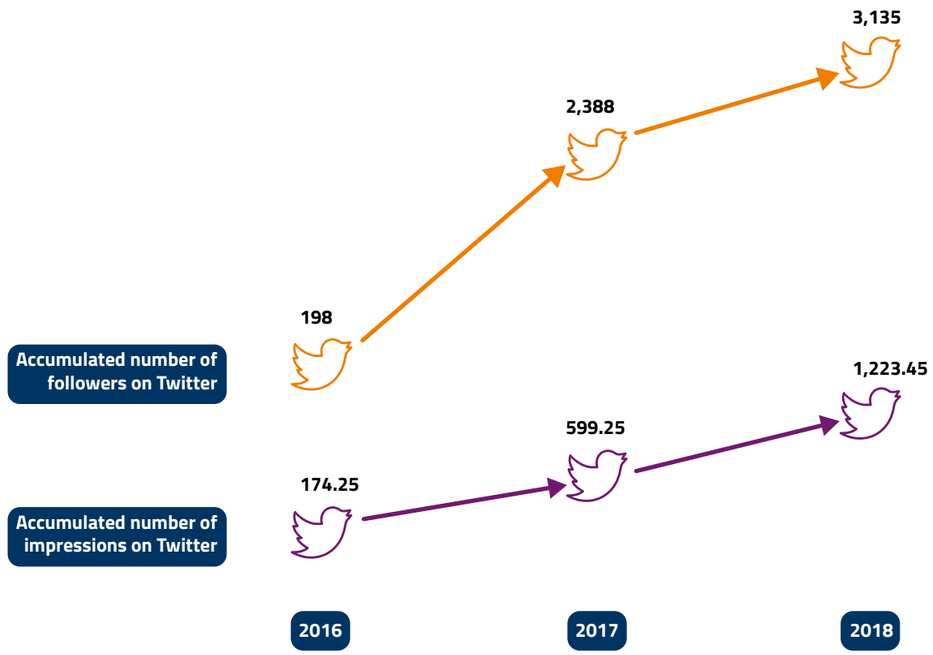


Figure 16: Activity on Twitter

and MAX IV Laboratory, the EU Interreg program MAX4ESSFUN (project period during 2015-2018) has continued to build user capacity by directly financing experiments and providing training and supervision for PhD and postdoc researchers. The €13.6 million project enabled 1,000 months of training and 500 months of learning, which includes an educational component of courses, workshops, and summer schools. At the Bachelor degree and Master degree of education, ESS contributed many courses at partner universities. For instance, at Technical University of Denmark (DTU), ESS has been involved in one Bachelor degree course, 8 Master degree courses, and 2 PhD courses, which involved no less than 530 DTU students during 2015-2018. A list of these courses can be found in Table 9.

Degree program	Course title	ECTs	Normal intake of students (class size)
BSc	X-ray and neutron experiments at international research facilities	5	10-12
MSc	The structure and dynamics of materials studied with X-rays and neutrons	5	10-15
MSc	Physics of soft materials	5	10-18
MSc	Condensed matter physics and nanoscale materials physics	10	60
MSc	Magnetism and magnetic materials	5	15-20
MSc	Applications of X-ray and neutron scattering in biology, chemistry and physics	5	10-24
MSc	Methods for experimental materials characterization	5	20
MSc	Large-scale superconductor technologies	5	10
MSc	Applied superconductor projects and experiments	5	8-15
PhD	CINEMAX: 3D modelling and imaging of material microstructure - PhD summer school	5	15-25
PhD	Application of x-ray diffraction in materials science	5	10

Table 9: Overview of DTU courses with ESS contribution and involvement

Students at the Technical University of Denmark preparing for their course.

Strategic objective 3: ESS is built safely, on time and on budget, operates safely, efficiently, and economically, and responds to the needs of its stakeholders, its Host Countries and Member Countries

Pathway 1: Safety – energy use – waste management – environmental impact

The ESS facility is being built with the highest consideration of efficiency and environmental impact. After an extensive procurement process, ESS selected Skanska, one of the world's largest construction companies, to deliver the complex project on the 70-hectare site in Lund. The work is executed by Skanska Sweden (75%) and Skanska UK (25%).

Skanska continuously develops solutions on the concept of circular economy, which puts emphasis on the reduction of waste, recycling, use of environmentally assessed resources, use of renewable energy, control of energy consumption and preservation of soil. These efforts were recognised when ESS became the largest Skanska project ever to successfully fulfil the strict criteria to qualify for a fossil-free green construction site, as well as when the project won Skanska Sweden's award as the most sustainable project of 2018. For example, the use of HVO100, a premium fossil-free diesel made from 100% renewable sources, to power the heavy equipment and machines on site reduces the climate impact by 88%.

Another example of environmental and societal impact is the care of the agricultural land on which the ESS facility is built. The nutrient-rich topsoil is safely stored on the site and saved for future generations. It can be strategically used in case of a future food shortage. The landscape design on the ESS construction site includes several new habitats and vast meadows with flowers that attract pollinating insects. Their presence is crucial for the agricultural crops growing in the fields surrounding ESS. In addition, several artificial small water ponds have been created to attract wildlife and increase the level of biodiversity. The ESS construction site creates new ecological value in the area.

Table 10 shows the annual production of waste and energy consumption from the start of civil construction in 2014 until the end of 2018. Through the progression of the Construction Phase, it is not surprising that the total consumption of energy and production of waste has been increasing, and reached a peak in 2018 – by far the busiest year of civil construction.

	2014	2015	2016	2017	2018
Waste (tons)	**47.86**	**340.72**	**672.49**	**810**	**998**
Hazardous waste (tons)	**0.7**	**6.68***	**2.13**	**1**	**2**
Electricity usage (kWh)	**211,634.1**	**1,367,571**	**3,029,776**	**4,113,864**	**5,140,996**

Table 10: Annual production of waste and energy consumption during 2014-2018

* In 2015, contaminated soil was found on the ESS construction site in an area where an old farm had been located before ESS was built. Because the soil was contaminated, it was classified as hazardous waste.

The use of electricity will be much higher during operations than during construction. Large-scale research facilities like ESS usually require hundreds of gigawatt hours of energy per year. ESS aims to be one of the world's first sustainable research facilities. With an innovative energy concept, which plans to keep energy usage below 270 GWh/year (for comparison, CERN uses 1.3 terawatt hours of electricity annually[3]), ESS is committed to renewable power production. Surplus energy from ESS will be recycled to heat homes and other properties in the surrounding area.

While the production of general waste has been increasing in line with the increasing construction works, Skanska has been extremely successful in preventing waste that cannot be recycled or burned. Since the beginning of the construction in 2014, there has been zero waste to landfills and zero concrete waste. This unique result has been achieved thanks to preventative work and an innovative solution. There is a lot of concrete work involved in the building of ESS, including the Accelerator tunnel, the Target station, three instrument halls and service buildings. The construction of the Accelerator tunnel itself included 456 separate casting sessions, using 16,500 m^3 of concrete. Leftovers from cast-in-place concrete are being used to create blocks in shapes similar to Lego pieces. These blocks are much bigger than actual Lego though and each of them weighs approximately two tons. The blocks are sturdy and stable, can be moved around, and are versatile in their use, which makes them a sought-after commodity by for example municipalities. During 2014-2018, 710 of these concrete blocks have been made from leftover concrete at the ESS construction site. That is approximately 1,420 tons of concrete that would have otherwise been wasted.

To build ESS safely, ESS has a firmly prioritised radiation protection due to the activated material in the target and the radiation emitted from the neutrons in the experimental halls. Research with sub-atomic particles, such as neutrons, requires a high level of radiation protection and awareness in order to minimize exposure to staff and the environment. The public dose rate exposure limit of 0.1 mSv per year, set by the Swedish authorities for any facility producing ionising radiation, only represents 2-3% of what a person living in Sweden on average receives from normal radiation sources. This is around the same dose that someone would receive from five X-rays over the course of a year whilst visiting the dentist. At these closely monitored levels, ESS will have only a marginal effect on the surrounding environment and staff, with even less on people living near the facility. Radiation protection and safety will be key aspects of ESS' operations and will be carefully monitored by the regulatory authorities. In 2017, ESS was granted a permit from the Swedish Radiation Safety Authority (SSM) to begin installing equipment that can generate ionising radiation, allowing installation processes to move forward in the Klystron Gallery Building, the Accelerator Tunnel and the Target Station. This was the second permit in the incremental licensing process being undertaken by ESS. The permission for the trial operation of the first part of the accelerator was received in 2018.

[3]Powering CERN, https://home.cern/science/engineering/powering-cern

Pathway 2: Employment & procurement – rendering economic benefits to Member Countries through suppliers and In-Kind Partners

To build ESS safely, on time and on budget, ESS has been working along with suppliers and In-Kind Partners in the Host and Member Countries to achieve the second strategic objective through cost-efficient procurement activities, the tendering system, and budgetary means. These activities should render benefits to the stakeholders, not only in an economic sense, but also with respect to the way that ESS interacts and cooperates with suppliers and In-Kind Partners so that a mutually supportive relationship can foster future cooperation.

The construction of the ESS facility is a collaborative effort involving all the Member Countries. Therefore, the economic impact is expected to extend the Host Countries' borders to all Member Countries. The European Spallation Source ERIC Procurement Rules follow the Community Legal Framework for a European Research Infrastructure Consortium (ERIC), so that the guiding principles for procurements include transparency, proportionality, mutual recognition, equal treatment, and non-discrimination. The ESS Procurement Rules seek to promote the objectives of value for money, publicity, integrity, innovation and sustainability. The Member Countries have appointed Industrial Liaison Offices (ILO) to connect their industry with ESS. It is reasonable to expect that firms in Member Countries get more information about business opportunities to work with ESS, despite the impartial treatment in the tendering process. Consequently, firms from Member Countries submitted more tenders and were awarded a significant share of contracts, compared to firms from non-Member Countries. Amongst a total of 457 tenders received during 2015-2018, 421 (92%) tenders were submitted by firms in the Member Countries. Among the 192 tendered contracts that were awarded, 176 (92%) tendered contracts were awarded to firms in the Member Countries during 2015 to 2018.

Figure 17 and Figure 18 show the proportion of tenders received from Member Countries and the proportion of contracts awarded to Member Countries during 2015-2018, respectively. ESS has a supplier base across all Member Countries. Besides the Host Countries, which have a clear geographic advantage in supplying general services and low-value procurements,

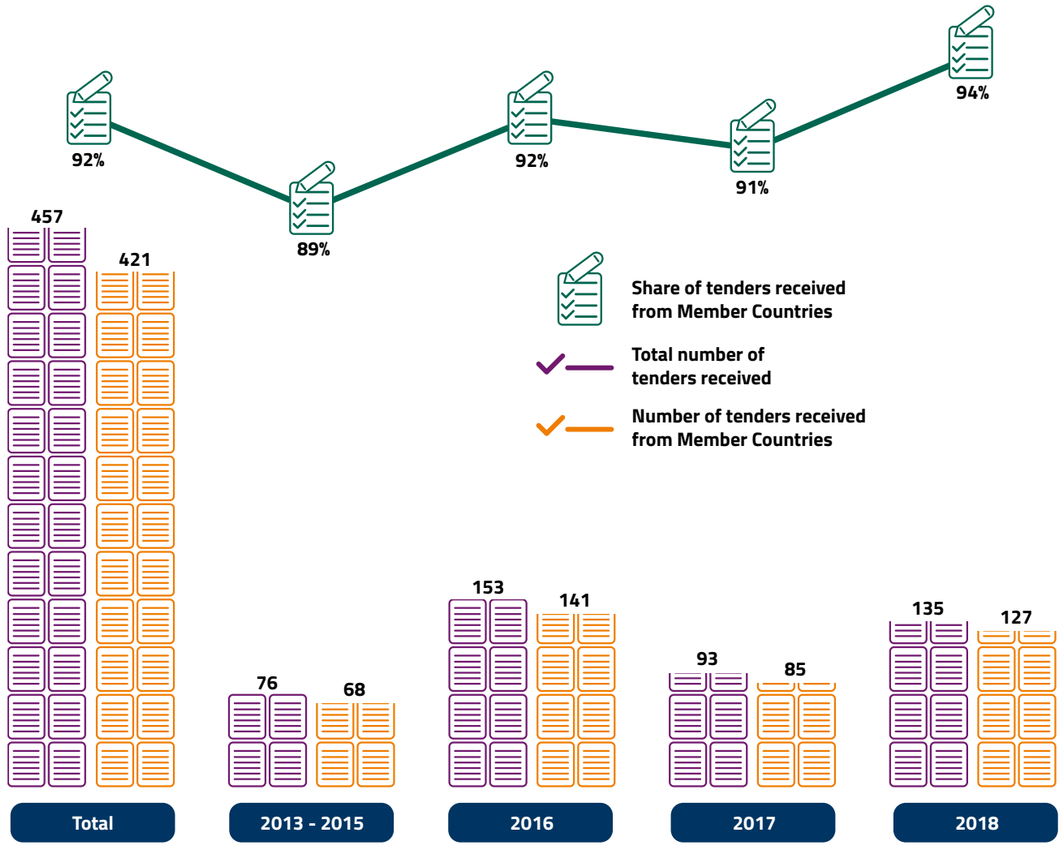


Figure 17: Share of tenders received from Member Countries

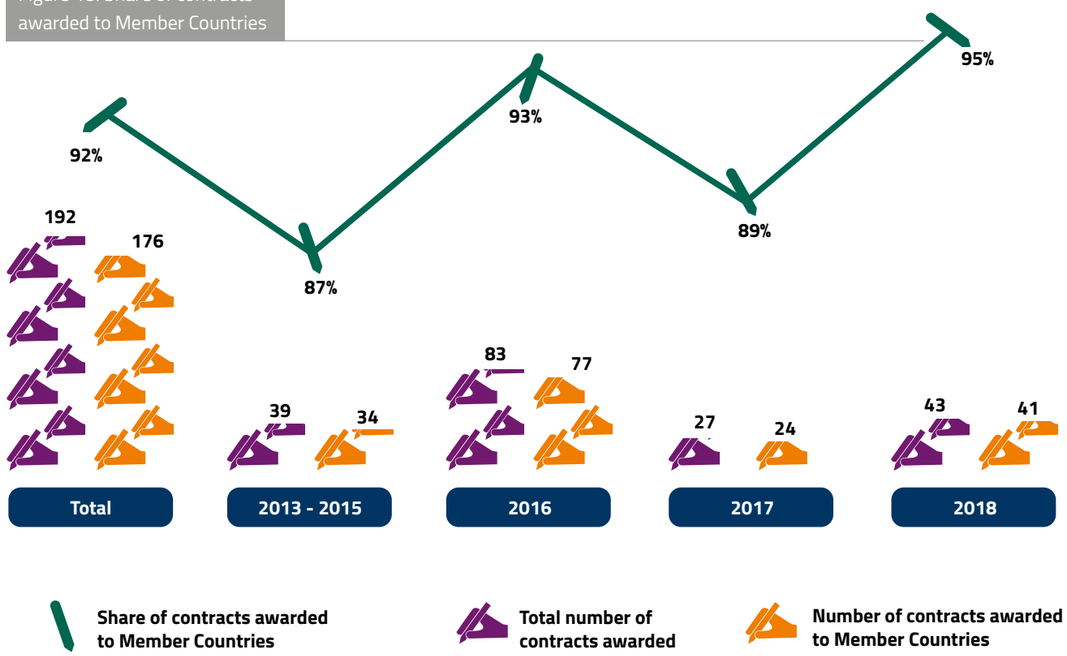


Figure 18: Share of contracts awarded to Member Countries

Germany and the United Kingdom have the most new suppliers registered in the ESS procurement system during 2013-2018, with 258 and 271 suppliers respectively, followed by France (94 suppliers) and Switzerland (48 suppliers). The larger numbers of suppliers in these countries might be explained by the existence of neutron sources at MLZ at Munich in Germany, ISIS at the RAL complex in the UK, SINQ at PSI in Switzerland and the ILL in Grenoble, France, in addition to the numerous light sources in those countries. Figure 19 displays the number of suppliers in the ESS procurement system every year, for purchases made directly by ESS in Lund or the DMSC in Copenhagen. It is important to note that the economic model for building ESS is based on a design of having nearly 30% of the construction cost expected to be supplied through IKC from the Member Countries. However, the Host Countries, Sweden and Denmark, mainly contribute through cash investment, whereas the local economy will

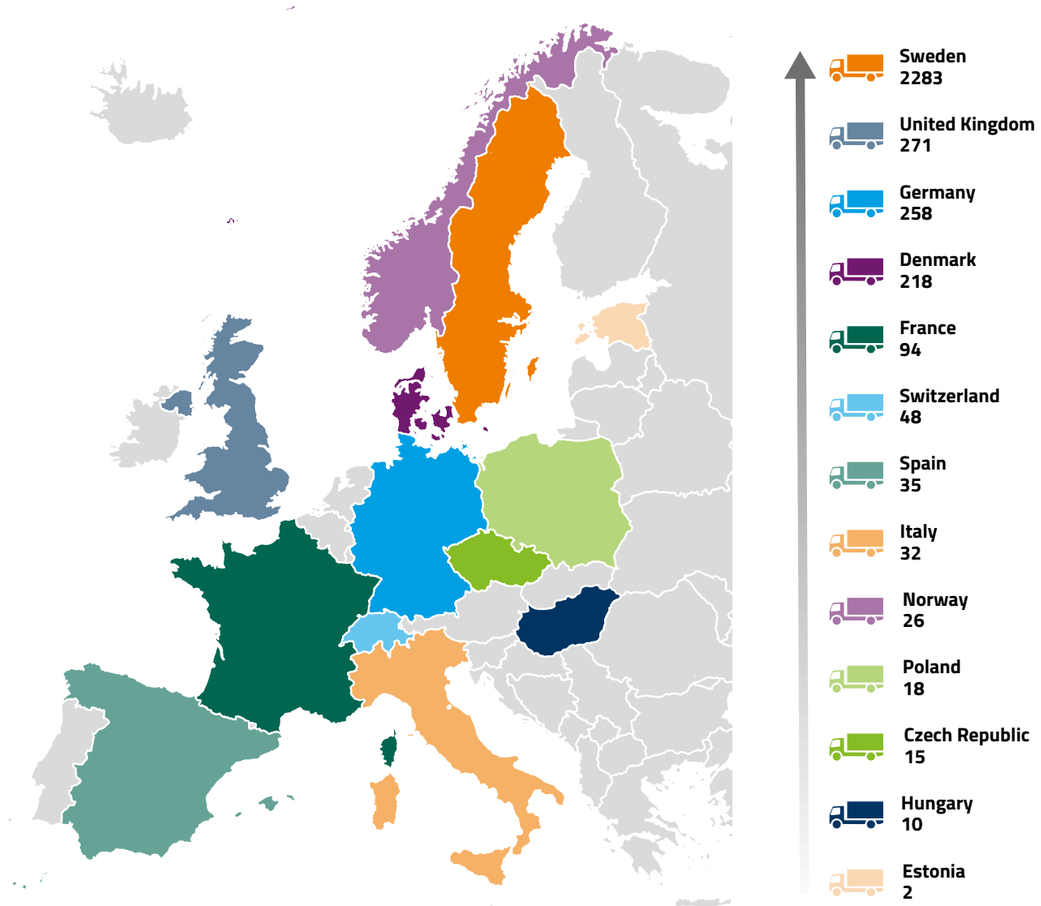


Figure 19: Total number of new suppliers per Member Country (2013-2018)

Aerial view of the Target Station, April 2018

naturally gain more direct economic benefit from procurement from local suppliers (especially for Sweden where the ESS facility is located).

The economic return to suppliers in Member Countries needs a more detailed look beyond the number of suppliers. Table 11 shows an overview of ESS high-value (50 k€+) awarded contracts during 2013-2018. The total number of high-value contracts and the volume of high-value contracts among the Member Countries are shown in the first two columns. Note that the total volume of contracts awarded in the second column for Sweden does not include a major contract of 520 M€ awarded to Skanska, the construction company that is building the ESS facility. The third column shows the average volume of high-value contract per contract in the Member Countries. It should be noted, however, that the total volume of high-value contracts excludes Framework Agreements.

The standard deviations for the total volume of high-value contracts and the average volume of high-value contract per contract are 22,070.69 and 3,621.98, respectively. The latter is nearly 83% reduced compared to the former, indicating that even though the total volume of high-value contracts seemed concentrated in some specific Member Countries, the avarage volume of high-value contract per contract is less skewed to these countries. This result also shows that the economic benefits for Member Countries through ESS procurement cannot be assessed by judging the number of suppliers, the number of contracts and the volume of contracts separately. This suggests that more nuanced insight must be probed by other means of measurement, e.g., survey methods. The overview of the number of tenders and suppliers and the volume of contracts indicated above shows the overall economic activities that ESS has been performing within the reach of its procurement. More evidence is needed to take a deep look at how the suppliers perceive the economic benefits received from doing business with ESS. The Supplier Survey was sent to approximately 2,600 suppliers by e-mail and two rounds of reminders. Eventually, 284 respondents completed the survey in full, resulting in a nearly 11% response rate. Figure 20 displays the overall results of economic benefits reported in the Supplier Survey. While more than a third of the responding suppliers agreed on increased overall profitability as a result of doing business with ESS, more than 20% managed

Member Country	Total number of high-value contracts (50 k€+)	Total volume of high-value contracts (50 k€+) awarded in 1,000€*	Average volume of high-value contract per contract in 1,000€*
Sweden	116	79,539.36**	685.68
Denmark	6	869.77	144.96
Czech Republic	1	91.44	91.44
Estonia	4	0	0.00
France	4	3,423.1	855.78
Germany	9	4,784.47	531.61
Hungary	5	715	143.00
Italy	9	1,131.38	125.71
Norway	0	0	0.00
Poland	0	0	0.00
Spain	7	10,075.29	1,439.33
Switzerland	2	26,692	13,346.00
United Kingdom	12	6,116.39	509.70
Standard Deviation		22,070.69	3,621.98

Table 11: Overview of high-value contracts awarded per Member Country during 2013-2018

* Total volume of high-value contracts excludes Framework Agreements, which are represented in the total number of contracts. Thus, any correlation between the total number of contracts and the total volume of contracts may be disproportionate.
** This volume excludes a contract value with a target price of 520 M€, awarded to Skanska. This major contract was signed in 2014 with Skanska for the construction of the state-of-the-art ESS facility, including groundwork, infrastructure at the work site, the accelerator tunnel, and adjoining buildings. The work would be performed by Skanska Sweden (75%) and Skanska UK (25%). Skanska Sweden is one of the largest construction companies in Sweden and has strong experience in green construction and social sustainability. While this contract is large, it is redistributed through a multitude of sub-contracts of varying values. For further insight, the distribution of Skanska staff and construction workers, and sub-contracted staff and workers, is visualised in Figure 28.

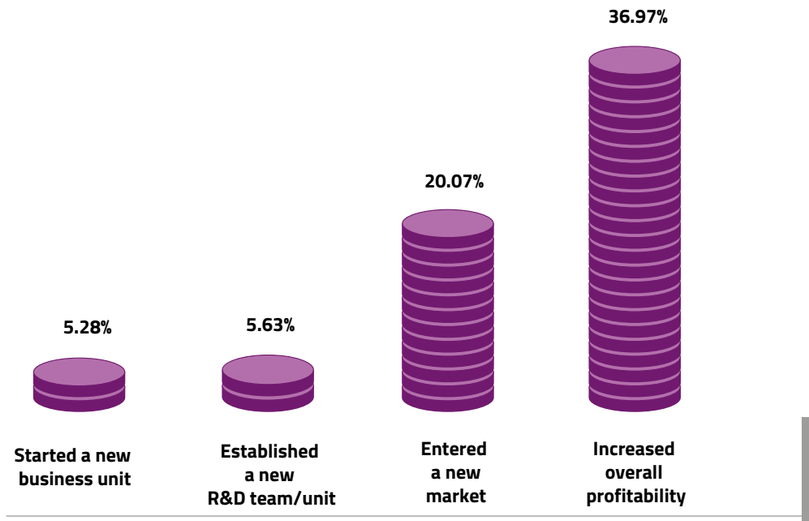


Figure 20: Overall economic benefits from supplying to ESS (results from ESS Supplier Survey n=284)

ESS campus and facility, March 2021

to enter a new market. A smaller percentage of responding suppliers managed to establish new R&D units or business units. While the overall pattern of economic benefits received by the suppliers seems promisingly positive, the nuanced differences among Member Countries deserves attention. Where the respondents have derived economic benefits in other areas of their business, by working with ESS, the responses by firms in the Member Countries show different patterns. Figure 21 shows the answers of suppliers from six Member Countries and the two Host Countries, regarding the economic benefits derived from supplying to ESS (Member Countries with less than five responses are excluded from the illustration). Suppliers from Sweden, Denmark, Germany, Italy, Switzerland, and the UK have recognised different benefits, including increased profitability, establishing new R&D, starting a new business unit, and entering a new market. Among the five responses from Spain, benefits of increased profitability and entering new markets were recognised. Interestingly, all seven French suppliers agreed that contracts with ESS increased their overall profitability, but none of the other listed economic benefits were recognised.

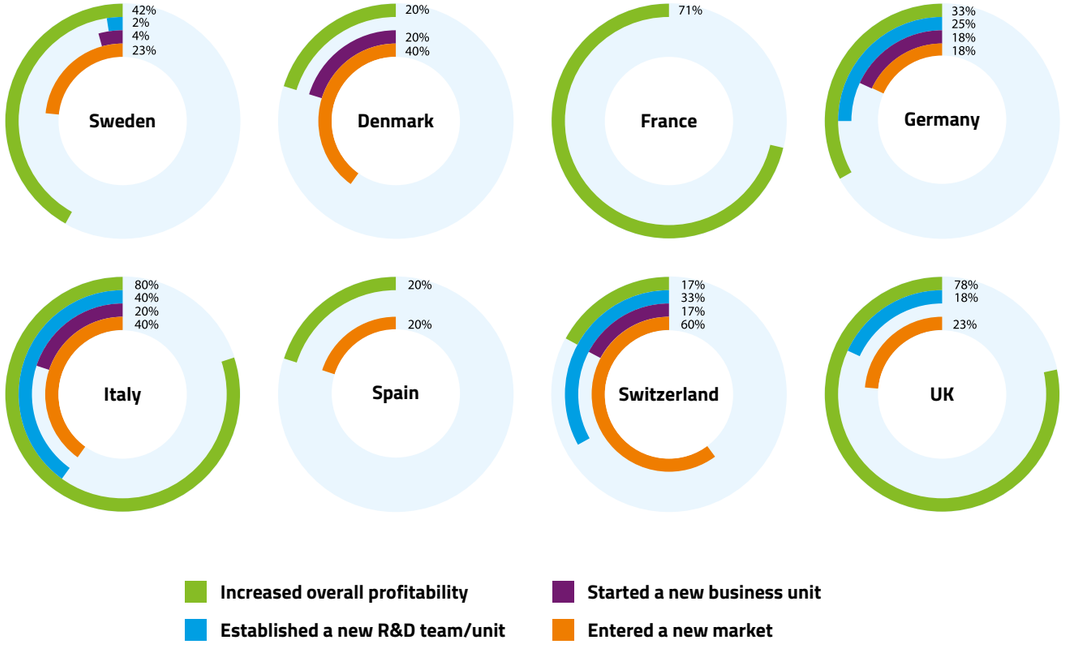


Figure 21: Economic benefit derived from supplying to ESS by responding Member Countries (results from ESS Supplier Survey)

Note: Member Countries with less than 5 responses are excluded.

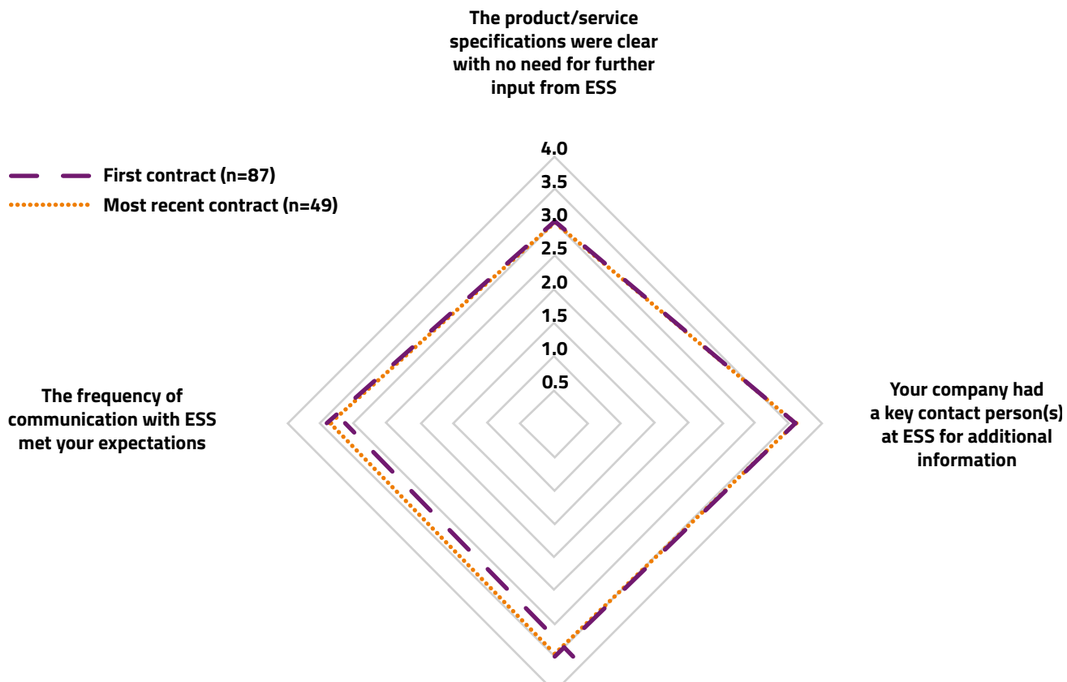


Figure 22: ESS supporting high-value contract industrial suppliers (results from the ESS Supplier Survey)

Supporting stakeholders' needs is also demonstrated through maintaining good communication and relationships with the suppliers. A good relationship between suppliers and ESS, based on strong support and good communication, increases interest in continuing to work with ESS in the future. The industrial suppliers with high-value contracts have expressed, in the Supplier Survey, that while working with ESS they have received relatively high levels of support from ESS regarding both their first contracts and most recent contracts with ESS (see Figure 22). The patterns look almost identical between the first and the most recent contracts.

We find that nearly 97% of the responding suppliers have expressed interest in working with ESS again in the future. Meanwhile, 67% of responding suppliers have expressed interest in contributing to ESS through their national In-Kind Partner.

Partner & Industry Days

Various outreach formats have been implemented in order to inform potential suppliers about business opportunities at ESS and those available with its In-Kind partners, as well. One of the formats is called "Partner & Industry Days", which was created in 2013 to promote ESS in potential Member States. It presented collaboration possibilities for science labs and relevant industries to stimulate buy-in from the funding agencies in the respective countries. Over the years the focus of this format has naturally evolved and matured: now ESS and the IKC partners together present industry with the business opportunities relative to their technical work packages. For example, the second French Partner & Industry Day was held February 4-5, 2016, supported by CEA Saclay and CNRS, the French ILOs for ESS. The first day included a visit to the laboratories of CEA Saclay, and then CNRS demonstrated the progress of the French accelerator and detector developments for ESS. This set the stage for the second day spent at the French Ministry of National Education, Higher Education, and Research.

Box 3: Industry outreach by ESS supported by ILOs. ESS French Partner & Industry Day 2016.

In supporting good communication between ESS and its suppliers, the Industrial Liaison Offices (ILO) in Member Countries have played an important role. In September 2013, ESS launched its ILO Network to establish two-way communication with key stakeholders. The rationale of establishing the ILO Network is to provide transparency and equilibrium for the benefit of the industries and labs of the Member Countries. The ILO Network is an excellent forum that anticipates national engagement with ESS procurement and In-Kind opportunities. Through various tools, information is disseminated through the ILOs to encourage participation and involvement of industry. The ILO nodes in the Member Countries play a crucial role in coordinating the participation of the respective national industries by generating synergies, matchmaking, capacity building, networking, and mapping of companies' competences. This direct engagement with industry enables companies to maximise the benefit from ESS procurement opportunities and R&D partnerships, and for ESS to integrate the companies' know-how into the construction of the facility. ESS held 11 regular ESS-ILO Network Meetings and one ESS-ILO Strategy Meeting during 2013-2018.

Looking forward, the ESS ILO Network has an ambitious outlook: while the Construction Phase is still ongoing, ESS has also entered its Initial Operations Phase (IOP). Under the BrightnESS[2] project, the ESS ILO network has tried to explore the possibility to elevate the role of ILOs as mediators between ESS and national industries and contribute to new economic activities in the ESS Member Countries. Two ESS-ILO Strategy Workshops were held during 2019-2020 (one in Budapest, in 2019, and the other in Catania, in 2020, to discuss the evolving roles of the ESS ILO Network, including integration into the ESS innovation ecosystem. The ILO terms of reference have been updated and approved by the ESS Administrative and Finance Committee (AFC).

The ILO representatives are expected to have extensive knowledge about their national science industry and labs (with strong experience in liaising with other Research Infrastructures) to stimulate opportunities in the most tangible ways. The ILOs serve the interests of their national labs and industries by leveraging the business opportunities provided by ESS. The responsibilities of the ILOs include:

- Information: Identifying business opportunities at ESS (tenders, IKC, other relevant opportunities) and communicating those between ESS and the private sector.
- Matchmaking: Mapping of companies' competences, finding suitable partners, and setting up joint bids.
- Capacity-building and networking: Training on tender requirements and processes.

The impact along the pursuit of this strategic objective is not limited to suppliers, but extends to In-Kind Partners as well. The nature of the collaboration within the In-Kind Contribution model is complex. By the end of 2018, ESS had contracted more than 550 M€ with 33 Partners around Europe under the In-Kind Contributions mechanism. This value is implemented through more than 170 technical annexes, which define the scope of work for In-Kind Contributions. The contracted work covers four ESS sub-projects: Accelerator, Integrated Controls Systems, Neutron Scattering Systems, and Target. These contributions are expected to finance up to 600 M€, or 30% of the total 1.843 B€ (2013) construction costs. To date, ESS has a track record of successful awareness-raising activities and campaigns, which have helped the organisation to engage stakeholders in various countries and increase the overall IKC value.

BSBF 2018, Copenhagen

During February 26-28, 2018, the first Big Science Business Forum (BSBF) was held in Copenhagen, co-organised by ESS and the Danish ILO (BigScience.dk). BSBF 2018 aimed at becoming the first one-stop shop for European companies and other stakeholders to learn about Europe's Big Science organisations' future investments and procurements worth billions of euros. The forum offered businesses the chance to learn about business opportunities in the coming years, within a wide range of business areas, to meet representatives from Europe's Big Science organisations and their key suppliers, network and establish long-lasting partnerships via business-to-business meetings (B2B), business-to-customer meetings (B2C), and in the open exhibition area, and also get insight into procurement rules, IPR, technology transfer, and how businesses can interface with the Big Science market. BSBF2018 had more than 1,000 participants, 500 businesses and organisations, 650 business meetings, and 250 people visited the stand of ESS and MAX IV. ESS was one of the co-organisers and was represented in the International Organising Committee (having met six times during the preparation and follow-up of the event). ESS also contributed to the conference programme with 14 speakers presenting various topics. There were almost 100 one-on-one meetings during the event by ESS staff from management, technical departments, and the Procurement team.

Box 4: ESS Director General John Womersley speaking at BSBF 2018, in Copenhagen.

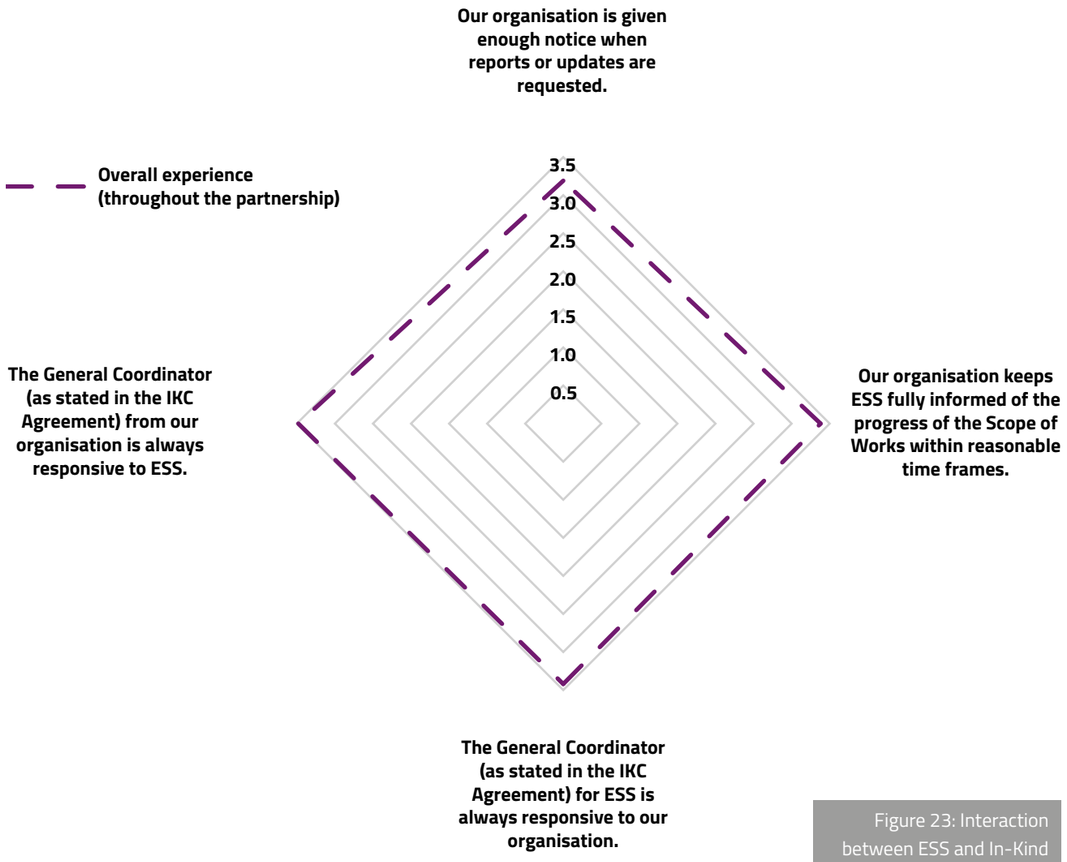
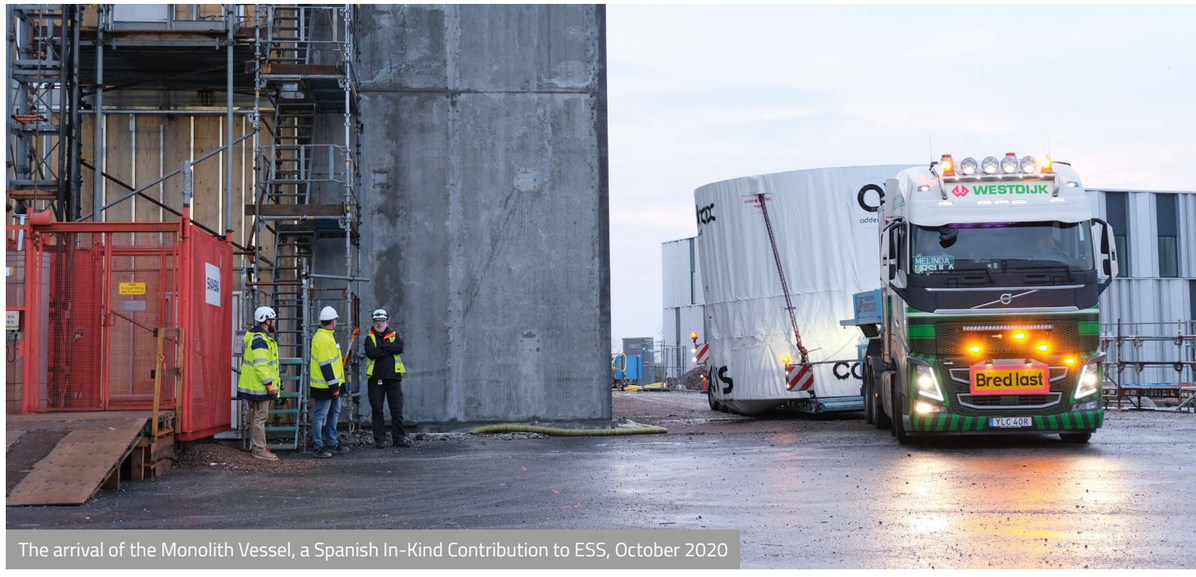


Figure 23: Interaction between ESS and In-Kind Partners (n=26)



The arrival of the Monolith Vessel, a Spanish In-Kind Contribution to ESS, October 2020

To ensure the IKPs' needs are always met, ESS is keen on building and maintaining effective interaction and cooperation with IKPs. According to the In-Kind Partner Survey, the IKPs have reported their perceptions of their interactions with ESS to be good overall, but with room for improvement. Figure 23 shows the overall positive experience of the 26 respondents among IKPs about their interactions with ESS along four dimensions. Meanwhile, the respondents mostly agree that the IKPs' collaboration with ESS has been positive with regard to critical decision-making, mutual trust, and meeting IKPs' ambitions and expectations (see Figure 25).

To respond to stakeholder needs during the Construction Phase, ESS recruits diversified staff to capitalise on their expertise. ESS is being built by hundreds of international and multicultural teams of experts at every level across the Organisation. ESS has employed staff including 45 nationalities by the end of 2018 with an average of about 35% being female. Over the period of 2013-2019, 214 new hires had relocated to Sweden, and 26 secondments were allocated to ESS. Figure 26 below indicates the number of nationalities of ESS staff by the end of a year and the percentage of female employees. The proportion of women employed by ESS has

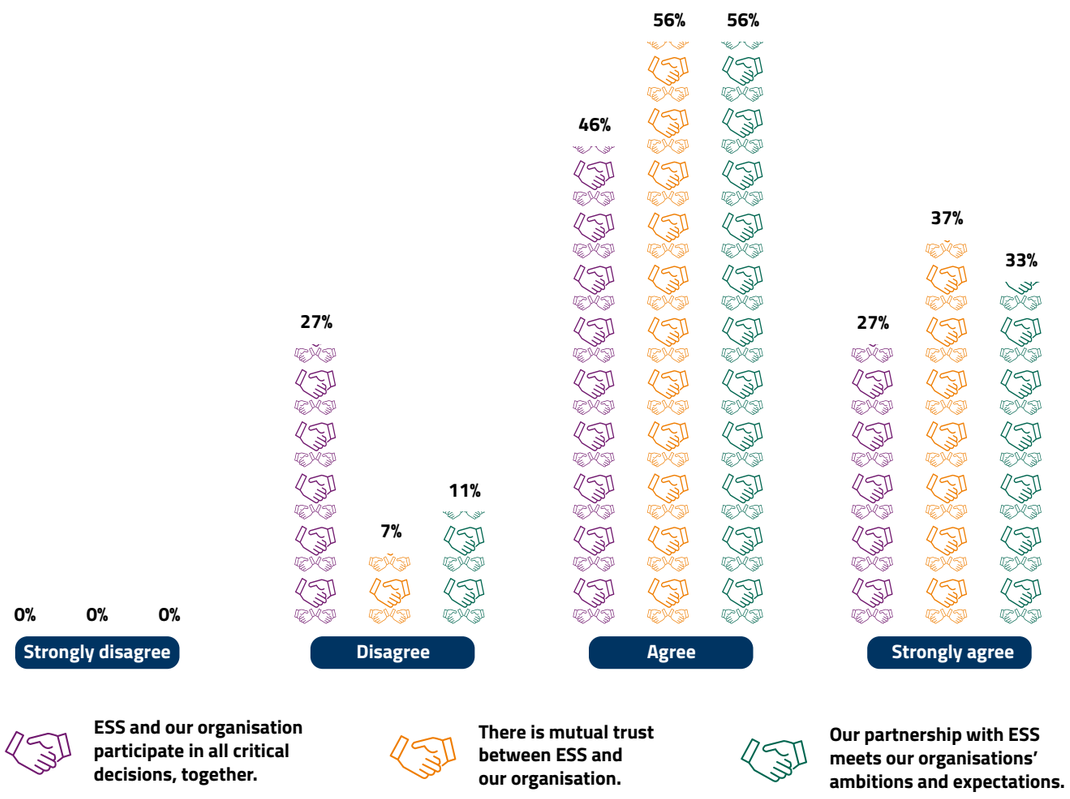
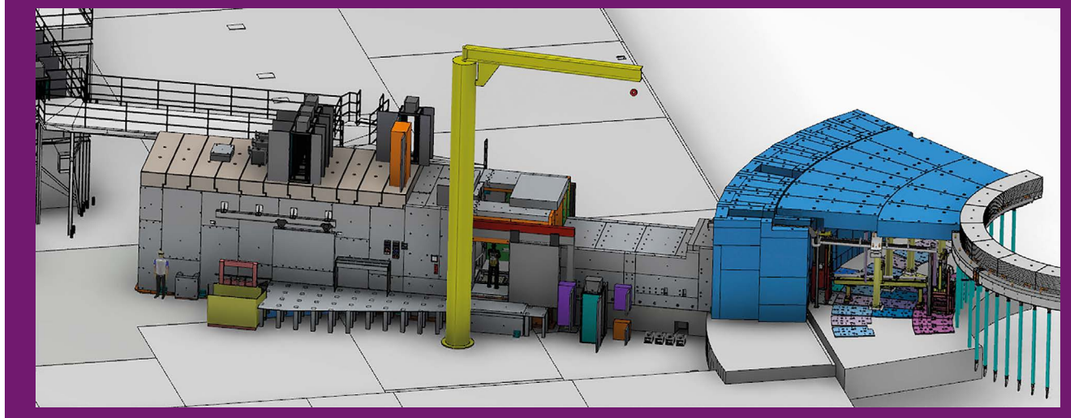


Figure 24: Perceived cooperation between ESS and In-Kind Partners (n=26)

LoKI collaboration at STFC

LoKI, one of two small-angle neutron scattering instruments being built for ESS, has been designed with the needs of the soft matter, materials and bio-science communities in mind. Since 2016, LoKI has been an in-kind collaboration with the Science and Technology Facilities Council (STFC) of United Kingdom Research and Innovation (UKRI). This includes the design, construction and partial pre-assembly of the instrument at STFC. After disassembly and shipment to Lund, LoKI will be installed in the experimental hall by a team from ESS, with support from key members of the STFC design team. The pre-building exercise, already underway at STFC, includes the installation team and different technical groups from ESS in order to reduce technical risks and speed up the final construction at ESS. The design team has worked intensely since the instrument was approved, having to maintain close interaction with ESS to keep up with changes to the facility design. This work and collaboration are reflected in the current progress of the instrument, where 90% of the detailed design of the critical components of the instrument is finished, and 70% of the instrument is in the process of manufacturing. Throughout the project the relationship between STFC and ESS has been very close, effective, and full of countless scientific and technical discussions. This open communication has been very productive, with lessons learned for both organizations. The vast experience of STFC has contributed a great deal to the project, and their continued support will undoubtedly enrich ESS during operations.



Box 5: Instrument collaboration; Image: LoKI instrument view.

declined as science and technical staff have increased. ESS management recognises that this imbalance needs attention.

The impact of ESS on employment during the Construction Phase extends beyond the Organisation. One example is that the ESS IKPs have also had the opportunity to hire new talent to work on their respective In-Kind Contributions. According to the In-Kind survey, while 44% of IKPs have small teams of 1-9 employees to work on ESS In-Kind Contributions, about 15% of the IKPs have large teams of more than 50 employees to work on ESS In-Kind Contributions (see Figure 26 below).

To build ESS, new jobs have been created directly as the result of the Construction Phase. Figure 27 shows the increasing number of staff and workers employed directly and indirectly by Skanska, the project development and construction firm, during 2014-2018.

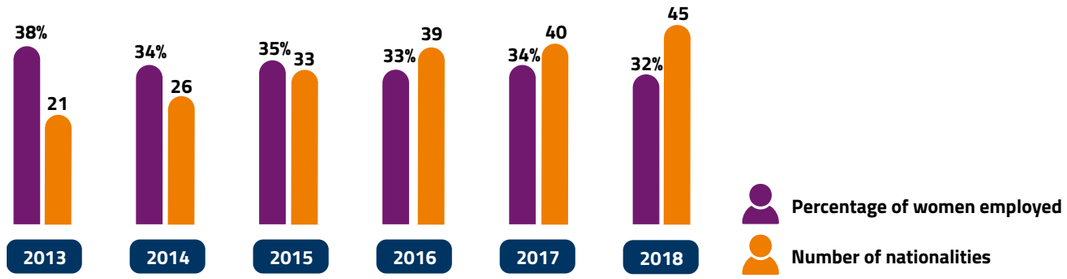


Figure 25: Number of nationalities & percentage of women employed at ESS

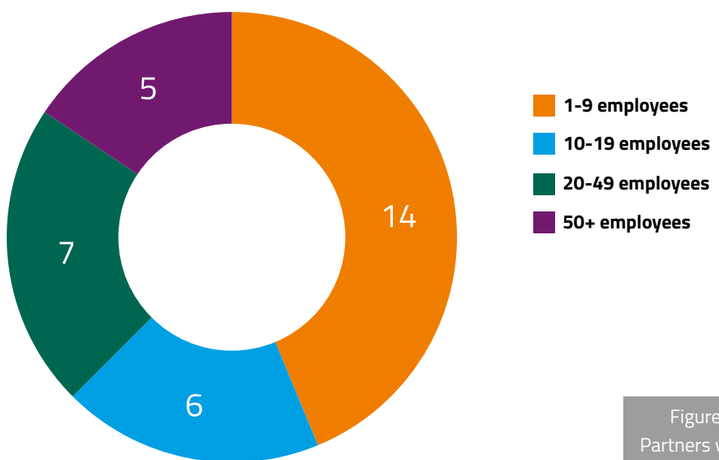


Figure 26: Number of In-Kind Partners with various team sizes working on the ESS In-Kind Contribution (n=32)

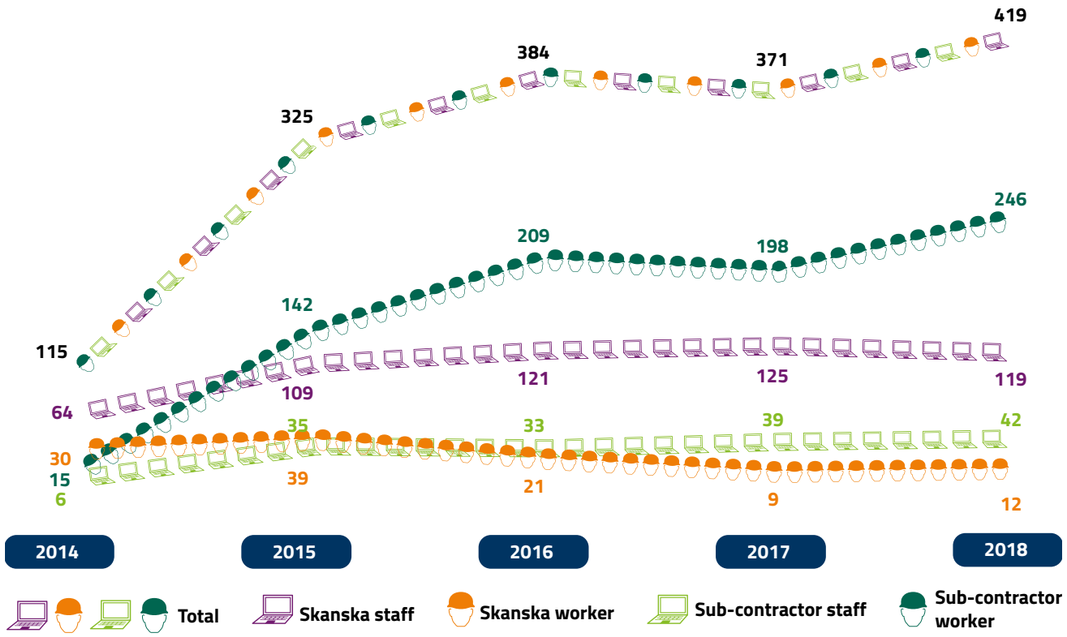
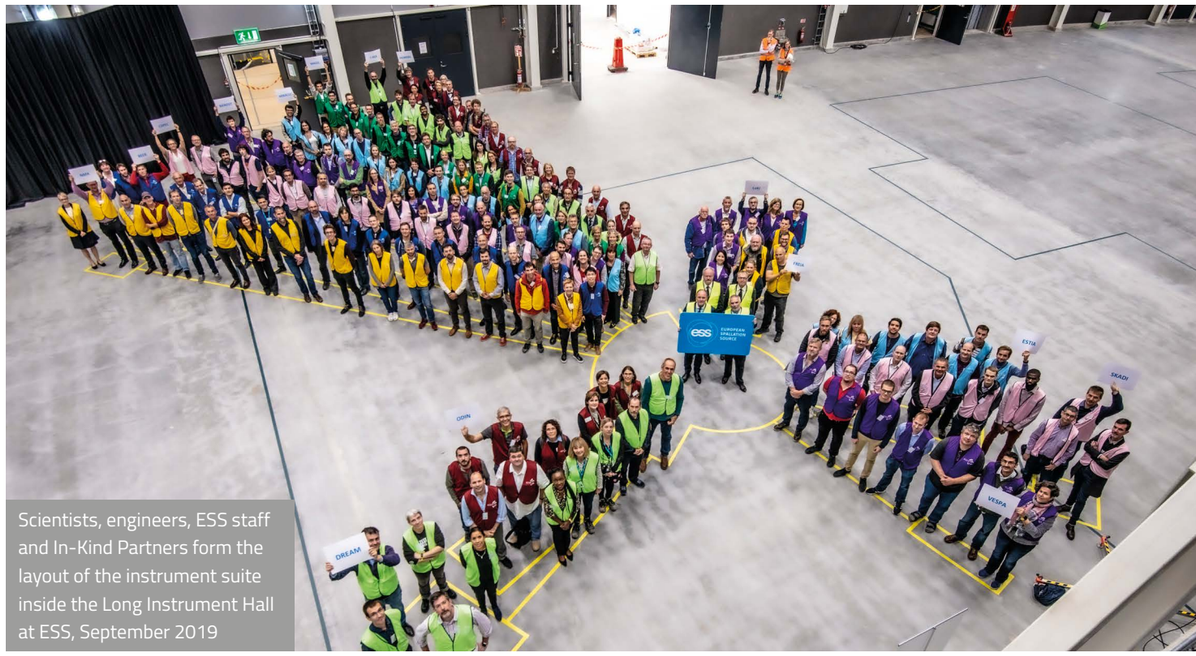


Figure 27: Number of staff and workers employed by Skanska (2014-2018)



Scientists, engineers, ESS staff and In-Kind Partners form the layout of the instrument suite inside the Long Instrument Hall at ESS, September 2019

Strategic objective 4: ESS develops innovative ways of working, new technologies, and upgrades to capabilities needed to remain at the cutting edge

Pathway: Technology push through procurement and In-Kind Contribution, and building innovation capacity of ESS and industry in Member Countries

ESS works closely with In-Kind Partners and suppliers in the Member Countries to make technological and process innovations and build innovative capabilities within ESS and with partners. This is achieved through joint R&D via In-Kind Contributions and through specialised procurement that add innovation value to the suppliers in Member Countries. In doing so, knowledge transfer and positive spillover effects in a medium to long run will contribute to innovation capacity building among the Member Countries.

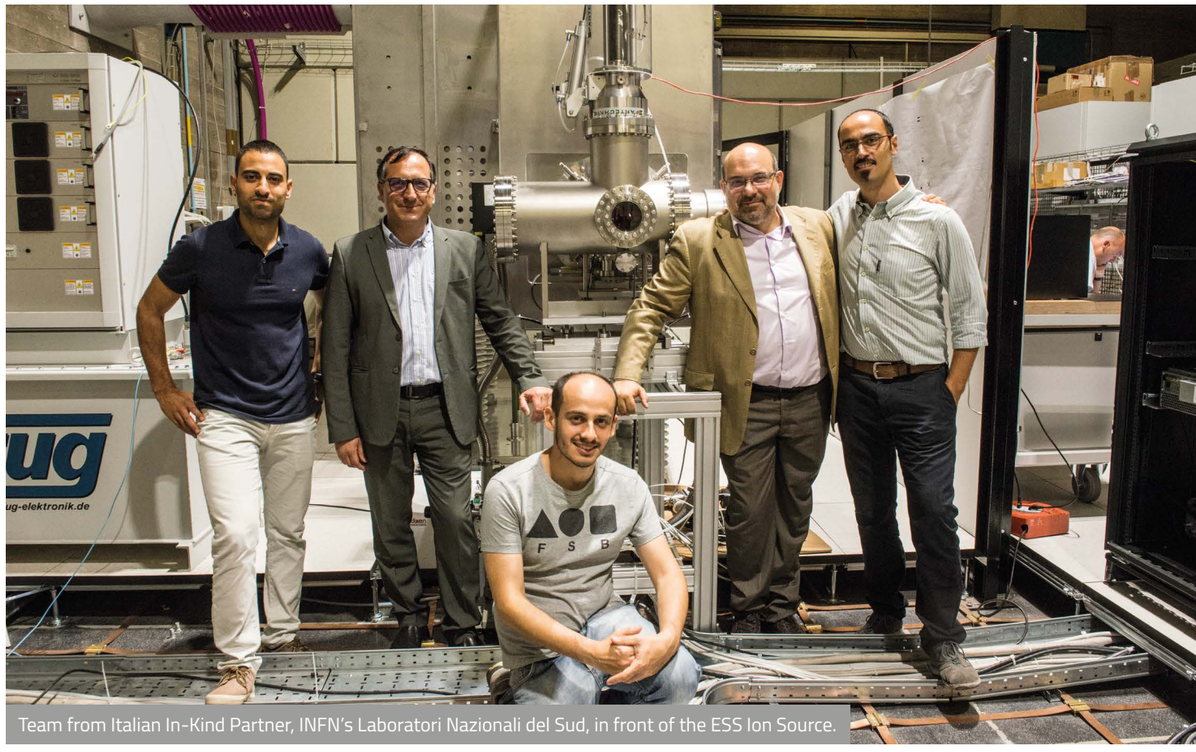
The In-Kind Contribution model assures the use of best available capacity within Member Countries for accelerating the construction of ESS. What the In-Kind Model also does is to build innovation capacity. This is particularly recognised in the vast potential for innovation, technological spillover effects, skills retention, and community development. Many In-Kind Contributions to ESS are deeply innovative. Some of the Accelerator, Control Systems, and Target technical components possess specifications which have not been reachable before but had to be reached for ESS. Some of the instrument technology is bleeding-edge, and once operational will push the boundaries of science as we know it. Some parts of the ESS Target, namely, the Target Wheel, have never seen real-life use before. What connects all of these stories of ESS' innovation is the In-Kind Model. Through this collaboration the Partners and their respective Member Countries are building capacity within their own scientific communities.

The ESS In-Kind model creates benefits in terms of technology advance and knowledge transfer due to ESS membership rather instantly already in the Construction Phase because In-Kind Partners play a decisive role to develop cutting-edge instruments and tools for ESS. The benefits are expected to exceed the direct relationship between ESS and In-Kind Partners, through collaborative projects beyond the scope of the In-Kind Contributions, encouraging future users, and procured R&D. Furthermore, In-Kind Partners are engaging with local, regional, and international industry partners who supply them with goods and services needed to execute these complex pieces of work. Through this process, the industrial suppliers see an increase of their business opportunities, create lasting partnerships in an otherwise narrow and competitive market, all while creating more jobs and opportunities in the process. Finally, the staff working on In-Kind Contributions acquire unique skills and know-how which will be retained in the scientific community. As a result, the community grows, and expands into new areas, bridging the gap between the industry and Research Infrastructure by narrowing skills gaps, and creating new areas of combined specializations.

A total 33 In-Kind Partners (IKPs) have joined the ESS project throughout the 2013-2018 period. The first In-Kind Agreements were signed in 2015. Since then, by the end of 2018, the In-Kind Partners have signed a total 22 In-Kind Agreements, with six In-Kind Agreements in preparation. Whereas the two Host Countries do not have In-Kind Partners, institutes from Sweden and Denmark are involved in single-source procurements done in the spirit of In-Kind and have signed five Collaboration Agreements (two by Swedish institutes and three by Danish institutes). Although the Danish institutes are not IKPs, they are however involved in In-Kind instrument Work Packages. Figure 28 below shows the number of IKPs per Member Country.

Figure 28: Total number of In-Kind Partner institutes per Member Country

Note: Sweden and Denmark do not have In-Kind Partners, though, institutes from the Host Countries are making contributions via Collaboration Agreements in the spirit of In-Kind.



Team from Italian In-Kind Partner, INFN's Laboratori Nazionali del Sud, in front of the ESS Ion Source.

Much progress has been made by the IKPs with a total of 84 Technical Annexes having been approved by the end of 2018. A further 41 Technical Annexes have been endorsed, with their approval pending signature of the associated In-Kind Agreement. Figure 29 below displays the number of Technical Annexes, approved or endorsed, per Member Country.

Note that for a Technical Annex to be approved, a corresponding In-Kind Agreement must be signed, otherwise a TA can only be legally considered as being endorsed. Nevertheless, both approved and endorsed TAs are the most important building blocks of contributions committed by the Member Countries.

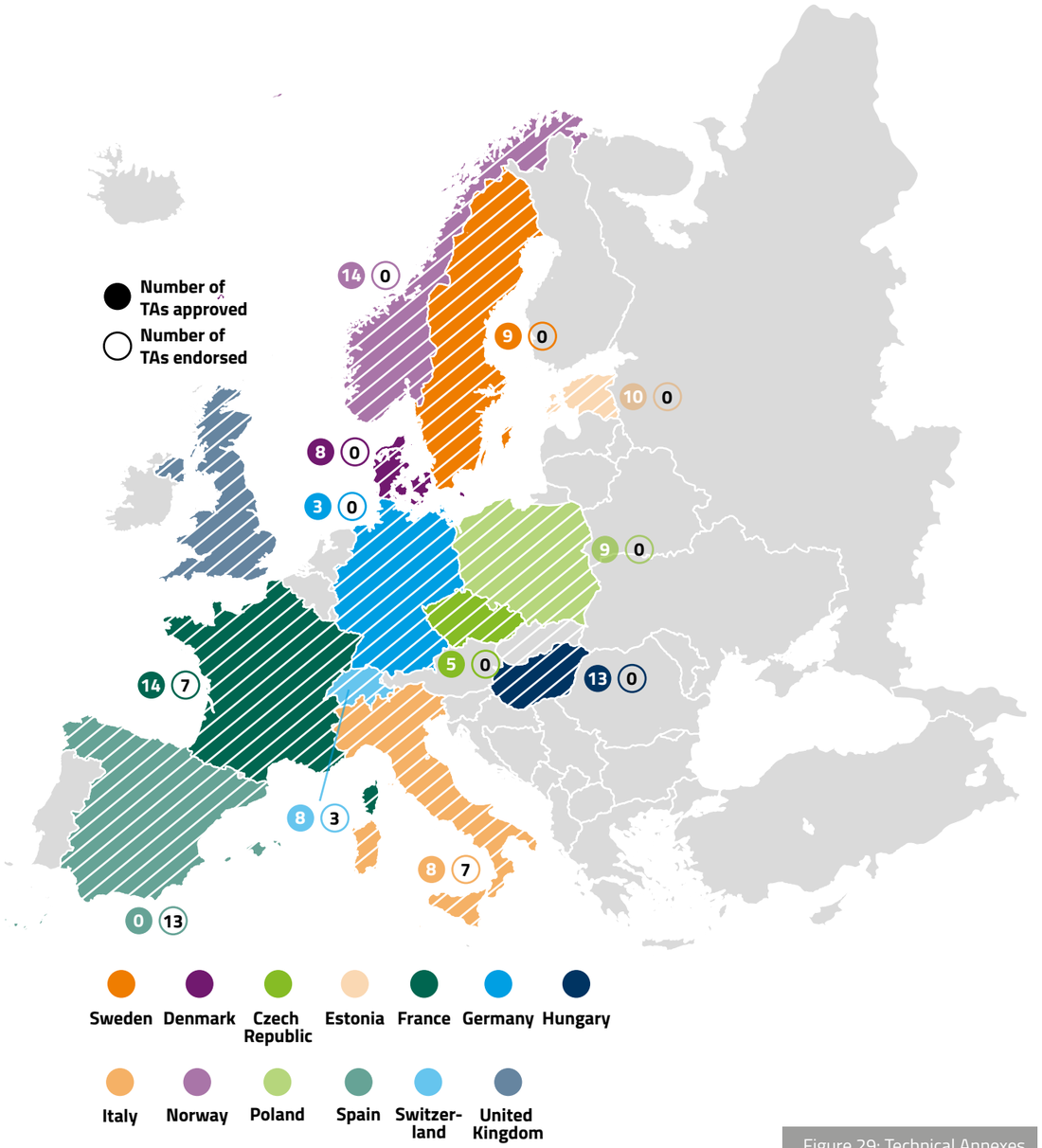


Figure 29: Technical Annexes by Member Country

A cryo module is being lifted after arriving at the ESS site

These endorsed and approved Technical Annexes have various total Cost Book values and represent the volume of contribution of Member Countries at different stages of the Construction Phase. Figure 30 shows the total Cost Book value of Technical Annexes up to 2018 among Member Countries, with France on the top of the list (97.30 M€), followed by Italy (63.70 M€) and the UK (60.30 M€, only endorsed) with the second and the third highest values, respectively. However, that is not to be misinterpreted as if the impact of ESS' technology push on Member Countries innovation capacity is dominated by those Member Countries on the top of this list. In fact, the interpretation of these figures must consider the development process of the Construction Phase and the relevant contribution made by individual Member Countries at different stages. For instance, at the early stage of the Construction Phase, a great amount of IKC is made for the construction of the Accelerator, and the IKC made for the construction of instruments is expected to take place in a later stage. Therefore, Member Countries like France, Italy and Poland, which mainly contribute to the construction of the Accelerator, had a much higher Cost Book value of IKC up to 2018, where countries like Germany, which is going to deliver most of its IKC for the construction of instruments, will show its great volume of IKC in the years to come. Figure 31 shows the proportion of Cost Book value among approved, endorsed and planned TAs across Member Countries.

The impact on IKPs' innovation capacity is expected to be evident as a result of a technology push made by ESS' demand, which cannot be directly seen from the Cost Book value of Technical Annexes. Therefore, an IKP Survey was used to probe the possible impact perceived by the IKPs. According to the IKP Survey, the IKPs have recognised high levels of innovation in their respective contributions. Figure 32 shows that among the 27 responding IKPs nearly three quarters of their contributions require either highly customised technologies and/or services, or new and advanced products, technologies and/or services. Comparing the Cost Book

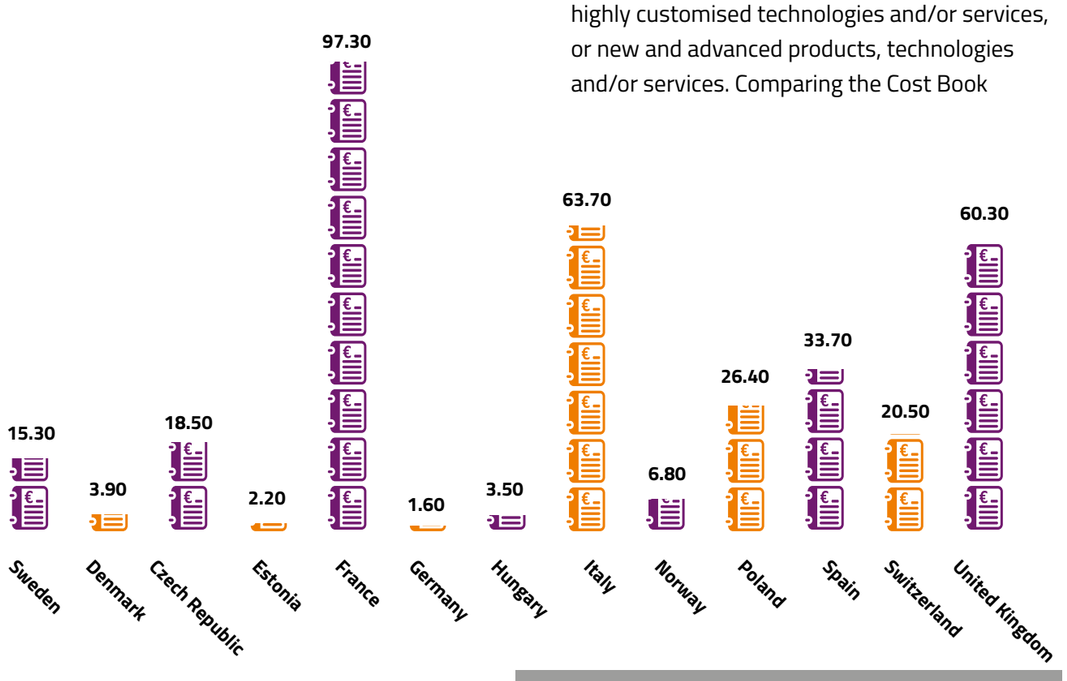


Figure 30: Total Cost Book value of In-Kind Technical Annexes (signed and endorsed) by Member Country in 2013 prices (M€)

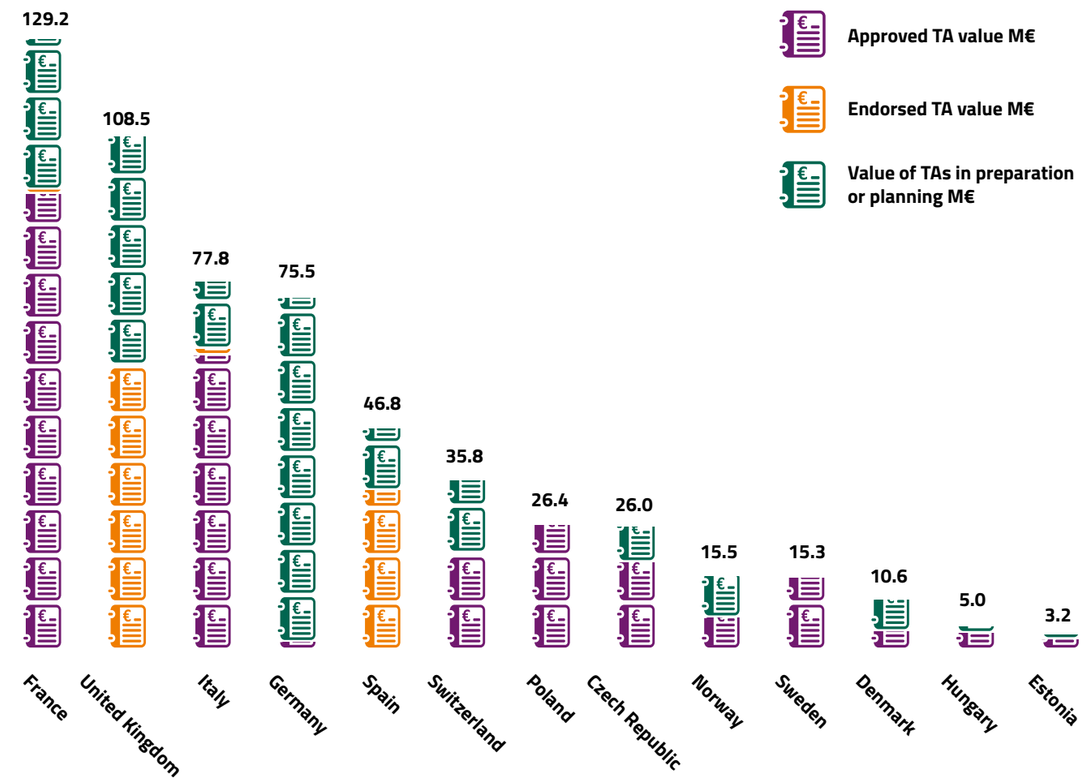


Figure 31: Proportion of Cost Book value among approved, endorsed and planned TAs across Member Countries up to 2018

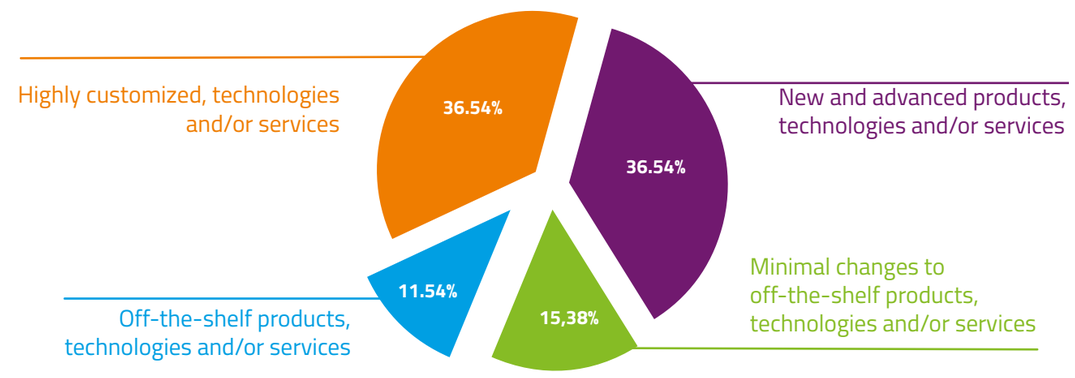


Figure 32: Innovation level of In-Kind Contributions (n=27)

value of Technical Annexes signed by Member Countries to the type of contributions they are supposed to make to ESS, a pattern appears. The In-Kind Partners have contributed all types of products, technologies or services to ESS with regards to their innovation levels. Table 12 shows such a contrast, where the number of responses agree on the level of innovation for the IKPs' contribution is listed along with each Member Country's Cost Book value of Technical Annexes. When we assign an innovation level score for each type with off-the-shelf being "1", changes to off-the-shelf being "2", highly customised being "3", and new and advanced being "4", then an average score of innovation level for the In-Kind Contributions can be calculated and seen in the third column from the left.

The average innovation level scores among Member Countries are quite close to each other, with Hungary scoring the highest with a score of "4" (with only one IKP response) and the UK being the lowest with a score of "2.3". The correlation coefficient between Cost Book value of technical annexes and average innovation level of In-Kind Contributions is -0.071, indicating no correlation at all between these two measures. Thus, it is safe to conclude that even though the IKPs have received Technical Annexes of different Cost Book value, the innovation types of contributions expected from Member Countries are not tied to the Cost Book value of In-Kind Contributions. Rather, ESS has managed to stimulate a well-balanced contribution from all Member Countries with respect to expected innovation inputs from the Member Countries.

Similarly, by working with ESS, suppliers may benefit in terms of developing new technologies, products and services, and potential leads to extended market opportunities. The ESS supplier Survey asked suppliers to indicate which types of products and/or services that they have supplied to ESS for their first contract with ESS and their most recent contract (if one had more than one contract with ESS). Figure 33 shows the distribution of various types of supplies to ESS based on the answers from the 87 suppliers that had high-value contracts (50 k€+) with ESS. As some of these suppliers supplied more than once to ESS, 49 suppliers in this subset answered questions about their first and most recent supplies. It is obvious that products (goods) are the majority, followed by procured consultancy among these suppliers, which also provided information about how innovative the products/services supplied to ESS were (innovation levels).

Figure 34 shows the innovation levels of supplied products and services. It is evident that most of the supplied products and services were relatively innovative as highly customised (reported by 53% of responding firms for both the first and the most recent supply) or new and advanced (reported by 36% and 41% of responding firms, for the first and the most recent supply, respectively) products and services, which required collaborative design and development with ESS.

Member Countries	Cost Book value of Technical Annexes signed or endorsed in M€	Average innovation level score of In-Kind Contributions	Number of IKP respondents agreeing contribution being **off-the-shelf** products, technologies or services (value = 1)	Number of IKP respondents agreeing contribution being **minimal changes to off-the-shelf** products, technologies or services (value =2)	Number of IKP respondents agreeing contribution being **highly customised** products, technologies or services (value =3)	Number of IKP respondents agreeing contribution being **new & advanced** products, technologies or services (value=4)
Sweden (Signed collaboration)	15.30	3.5			1	1
Denmark (Signed collaboration)	3.90	3			1	
Czech Republic	2.20	3.5			1	1
Estonia	97.30	3		1	2	1
France	1.60	2.6	2	2	4	2
Germany	18.50	3.333		1	2	3
Hungary	3.50	4				1
Italy	63.70	3.333			4	2
Norway	60.30	3.143	1	1	1	4
Poland	20.50	2.5				1
Spain	33.70					
Switzerland	26.40	3		1		1
United Kingdom	6.80	2.3	2	2	3	2

Table 12: Cost Book value of Technical Annexes signed by Member Countries vs. innovation level of contributions (2013-2018)

Note: We failed to receive responses from IKPs from Spain.

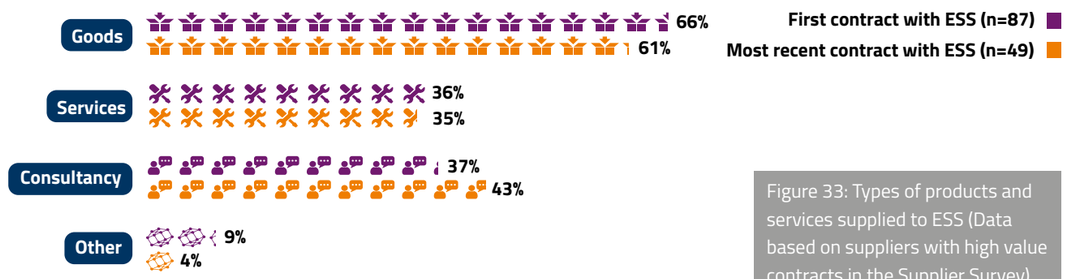


Figure 33: Types of products and services supplied to ESS (Data based on suppliers with high value contracts in the Supplier Survey)

Note: Survey respondents could select more than one option.

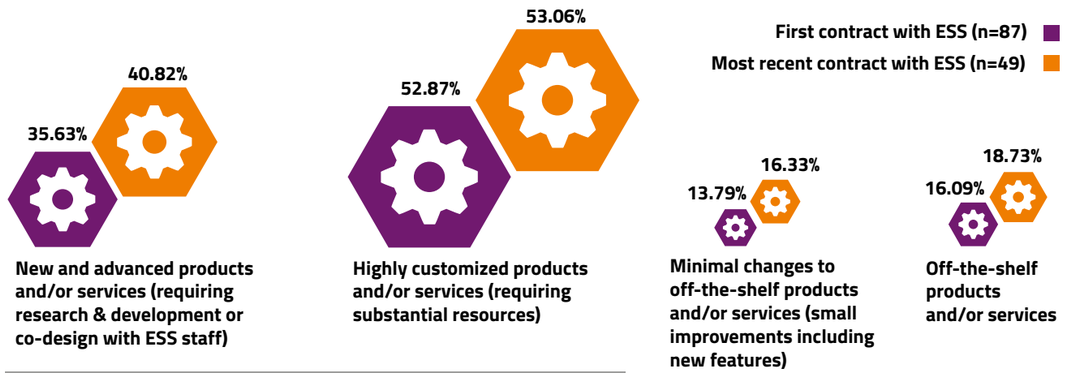


Figure 34: Innovation level of products and services supplied to ESS (Data based on suppliers with high value contracts in the Supplier Survey)

Note: Survey respondents could select more than one option.

By supplying to ESS, suppliers may expect to derive various benefits, including improving organisational and R&D capabilities, improving technical know-how, acquiring new knowledge about market needs and trends, and developing new products and services. Figure 35 shows the ESS survey results regarding suppliers' innovation benefits due to working with ESS. More than 41% of the 284 responding suppliers agreed that they improved technical know-how; more than 27% of suppliers agreed that they improved quality of products and services, and; 25% of suppliers acknowledge that they acquired new knowledge about market needs and trends. If the responding suppliers who only supplied off-the-shelf products and services are removed from the sample, then a difference emerges. Figure 36 shows that innovation benefits are higher in all regards for those suppliers who supplied non-off-the-shelf products and services: 50% of those agreed that they improved technical know-how; more than 35% of suppliers agreed that they improved quality of products and services; more than 29% of suppliers acknowledge that they acquired new knowledge about market need and trends.

Moreover, innovation based on ESS technologies is beginning to take shape at home. In recent years, five patent applications made by ESS staff with industry and non-commercial partners have been submitted during 2013-2018. Among these patent applications, European Spallation Source ERIC was the applicant for three of them, and the other two had ESS staff as inventors. An overview of these patent applications is provided in Box 6.

Beyond patentable technologies, ESS technologies have great potential to make an impact on solving grand societal challenges. For instance, there are 16 non-structural proteins (NSPs) in SARS-CoV-2 that play important roles in viral replication and transcription. The virus has proof-reading capabilities and the proteins involved are possible drug targets. Interfering with the virus's ability to replicate and produce a mature, infectious virus capsid is a key focus for many international researchers. High-resolution crystallographic studies play an important role in finding either new inhibitors or studying how existing drugs can be repurposed to block the novel coronavirus. Therefore, the Deuteration & Macromolecular Crystallisation (DEMAX) platform at ESS has been offering prioritised access to laboratory services for scientists and researchers working on such COVID-19-related research projects. A research project on viral proteins has now started to analyse one of these proteins, Nsp10, with the help of the BioMAX beamline at MAX IV Laboratory.

To harvest the innovation impact of ESS, a crucial role must be played by the ILOs. Although during the Construction Phase ESS ILOs have primarily focused on promoting ESS and Big Science as market potential for their national industries, their role will naturally evolve as ESS transitions away from the significant procurement accompanying construction and moves into operations. The ILO strategy meetings (June 2019, Budapest, and February 2020, Catania, Italy) have set an agenda to further harvest innovation impact of ESS. The innovation impact of ESS created by the development of ESS' own technologies and the technology push effect on In-Kind Partners and suppliers will increasingly emerge when ESS moves into the Operations Phase.

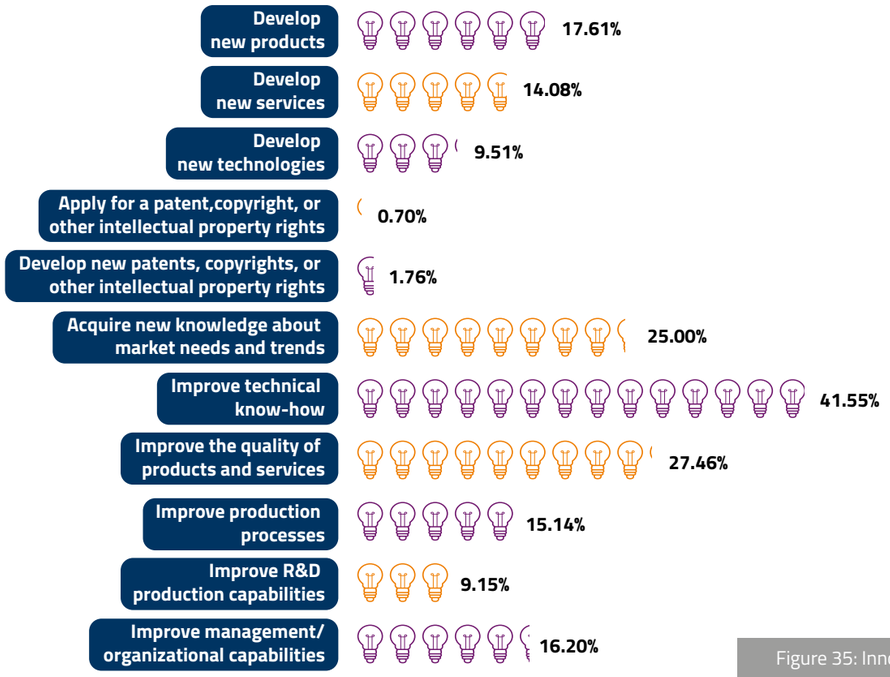


Figure 35: Innovation benefits for responding suppliers (n=284)

Note: Survey respondents could select more than one option.

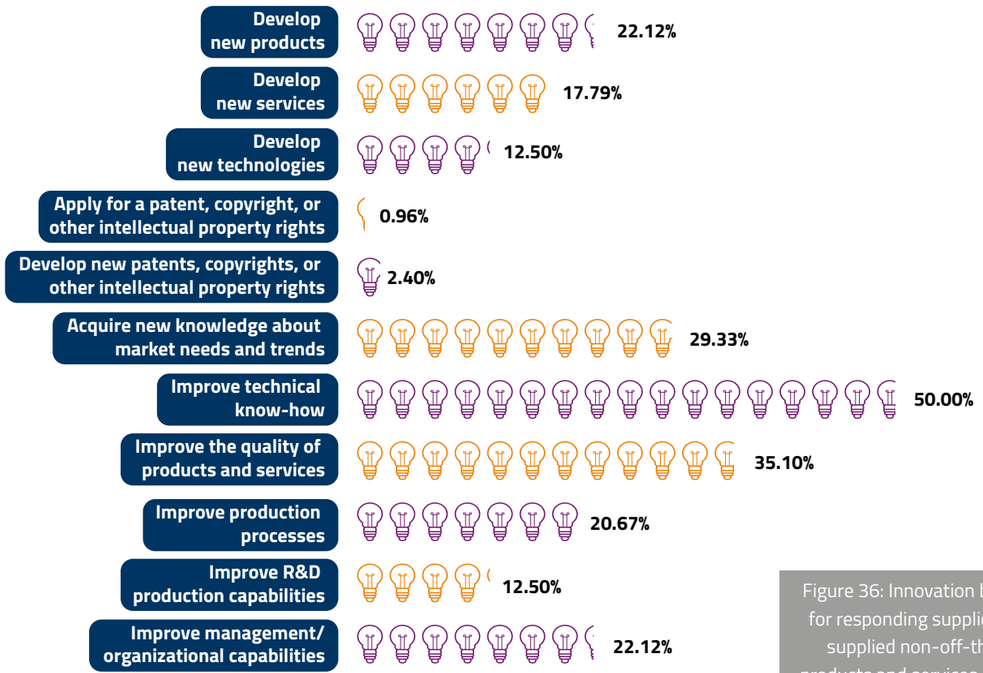


Figure 36: Innovation benefits for responding suppliers who supplied non-off-the-shelf products and services (n=208)

Note: Survey respondents could select more than one option.

Title: A Method for Producing a Neutron Detector Component Comprising a Boron Carbide Layer for Use in a Neutron Detecting Device
Applicants: Lars Hultman; Jens Birch, and ESS
ESS inventors: Carina Hoeglund; Lars Hultman; Jens Birch
Patent application numbers: CA2839780A1; EP2726640A1; EP2726640A4; SE1250745A1; SE535805C2; US2014299781A1; WO2013002697A1

Title: Ett förfarande för framställning av en neutrondetektorkomponent innefattande ett borkarbidskikt för användning i en neutrondetektor (patent in force)
Applicants: ESS; Lars Hultman; Jens Birch
ESS Inventors: Lars Hultman; Jens Birch
Patent application numbers: CA2839780A1; EP2726640A1; EP2726640A4; SE1250745A1; SE535805C2; US2014299781A1; WO2013002697A1

Title: Method of Providing a Neutron Source
Applicants: ESS; MIFLER CONSULTING KFT
ESS Inventors: Ferenc Mezei; Luca Zanini
Patent application numbers: EP3459083A1; US2019189294A1; WO2017198303A1

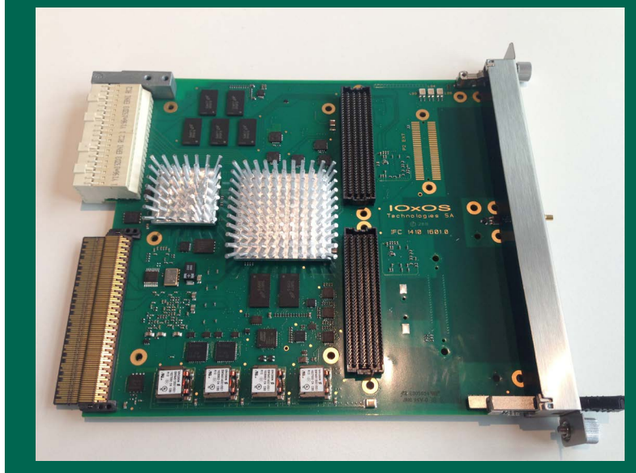
Title: Scintillation Detector with a High-Count Rate
Applicants: FORSCHUNGSZENTRUM JÜLICH GMBH
ESS inventors: Richard Hall-Wilton
Patent application numbers: CN107003418A; DE102014224449A1; EP3224652A1; JP2018505421A; US10451750B2; US2017329027A1; WO2016083021A1

Title: Control and Evaluation of Material Integrity in Real Time and Quality Assurance (in Greek)
Applicants: Gazis Nikolaos; Eastern Macedonia and Thrace Institute of Technology
ESS inventors: Nick Gazis
Patent application numbers: No 20170100590 (Greece)

The ESS Detector Coatings Workshop is an in-house production facility that ESS has established in Linköping, Sweden

Box 6: Patent applications with ESS staff as inventors or applicants.

Innovation benefits: A tale of two suppliers
To better understand how exactly some suppliers managed to get innovation benefits by supplying to ESS, a few in-depth interviews were conducted during May-June 2020. Some inspiring lessons learned from two suppliers, Recab (Denmark) and iOxOS Technologies (Switzerland), are representative for most successful cases. First, Recab is an engineering company with offices in Denmark, Norway and Sweden. It offers both hardware and software solutions with expertise in industrial data communication, sensor, ID & vision and embedded computer systems. The company supplies part of the turnkey solution of EPICS to ESS. The company appreciated getting information directly from ESS, who gave constant support. Recab has witnessed significant improvement of communication with ESS during the recent years. Resulting from supplying to ESS, the company pushed its technical boundary to develop technology in high speed data acquisition, which now has made the company one of the few companies in the world that hold the leading technology. Recab also hired new technical staff and acquired new software, a big investment in technology development, which could not be made possible without the financial support of the Vinnova program in Sweden. Second, iOxOS Technologies is a Swiss electronic design company offering innovative solutions to system integrators. The company complements a comprehensive product line with engineering, consulting and training services covering both hardware and software domains. The company supplied to ESS through both direct procurement tenders and In-Kind Contribution. Supplying to ESS is a driver to develop a new generation of electronics for Big Science through co-development and new investment. As the volume of the contract is not small for a small Swiss company, it made economic sense. By receiving the contract, 70% of the company's resource were used for developing the ESS product. By supplying to ESS, the company creates a new user/customer community through its own business development and the helpful reference made by ESS and the Swiss ILO. The company has been also actively searching for the "sameness" in technologies and finding common needs in other industries, including the military and aerospace markets.



The ICS digital controller platform from iOxOS Technologies, an In-Kind Contribution from Switzerland's PSI

Box 7: Innovation benefits: A tale of two suppliers.

Conclusion

This report, as part of the work under the EU project BrightnESS[2], showcases some important aspects of the socio-economic impact (SEI) of ESS, primarily in its Member Countries and among its various stakeholders. The report follows the principle and practical suggestions of several recent EU forums, initiatives and programs by applying data measures to a mix of indicators that include the inputs, activities, outputs and impact of the ESS project's pursuit of its strategic objectives during the ongoing Construction Phase (evidence collected for the period 2013-2018). Several indicators and measures have been selected to highlight the early evidence of the SEI of ESS. Six impact pathways related to the ESS strategic objectives are illustrated by a mix of quantitative data and qualitative cases.

The ESS SEI assessment framework, thus, has the potential to be adopted and adapted by other European RIs according to their own scientific, economic and political context. There has not been a consistent SEI assessment model across the majority of RIs in Europe over the past decades, making it difficult to benchmark assessment results previously published by other RIs against those in this report. It is our hope that these results can be useful for other European RIs to develop and compare their SEI across peer organisations.

Looking forward, ESS will move from the Construction Phase to the Operations Phase and ultimately to Steady State operations, accumulating greater societal impact with each passing year. This early SEI pilot, undertaken by ESS during its Construction Phase, marks it as a pioneering document among European RIs, which share the common responsibility to maximise their societal impact by enabling scientific discovery.

ESS will continue to monitor its SEI through its planned phases of development, and will continually revisit its SEI indicators and measures by involving a wide range of scientific, educational and industrial partners and stakeholders.

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APPENDIX 1: INDICATORS AND MEASURES

Each of the ESFRI and OECD indicators have been considered and all those deemed relevant to ESS throughout its life cycle are adapted to the current framework. Tables 13-16 below list the indicators and measures of this framework for the four strategic objectives of ESS, respectively. The second column of each table, Indicator & detail source, indicates the origin of each indicator.

These indicators and measures are defined specifically for use by ESS during its ongoing Construction Phase (evidence collected for the period 2013-2018) with an eye toward adaptability to other RIs' own scientific, economic and political contexts. ESS will continue to assess the relevance of these indicators and measures while adapting them to scientific, economic, political, and environmental changes. It is important to note that it is difficult to benchmark against other RIs if different RIs use different indicators and measures. It is the hope of the authors of this report that the indicators and measures used here will serve as a reference point for other RIs to adopt those relevant to their individual organisations. Only when several RIs use similar indicators and measures will a meaningful benchmarking across RIs be possible.

Table 13: Objective 1 - ESS produces research outputs that are best-in-class both in terms of scientific quality and in terms of socio-economic impact

Impact type	Indicator & detail source	Indicator	Indicator detail	Measures	Phase
Scientific	OECD Standard Indicator/ESFRI	Share of users and publications per ESFRI Member Country	For access to facilities: number of granted proposals/accepted users For resource RIs: number of downloads/ studies or provisions of service.	Share of users per ESFRI Member Country	Operations
				Share of publications per ESFRI Member Country	Construction and operations
Scientific	OECD Standard Indicator/ESFRI	Number of publications	Number of publications based on the research performed using facilities/resources of the RI. The publication is shared by the countries of the home institutions of all authors, the sum of the shares being one.	Number of publications this year in all databases in Web of Science by Member Country	Construction and operations
				Number of publications with ESS affiliation (publications including ESS staff) this year	Construction and operations
				Total number of publications with ESS affiliation (publications including ESS staff)	Construction and operations
				ESS h-index	Construction and operations
				Number of publications and degree centrality vs. ILL & ESRF, in ESS' main publication categories	Construction and operations
				Total number of publications authored/co-authored by ESS in open data journals	Construction and operations
				Number of publications co-authored by ESS and ILL (non-exclusive) this year	Construction and operations
				Number of publications co-authored by ESS and MAX IV (non-exclusive) this year	Construction and operations
Scientific	OECD Core Impact Indicator	Papers co-authored with regional universities	Measure scientific productivity and the capacity to enable cooperation with regional scientific actors	Number of publications co-authored by ESS and In-Kind Partner universities and Lund University:	Construction

Scientific	ESFRI	Percentage of top (10%) cited publications	Percentage of publications based on research performed using facilities/ resources of the RI that, compared with the publications in the same field and in the same year, belong to the top 10% most frequently cited	Percentage of publications belonging to the top 10% most frequently cited	Operations
Scientific	OECD Core Impact Indicator	Number of citations	Quality of RI publications and number	Total number of citations to publications by ESS	Construction and operations
				Total number of citations to publications by external ESS users, citing ESS data	Operations
Scientific	BrightnESS	Neutron source reliability		Faults statistics (duration and cause)	Operations
Scientific	BrightnESS	Commitment to a certain level of performance		Neutrons produced	Operations
Scientific	BrightnESS	Sustainability		Incremental use of energy (neutron source)	Operations
				Incremental heat recovery (neutron source)	Operations
Social	OECD Core Impact Indicator/ESFRI	Participation by RIs in policy related activities	Number of participations, reimbursed by the organisers, in policy related working groups, committees & advisory boards. In the case of working groups, etc., organised by intergovernmental organisations, the invitation suffices.	Number of contracts with public/policy services for consulting/production of reports	Operations
				Number of policy related events (where ESS participated)	Operations
				Number of ESS employees in external committee or advisory board	Operations
				Number of committees or advisory boards consisting of ESS staff	operations
Social	OECD Core Impact Indicator/ESFRI	Citations in policy related publications	Number of times the RI or its projects are cited in policy related publications	Number of times the RI or its projects are cited in policy related publications	Construction and operations

Table 14: Objective 2 - ESS supports and develops its user community, fosters a scientific culture of excellence and acts as an international scientific hub

Impact type	Indicator & detail source	Indicator	Indicator detail	Measures	Phase
Scientific	ESFRI	Number of Members of the RI	Number of organisations/ countries with a formal engagement (e.g. Members, associated Members or observers, bound by legal agreement or MoU),	Number of Members of the RI	Construction and operations
Scientific	OECD Core Impact Indicator	Structuring effects of the RI on the scientific community	To measure the visibility attractiveness and community building of the RI (collaborations with other RIs)	Number of new partners involved in research projects coordinated by ESS	Operations
				Number of new research projects with other scientific teams	Operations
				Number of consultant framework agreements signed.	Construction and operations
				Number of technical consultant framework agreements signed	Construction and operations
				Number of events co-organised by ESS and ILL	Construction and operations
				Number of new grant projects with one or more partners outside the EU	Construction and operations
				Number of new grant project partners from outside the EU	Construction and operations
				Amount of grant funding allocated to In-Kind Partners (periodic data collection) in EUR*	Construction and operations
Scientific	ESFRI	Training of people who are not RI staff	The total number of person hours for which people external to the RI have made use of training opportunities provided by the RI, through both real (e.g. face to face) events and on-line services	Non-RI staff: Total number of hours spent in training sessions (excl. Registration, breaks); for online sessions, time logged in.	Operations

Scientific	OECD Core Impact Indicator/ ESFRI	Number of users served	For access to facilities: number of granted proposals/ accepted users For resource RIs: number of downloads/ studies or provisions of service	Number of scientific users (ESS staff)	Operations
				Number of scientific users (external)	Operations
				Number of remote users	Operations
				Number of scientific users per discipline	Operations
Scientific	OECD Core Impact Indicator/ ESFRI	Number of user requests for access	For access to facilities: number of user proposals for access For resource RIs: number of users of resources, such as collections, data, services	Total number of proposals to use the ESS facility received	Operations
				Total number of proposals to use the ESS facility received by instrument	Operations
				Total number of successful applications to use the ESS facility (proposals accepted)	Operations
				Total number of successful applications to use the ESS facility (proposals accepted) by instrument	Operations
				Total number of successful applications to use the ESS facility (proposals accepted) by societal challenge	Operations
				Total number of successful applications to use the ESS facility (proposals accepted) for each discipline science area	Operations
				Total number of successful applications to use the ESS facility (proposals accepted) for each discipline science method	Operations
				Share of users as per ESFRI country	Operations
				Share of academic users	Operations
Scientific	OECD Core Impact Indicator	Collaboration Excellence (scientific)	For access to facilities: number of granted proposals/ accepted users For resource RIs: number of logins/ downloads/studies or provisions of service.	Total number of proposals to use the ESS facility completed	Operations
				% Oversubscribed (proposals to use the ESS facility)	Operations
				Story about world leading teams using the ESS facility	Operations
				Number of In-Kind technical annexes signed by partner country per year	Construction
				Total Cost Book value of In-Kind technical annexes signed by partner country per year (EUR)	Construction
				Total number of In-Kind Partner institutes (includes all with a technical annex signed by the partner)	Construction
				Number of In-Kind Agreements	Construction

Scientific	OECD Standard Indicator	User satisfaction	Based on survey results; a survey can be run to measure user satisfaction on project selection, support and other items, to evaluate how the RI answers its user needs.	Overall user satisfaction	Operations
Scientific	ESFRI	Extent of resources made available	Experimental time available or size of resources database made available to users to facilitate research	Number of machine hours offered to users (operating schedule)	Operations
				Number of hours of beam time offered to users (planned time with neutrons)	Operations
				Number of machine hours offered to users by instrument (operating schedule)	Operations
				Number of hours used by users (effective time with neutrons)	Operations
				Number of hours used by users (effective time with neutrons)	Operations
Innovation	OECD Core Impact Indicator	Collaborative projects with industrial partners	New collaborative projects carried out with industry are a major mechanism through which knowledge circulates and impacts innovation	Number of ongoing research projects involving industry	Construction and operations
				Number of ongoing research projects involving industry coordinated by ESS	Construction and operations
				Number of ongoing research projects involving industry AND academia	Construction and operations
				Number of ongoing research projects involving industry AND academia coordinated by ESS	Construction and operations
Innovation	ESFRI	Share of users and publications per non-ESFRI Member Country		Share of users per non-ESFRI Member Country	Operations
				Share of publications per non-ESFRI Member Country	Construction and operations
Innovation	OECD Core Impact Indicator	Regional firms using the RI facilities	Contributes to the development of the regional firms skills and impacts on their innovation capacity	Number of regional firms using the RI	Operations
Innovation	OECD Core Impact Indicator	Share of users associated with industry and publications with industry Objective	For access to facilities: number of granted proposals/ accepted users For resource RIs: number of downloads/ studies or provisions of service	Number of industrial users	Operations

Social	OECD Core Impact Indicator	Students trained and distribution	Illustrates the RI attractiveness and excellence of its training	Number of PhD students co-funded by ESS	Operations
				Number of placement students supervised at ESS	Operations
				Attendance at SCUO organised training (Number of participants)	Operations
Social	ESFRI	Number of MSc and PhD students using the RI	Number of master and PhD students who have performed some of their studies at or using the services of the RI in a particular year regardless of whether they are funded/hosted by the RI or access it as a user.	Number of PhD or Masters students using the ESS facility	Operations
Social	OECD Core Impact Indicator/ ESFRI	Outreach through printed, broadcast and web-based media	Impact of press and communication actions in raising awareness of RI mission, activities and societal relevance of results	Number of online media articles about ESS	Construction and operations
				Number of online media articles mentioning ESS	Construction and operations
				Top 6 online publishers	Construction and operations
				Potential reach of online media articles	Construction and operations
Social	OECD Standard Indicator/ ESFRI	Outreach via the RI's own web and social media	Website popularity and level of social media engagement Web (e.g. Google analytics) analytics and social media analytic tools (Twitter, LinkedIn, YouTube, Flickr, Facebook, etc.)	Number of unique visitors to the ESS website	Construction and operations
				Number of sessions on the ESS website	Construction and operations
				Average session duration on the ESS website	Construction and operations
				Number of page views on the ESS website	Construction and operations
				Number of referrals from Google search to ESS website	Construction and operations
				Number of new followers on Twitter	Construction and operations
				Number of impressions on Twitter	Construction and operations
				Number of followers on LinkedIn	Construction and operations
				Number of page views on LinkedIn	Construction and operations
				Number of unique visitors on LinkedIn	Construction and operations
				Number of post engagements on Facebook	Construction and operations
				Number of page views on Facebook	Construction and operations
				Number of followers on Facebook	Construction and operations
				Number of followers on Instagram	Construction and operations

Social	OECD Standard Indicator/ ESFRI	Engagement achieved by direct contact	Outreach by public relations/direct contact with specific target groups: organisation of (e.g. summer schools, events for industry, government sector etc.) or participation at events organised by third parties; and visitors to the RI	Number of events organised by ESS for the public	Construction and operations
				Number of events hours organised by ESS for the public (reported to a minimum 0.25 days)	Construction and operations
				Number of public event participants (events organised by ESS)	Construction and operations
				Number of other non-scientific events organised by ESS	Construction and operations
				Number of other non-scientific event participants	Construction and operations
				Number of visitors (individuals) to ESS	Construction and operations
				Number of visits (groups) to ESS	Construction and operations
				Number of informational visitors (individuals)	Construction and operations
				Number of informational visits (groups)	Construction and operations
Social	OECD Core Impact Indicator	Knowledge sharing	Scientific events organised and number of people trained to demonstrate the impact on human resources (development of skills and knowledge)	Number of scientific events organised/co-organised by ESS	Construction and operations
				Number of science seminars organised at ESS	Construction and operations
				Number of participants of scientific events organised/co-organised by ESS	Construction and operations
				Number of participants at science seminars organised at ESS	Construction and operations
Social	OECD Core Impact Indicator	Educational and outreach activities	The educational training activities have an indirect impact on participants knowledge and skills	Total number of participants (educational training activities organised/co-organised by ESS) - incl. ESS staff	Construction and operations
				Total number of ESS staff attended, incl. speakers (educational training activities organised/co-organised by ESS)	Construction and operations
				Total number of educational training activities organised/co-organised by ESS	Construction and operations

Table 15: Objective 3 - ESS is built safely, on time and on budget, operates safely, efficiently and economically, and responds to the needs of its stakeholders, its Host Countries and Member Countries

Impact type	Indicator & detail source	Indicator	Indicator detail	Measures	Phase
Scientific	OECD Core Impact Indicator	Number of projects granted	Demonstrates the RI capacity to attract funding and excellence in projects	Number of grant proposals granted this year (where ESS is a member or coordinating the consortium)	Construction and operations
				Number of grant proposals coordinated by ESS granted this year	Construction and operations
				Number of grant proposals not granted (where ESS is a member or coordinating the consortium)	Construction and operations
				Number of grant proposals coordinated by ESS not granted	Construction and operations
				Granted proposal information	Construction and operations
Scientific	OECD Standard Indicator	National grants	National grants received demonstrate the RI excellence	Number of grant projects NOT coordinated by ESS granted by a funding agency in:	Construction and operations
				Number of grant projects coordinated by ESS granted by a funding agency in:	Construction and operations
				Number of grant projects NOT coordinated by ESS NOT granted by a funding agency in:	Construction and operations
				Number of grant projects coordinated by ESS NOT granted by a funding agency in:	Construction and operations
				Amount granted from funding agencies in:	Construction and operations
Social	OECD Core Impact Indicator	Gender balance and diversity	Demonstrates the effort made by the RI for equity (RI exemplarity)	Percentage of women employed	Construction and operations
				Number of nationalities employed	Construction and operations
				Percentage of women (users & trainees)	Operations
				Number of nationalities (users)	Operations
Social	ESFRI	International trainees	The total number of person hours for which people external to the RI have made use of training opportunities provided by the RI, through both real (e.g. face to face) events and on-line services.	Number of person-hours for which international trainees have made use of training opportunities provided by the RI (excluding registration and breaks), both face to face and online.	Operations
Social	BrightnESS	Employee satisfaction		Overall perception of ESS	Construction and operations
Social	BrightnESS	Staff mobility		Number of new hires relocated to Sweden	Construction and operations
				Number of secondments coming to ESS	Construction and operations
				Number of secondments from ESS	Construction and operations
Social	BrightnESS	Extent of training of RI staff		Number of person hours for training workshops for engineers	Operations
				Number of staff attended (training workshops for engineers)	Operations
				Number of person hours for training workshops for administrative staff	Operations
				Number of staff attended (training workshops for administrative staff)	Operations
				Number of person hours for training workshops for scientific staff	Operations
				Number of staff attended (training workshops for scientific staff)	Operations
Social	OECD Core Impact Indicator	Number of Full time equivalent within the RI	Development of new skills and increase of the economic activity of the region (multiplier)	Total number of new FTEs this year	Construction and operations
				Total number of new PTEs this year	Construction and operations
				Number of FTEs (end of year)	Construction and operations
				Number of PTEs (end of year)	Construction and operations

Social	BrightnESS	Safety Training		Percentage of Safety Training coverage of ESS divisions	Construction and operations
				Number of requests for the identification of Safety Training needs	Construction and operations
				Percentage of coverage of identified Safety Training needs	Construction and operations
				Number of released Safety Training courses	Construction and operations
				Number of Safety Training courses performed	Construction and operations
				Number of Safety Training belated enrolments	Construction and operations
				Number of enrolled persons to not attend Safety Training courses	Construction and operations
				Number of new trainers for Safety Training courses (trainers amongst ESS staff)	Construction and operations
				Average post-Safety Training test score (tests completed by ESS staff)	Construction and operations
Social	BrightnESS	Incidents & incident reporting		Number of all non-compliances per audit	Construction and operations
				Number of days lost due to accidents at work	Construction and operations
				Number of safety incident reports received	Construction and operations
				Number of emergency drills performed	Construction and operations
Economic	OECD Core Impact Indicator	Number of local/regional suppliers	Increased revenues of suppliers and related new skills impact the economic activity of the region	Number of suppliers based in Lund	Construction and operations
				Number of suppliers in Copenhagen	Construction and operations
				Number of suppliers in Skåne	Construction and operations
				Number of suppliers in the Capital Region of Denmark	Construction and operations
				Number of suppliers per Member Country	Construction and operations
Economic	OECD Standard Indicator	Total expenditure in regional / local area	All the regional/local RI expenditures have an impact on the economy	Expenditures in Skåne	Construction and operations
				Expenditures in the Capital Region of Denmark	Construction and operations
				Expenditures in Sweden (suppliers)	Construction and operations
				Expenditures in Denmark	Construction and operations
				Expenditures in each ESS Member Country	Construction and operations

Economic	OECD Standard Indicator	Public procurement and contracts	Development of new skills, technology and industrial processes, innovation induced through public procurement	Number of tenders received	Construction and operations
				Number of contracts awarded	Construction and operations
Economic	NEW	Cost performance index		Staffing expenditures by year	Construction and operations
				Annual overall expenditures	Construction and operations
				Annual budget - operations	Operations
				Actual annual cost - operations	Operations
				Annual budget - initial operations	Construction and operations
				Actual annual cost - initial operations	Construction and operations
				Annual budget for Construction Phase	Construction
				Actual annual Construction Phase cost	Construction
Economic	ESFRI	Revenues	Sources of revenue and their respective contributions to investments and operational costs.	Annual financial contribution received per Member Country (EUR)	Construction and operations
				Total external funding received (EUR)	Construction and operations
Economic	ESFRI	Income from commercial activities and the number of entities paying for service	Share of revenue from the RI's economic activities (sale of services and goods, access provision) reported in the in the annual accounts	Share of revenue from access provision	Operations
				Share of revenue from commercial activities	Operations
Environmental	OECD Core Impact Indicator	Waste management	How the RI manages the waste: effect on environment RI exemplarity	Waste (t)	Construction and operations
				Hazardous waste (t)	Construction and operations
				Landfill waste (t)	Construction and operations
				Waste for incineration (t)	Construction and operations
Environmental	OECD Core Impact Indicator	Energy consumption	What is done by the RI to save energy during the construction and its functioning: effect on environment and RI exemplarity	Electricity usage (kWh)	Construction and operations
				District heating, energy (kWh)	Construction and operations
				District heating, flow (m3)	Construction and operations

Table 16: Objective 4 - ESS develops innovative ways of working, new technologies, and upgrades to capabilities needed to remain at the cutting edge

Impact type	Indicator & detail source	Indicator	Indicator detail	Measures	Phase
Innovation	OECD Standard Indicator	Patents	The number of patents developed by the RI demonstrate its impact on innovation	Number of patents granted to ESS staff	Construction and operations
				Number of patents applications by ESS with industry partners granted	Construction and operations
				Number of patents applications by ESS with a non-commercial partner	Construction and operations
				Number of patents applications by ESS with a non-commercial partner granted	Construction and operations
				Number of patent applications by ESS with industry	Construction and operations
Innovation	OECD Core Impact Indicator	Patents with a commercial use	Commercial use demonstrates the usefulness of the patents developed by the RI	Annual aggregate licensing fee	Construction and operations
				Number of licensing contracts	Construction and operations
				Number of sold patents	Construction and operations
				Price of patents sold	Construction and operations
Innovation	NEW	Technology transfer		Number of outgoing technology transfer agreements	Construction and operations
Innovation	NEW	ESS inventors		Number of ESS inventors	Construction and operations
Scientific	OECD Standard Indicator	Use and production of open data	How the RI contributes to the development of open science	Number of grant projects using open data	Construction and operations
				Number of Open Data sets accessed	Construction and operations
				Number of Open Data sets made available	Construction and operations
				Number of Open Data sets downloaded	Construction and operations
Scientific	BrightnESS	Use and production of data		Total number of data sets available	Construction and operations
				Number of data sets accessed	Construction and operations
				Number of data sets downloaded	Construction and operations
				Number of data catalogue queries	Construction and operations
Scientific	ESFRI	Number of publicly available data sets used externally	Number of data sets produced as a consequence of access to the RI that are subsequently accessed by other users		Operations

APPENDIX 2: DATA

Table 17: Number of Members of the RI

Indicator: Number of Members of the RI						
Measures (grey rows) & contingencies (white rows)	2013	2014	2015	2016	2017	2018
Number of Members of the RI			11	12	12	13
Number of Observers of the RI			4	3	3	2
Number of Associates of the RI						0

Note: The United Kingdom became a Member in 2016 and Spain in 2018. Belgium and the Netherlands are the remaining Observers in 2018.

Table 18: Collaborative projects with industrial partners

Indicator: Collaborative projects with industrial partners						
Measures	2013	2014	2015	2016	2017	2018
Number of R&D contracts involving industry	2	8	8	8	11	11
Number of ongoing research projects involving industry	5	11	13	12	17	16
Number of ongoing grants involving industry coordinated by ESS	0	0	0	0	0	0
Number of ongoing research projects involving industry AND academia	3	3	5	4	6	5
Number of grants involving industry AND academia coordinated by ESS	0	0	0	0	0	0
Number of In-Kind Technical Annexes signed by partner country per year (total)	0	2	18	78	20	7
Total Cost Book value of In-Kind technical annexes signed or endorsed by partner country per year (EUR) (total)	0	216,000	38,501,000	228,681,291	53,500,343	13,019,684
Total number of In-Kind Partner institutes (includes all with a technical annex signed by the partner)	0	7	16	32	33	33
Number of In-Kind Agreements	0	0	1	49	22	12

Note: Research projects is defined as grants, procured R&D and user projects (upon Operations Phase).

Table 19: Structuring effects of the RI on the scientific community

Indicator: Structuring effects of the RI on the scientific community						
Measures	2013	2014	2015	2016	2017	2018
Number of consultant framework agreements signed.			0	2	1	0
Number of technical consultant framework agreements signed with existing partners			0	2	1	0
Number of new research projects with one or more partners outside the EU	1	1	7	3	2	6
Number of new grant project partners from outside the EU	4	2	7	1	0	2
Amount of grant funding allocated to In-Kind Partners (periodic data collection) in EUR*	31,529,092.78 € (YEARS 2012-2019)					

Note: The term research partners includes grant projects, R&D collaborations, and will include upon the Operations Phase, completed user proposals. The figures representing each measures contingency are available upon request.

Table 20: Number of projects granted

Indicator: Number of projects granted						
Measures	2013	2014	2015	2016	2017	2018
Number of grant proposals granted this year (where ESS is a member or coordinating the consortium)	1	2	9	8	3	8
Number of grant proposals coordinated by ESS granted this year	1	2	1	0	0	1
Number of grant proposals not granted (where ESS is a member or coordinating the consortium)	x	7	10	12	9	17
Number of grant proposals coordinated by ESS not granted	x	2	4	1	3	2

Table 21: National grants

Indicator: National grants						
Measures (grey rows) & contingencies (white rows)	2013	2014	2015	2016	2017	2018
Number of grant projects NOT coordinated by ESS granted by a funding agency in: (total)	0	0	1	4	2	4
Sweden	0	0	1	3	2	2
Denmark	0	0	0	0	0	0
Other	0	0	0	1	0	2
Number of grant projects coordinated by ESS granted by a funding agency in: (total)	1	0	0	0	0	0
Sweden	1	0	0	0	0	0
Denmark	0	0	0	0	0	0
Other	0	0	0	0	0	0
Number of grant projects NOT coordinated by ESS NOT granted by a funding agency in: (total)	0	0	2	4	5	3
Sweden	0	0	0	4	5	2
Denmark	0	0	2	0	0	0
Other	0	0	0	0	0	1
Number of grant projects coordinated by ESS NOT granted by a funding agency in: (total)	0	0	2	0	0	0
Sweden	0	0	1	0	0	0
Denmark	0	0	1	0	0	0
Other	0	0	0	0	0	0
Amount granted from funding agencies in: € (total)	0.00	0.00	5,373,493.00	50,028.00	4,789,262.00	1,716,491.90
Sweden	0.00	0.00	0.00		27,984.00	86,639.00
Denmark	0.00	0.00	0.00	0.00	0.00	0.00
Other	0.00	0.00	5,373,493.00	50,028.00	4,761,278.00	1,629,852.90

Table 22: Number of local/regional suppliers

Indicator: Number of local/regional suppliers						
Measures (grey rows) & contingencies (white rows)	2013	2014	2015	2016	2017	2018
Number of suppliers based in Lund	120	35	42	33	30	20
Number of suppliers in Copenhagen	347	138	146	150	134	109
Number of suppliers in Skåne	6	14	8	16	9	10
Number of suppliers in the Capital Region of Denmark	8	24	17	45	24	28
Number of suppliers per Member Country	773	446	554	620	466	451
Sweden	634	318	371	373	304	283
Denmark	15	31	34	71	36	31
Germany	38	30	62	51	35	42
Czech Republic	6	3		1	3	2
Estonia			1			1
France	20	13	17	18	9	17
Hungary	2	2	3	1	2	
Italy	2	2	3	12	8	5
United Kingdom	34	25	48	63	51	50
Switzerland	10	9	5	14	6	4
Spain	6	7	4	6	5	7
Poland	1	1	2	5	4	5
Norway	5	5	4	5	3	4

Table 23: Public procurement and contracts

Indicator: Public procurement and contracts						
Measures	2013	2014	2015	2016	2017	2018
Number of tenders received			76	153	93	135
Number of contracts awarded			39	83	27	43
Number of procedures			39	53	50	74
Success rate of contracts in relation to tenders			0.51	0.52	0.29	0.32
Value of low-value procurements					7,644,895	9,078,191

Note: The contingency figures (breakdown by Member Country) are available upon request.

Table 24: Patents

Indicator: Patents						
Measures	2013	2014	2015	2016	2017	2018
Number of patents granted to ESS staff					0	0
Number of patents applications by ESS with industry partners granted					0	2
Number of patents applications by ESS with a non-commercial partner					3	0

Table 25: Engagement achieved by direct contact

Indicator: Engagement achieved by direct contact						
Measures (grey rows) & contingencies (white rows)	2013	2014	2015	2016	2017	2018
Number of visitors (individuals) to ESS			2,166	5,075	6,423	5,801
Number of school children			275	352	852	1,072
Number of visits (groups) to ESS			164	375	682	839
Number of school groups			12	25	56	56
Number of informational visitors (individuals)			215	1,911	2,816	2,535
Number of informational visits (groups)			15	81	118	210

Table 26: Number of publications

Indicator: Number of publications						
Measures (grey rows) & contingencies (white rows)	2013	2014	2015	2016	2017	2018
ESS h-index	29	30	33	33	33	34
Total number of publications with ESS affiliation (publications including ESS staff)						
(Total number of publications since 2008)	166	252	349	444	541	653
Number of publications with ESS affiliation (publications including ESS staff) this year	53	86	97	95	98	112
Number of publications this year in all databases in Web of Science by Member Country						
(The country of each institution measured as a share of each publication. Annual total.)						
Sweden	7.65	9.91	8.89	15.74	12.34	9.86
Denmark	2.36	6.87	9.41	5.22	6.91	7.94
Germany	5.41	9.24	10.23	14.43	8.60	10.33
Czech Republic	0.79	0.00	0.00	1.06	0.46	1.66
Estonia	0.00	0.00	0.00	0.00	0.00	0.00
France	2.79	4.61	2.63	0.65	1.83	2.17
Hungary	1.00	1.00	1.00	0.56	1.64	2.56
Italy	0.41	1.50	1.79	3.04	1.25	4.96
United Kingdom	3.17	6.23	8.82	5.68	11.18	12.47
Switzerland	0.57	1.08	4.18	3.03	5.05	2.89
Spain	0.85	3.63	1.64	0.54	1.72	1.56
Poland	0.08	0.65	0.38	0.03	3.71	0.00
Norway	0.13	0.11	0.39	1.70	1.81	1.36
ESS	11.83	22.71	26.20	19.48	19.44	36.37
International RIs (excl. ESS)	5.40	5.01	6.79	4.98	4.44	3.30
Number of publications authored/co-authored by ESS in open data journals	8	35	61	51	53	70

Note: The indicators related to publications and citations were measured through Web of Science (WoS), an online database created by Clarivate Analytics ("Clarivate Analytics," n.d.). All publications involving an ESS author were extracted through the following advanced search formula, where the year is specified:

AD=(ESS OR ESS AB OR ESS ERIC OR ESS European Spallat Source OR ESS European Spallat Source ERIC OR ESS European Spallation OR Source ESS European Spallation Source AB OR ESS European Spallation Source ERIC OR ESS Scandinavia OR European Spallat Source OR European Spallat Source AB OR European Spallat Source ERIC OR European Spallat Source ERIC ESS OR European Spallat Source ESS OR European Spallat Source ESS AB OR European Spallat Source ESS ERIC OR European Spallation Source OR European Spallation Source AB OR European Spallation Source ERIC OR European Spallation Source ESS OR European Spallation Source ESS AB OR European Spallation Source ESS ERIC OR DMSC OR Data Management and software center) AND AD=(Lund OR Copenhagen) AND PY=xxxx
Search results were manually verified.

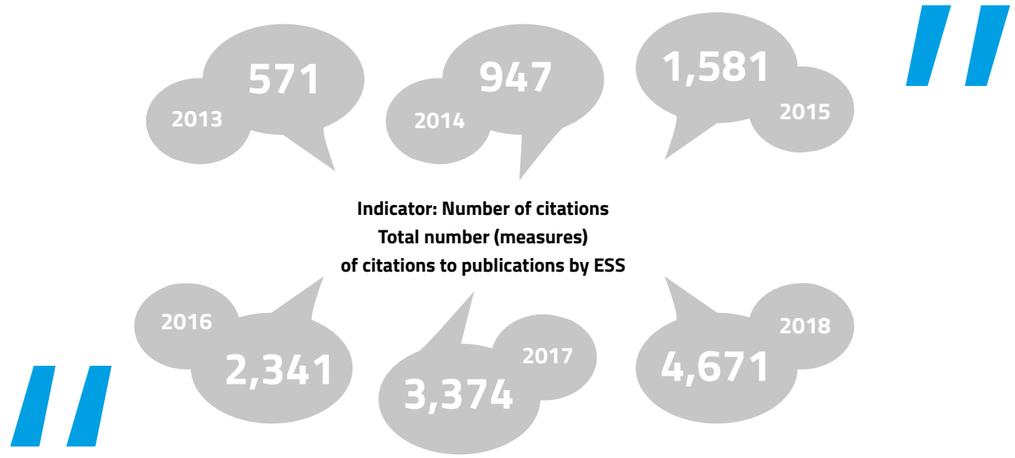
The built in WoS citation report was used to calculate the h-index at the end of each year, and; the number of publications co-authored by ESS and pair RIs (result analysis by organisation).
Whereas the ESFRI KPI counts publications by Member Country as a ratio per publication (ie. If a publication is co-authored by two institutions in different countries, each are counted as 0.5), the same has been applied to publication counts by ESS Member Country. The ESS User Office created an excel macro to run these calculations.

Table 27: Papers co-authored with regional universities

Indicator: Papers co-authored with regional universities						
Measures (grey rows) & contingencies (white rows)	2013	2014	2015	2016	2017	2018
Number of publications co-authored by ESS and In-Kind Partner universities and Lund University:	22	43	51	56	62	60
Aarhus University	0	1	0	1	1	2
Copenhagen University	6	11	18	9	15	14
Huddersfield University	1	1	0	0	1	0
Lund University	10	13	13	21	23	22
Roskilde University	0	0	0	0	0	0
Tallinn University of Technology	0	0	0	0	0	0
Technical University of Denmark	1	6	9	8	8	11
Technical University of Munich	3	4	5	3	2	2
University of Bergen	0	0	3	0	0	4
University of Oslo	0	0	0	1	2	2
University of Tartu	0	0	0	0	0	0
Uppsala University	1	7	3	13	6	3
Warsaw University of Technology	0	0	0	0	0	0
Wroclaw University of Science and Technology	0	0	0	0	3	0
ZHAW Zurich University of Applied Sciences	0	0	0	0	1	0

Note: The built in WoS and analyses functions were used to calculate the number of publications co-authored by ESS and each In-Kind Partner university (result analysis by organisation).

Table 28: Number of citations



Note: The built in WoS citation report and analyses functions were used to calculate the citation count at the end of each year.

Table 29: Outreach through printed, broadcast and web-based media

Indicator: Outreach through printed, broadcast and web-based media						
Measures (grey rows) & contingencies (white rows)	2013	2014	2015	2016	2017	2018
Number of online media articles about ESS				616	317	457
Sweden				493	172	349
Denmark				53	49	20
Other				70	96	88
Number of online media articles mentioning ESS	1,691	2,992	1,637	1,695	1,264	2,014
Sweden	1,130	2,297	1,088	1,242	625	880
Denmark	130	141	106	107	113	64
Other	431	554	443	346	526	1070
Potential reach of online media articles	766.6	1,954.4	2,109	805.3	530.5	908.9
Sweden	187.6	445.6	1,544	383	95.1	138
Denmark	51	8.8	6	9.3	7.2	23.9
Other	528	1,500	559	413	428.2	747

Table 30: Top 6 online publishers (Outreach through printed, broadcast and web-based media)

	Sweden	Denmark	International
2013	1. Sydsvenskan (132), 2. Lokaltidningen Lund& Staffanstorp (67), 3. Skånska Dagbladet (60), 4. My Newsdesk (36), 5. Presskontakt.se (29), 6. Lokaltidningen.se (18)	1. Ingeniøren (8), 2. MedWatch (5), 3. Fyens.dk (4), 4. Kristeligt Dagblad (3), 5. Information (3)	1. PLOS Computational Biology (19), 2. PLOS Pathogens (13), 3. Europa Press (8), 4. La Informacion.com (8), 5. TeInteresa.es (8), 6. 20Minutos.es (8
2014	1. Skånska Dagbladet (142), 2. Sydsvenskan (137), Norra Skåne (54), 3. Svenska Dagbladet (45), 4. Lokaltidningen Lund & Staffanstorp (41), 5. My Newsdesk Sweden (39)	1. Ingeniøren (19), 2. MedWatch (13), 3. Jyllands-Posten.dk (6), 4. Politiken.dk (4), Forskningsrådet (4), Electronic Supply DK (4)	1. Europa Press (13), 2. La Informacion.com (13), 3. TeInteresa.es (12), 4. Deia (11), 5. 20 Minutos.es (8), 6. Eldiario.es (8)
2015	1. Sydsvenskan (106), 2. MyNewsdesk Sweden (58), 3. Helsingborgs Dagblad (43), 4. Lokaltidningen Lund & Staffanstorp (42), 5. Skånska Dagbladet (34), 6. Cision (33)	1. DTU (4), 2. Teknovation.dk (4), 3. Altinget.dk (4), 4. MyPressWire (4), 5. Dansk Industri (3), 6. Videnskab.dk (3)	1. CORDIS News (7), 2. News Cision (7), 3. LaVanguardia.com (6), 4. Europa Press (6), 5. TeInteresa.es (6), 6. Noodls (5)
2016	1. Sydsvenskan (84), 2. Helsingborgs Dagblad (49), 3. MyNewsdesk Sweden (43), 4. Skånska Dagbladet (29), 5. Cision (28), 6. Dagens Industri (27	1. Ingeniøren (11), 2. Altinget.dk (10), 3. DTU (7), Uddannelses og Forskningsministeriet (7), 4. Videnskap.dk (6), 5. Folketinget (5), 6. Technical University of Denmark (5)	1. Cision (21), 2. Wired-Gov (4), 3. Phys.org (4), 4. Inforations Dienst Wissenschaft (4), 5. Elcorreo.com (4), 6. Investors Hangout (4)
2017	1. Sydsvenskan (58), 2. MyNewsdesk Sweden (43), 3. Skånska Dagbladet (31), 4. Cision (23), Lokaltidningen Lund & Staffanstorp (19), 5. Helsingborgs Dagblad (16),	1. Ingeniøren (9), 2. Teknovation.dk (9), 3. Science Report (7), Electronic Supply DK (6), 4. Uddannelses og Forskningsministeriet (6), 5. Idag.dk (5)	1. News Cision (13), 2. El Mundo.es (11), 3. Diario de Noticias de Alava (8), 4. All-Latest-News (8), 5. Deia (7), 6. Elcorreo.com (6)
2018	1. Sydsvenskan (56), 2. Helsingborgs Dagblad (29), 3. Cision (27), Skånska Dagbladet (24), 4. MyNewsdesk Sweden (21), 5. Sveriges Radio (19)	1. Newsøresund (8), 2. Teknovation.dk (5), 3. Science Report (4), 4. Science at the Fringe (4), Altinget.dk (3), 5. Technical University of Denmark (3)	1. East Money.com (152), News Cision (12), 2. European Pressphoto Agency (9), 3. AP (7), 4. Euskadi.net (7), Publicnow (7), 5. Science and Technology Research News (7)

Note: Printed media is not measured at ESS, thus not represented in Table 30.

Table 31: Outreach via the RI's own web and social media

Indicator: Outreach via the TI's own web and social media						
Measures (grey rows) & contingencies (white rows)	2013	2014	2015	2016	2017	2018
Number of new followers on Twitter					2,190	747
English profile				198	2,002	526
Swedish profile					188	221
Number of impressions on Twitter				174.25	425	624.2
English profile				174.25	320.5	476
Swedish profile					104.5	148.2
Number of followers on Facebook						2,750
English profile						2,559
Swedish profile						191

Note:
The English Twitter account was created in April 2009, the Swedish account in June 2017. The English Facebook profile was created in 2010, the Swedish profile in 2017. The ESS LinkedIn account was created in 2016. The ESS Instagram account was created in 2019. These platforms provide limited retroactive data collection and as such, various measures within this indicator could not be collected. However, the ESS Communications team intends to measure this indicator systematically going forward.

Table 32: Waste management

Indicator: Waste management						
Measures	2013	2014	2015	2016	2017	2018
Waste [t]		47.86	340.72	672.49	810	998
Hazardous waste (t)		0.7	6.68	2.13	1	2
Landfill waste (t)		0	0	0	0	0
Waste for incineration (t)		12.62	56.33	105.15	95	118

Table 33: Energy consumption

Indicator: Energy consumption						
Measures	2013	2014	2015	2016	2017	2018
Electricity usage (kWh)		211,634.1	1,367,571	3,029,776	4,113,864	5,140,996
District heating, energy (kWh)				90,308	268,243	519,900
District heating, flow (m3)				4,912	10,064	16,275.2

Table 34: Gender balance and diversity

Indicator: Gender balance and diversity						
Measures	2013	2014	2015	2016	2017	2018
Percentage of women employed	38	34	35	33	34	32
Number of nationalities employed	21	26	33	39	40	45

Table 35: Staff mobility

Indicator: Staff mobility

Number of new hires relocated to Sweden 2013 - 2019
214

Number of secondments coming to ESS 2013 - 2019
26

Table 36: Employee satisfaction

Indicator: Employee satisfaction						
Measures	2013	2014	2015	2016	2017	2018
Overall perception of ESS (Average score out of 5)						3.47
Very positive (percentage of respondents)						17.29
Positive (percentage of respondents)						34.59
Neutral (percentage of respondents)						28.82
Negative (percentage of respondents)						13.78
Very negative (percentage of respondents)						4.26

Note:
Table 37: Total expenditures in regional/local area. Data available upon request.
Table 38: Cost performance index. Data available upon request.
Table 39: Revenues. Data available upon request.

APPENDIX 3: SUPPLIER SURVEY

Name of company

Country

Postal code

VAT number

Name of person filling in the survey

E-mail of person filling in the survey

Position of the respondent within the company

1. Company description

Annual turnover

- Micro (below €2 million)
- Small (€2 million or above, but below €10 million)
- Medium (€10 million or above, but below €50 million)
- Large (€50 million or above)

Employees

- Micro (1-9 employees)
- Small (10-49 employees)
- Medium (50-249 employees)
- Large (250+ employees)

2. Value of products and/or services

What is the highest value (excl. VAT), of a product or service that your company has supplied to ESS?

- €0 – €9,999 (skip to section 6)
- €10,000 – €49,999 (skip to section 6)
- €50,000 or above

3. First contract valued at or above €50,000 (excl. VAT) with ESS

The following section is with regard to your organisation's first contract valued at or above €50,000 (excl. VAT) with ESS. Please answer the following questions with regard to your first contract valued at or above €50,000 (excl. VAT), with ESS.

What type of products and services were supplied to ESS? (you may select more than one option)

- Goods
- Services
- Consultancy
- Other

Which year was this contract awarded?

- 2009 or earlier
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

What was the innovation level of the products and services supplied to ESS? (Select at most 2 options)

- Off-the-shelf products and/or services
- Minimal changes to off-the-shelf products and/or services (small improvements including new features)
- Highly customised products and/or services (requiring substantial resources)
- New and advanced products and/or services (requiring research & development or co-design with ESS staff)

Communication and relationship with ESS

	Strongly disagree	Disagree	Agree	Strongly Agree	Not applicable
The product/service specifications were clear with no need for further input from ESS					
Your company had a key contact person(s) at ESS for additional information					
When your company had questions or concerns, ESS was always responsive					
The frequency of communication with ESS met your expectations					

Has your company had more than one contract valued at or above €50,000, before VAT, with ESS?

- Yes
- No (skip to section 5)

4. Most recent contract valued at or above €50,000 (excl. VAT), with ESS

The following section is with regard to your most recent contract valued at or above €50,000 (excl. VAT), with ESS.Please answer the following questions with regard to your most recent contract valued at or above €50,000 (excl. VAT), with ESS.

What type of products and services were supplied to ESS? (you may select more than one option)?

- Goods
- Services
- Consultancy
- Other

Which year was this contract awarded?

- 2009 or earlier
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

What was the innovation level of the products and services supplied to ESS? (Select at most 2 options)

- Off-the-shelf products and/or services
- Minimal changes to off-the-shelf products and/or services (small improvements including new features)
- Highly customised products and/or services (requiring substantial resources)
- New and advanced products and/or services (requiring research & development or co-design with ESS staff)

Communication and relationship with ESS

	Strongly disagree	Disagree	Agree	Strongly Agree	Not applicable
The product/service specifications were clear with no need for further input from ESS					
Your company had a key contact person(s) at ESS for additional information					
When your company had questions or concerns, ESS was always responsive					
The frequency of communication with ESS met your expectations					

5. Additional products or services

In addition to your contract(s) valued at or above €50,000, your company has supplied ESS with low-value (below €50k) products or services… (you may select more than one option)

- Prior to your first contract valued at or above €50,000
- Between your first and most recent contracts valued at or above €50,000 (if applicable)
- After your most recent contract valued at or above €50,000
- N/A (skip to section 7)

6.Most recent contract valued below €50,000 (excl. VAT), with ESS.

The following section is with regard to your most recent contract valued below €50,000 (excl. VAT) with ESS. Please answer the following questions with regard to your most recent contract valued below €50,000 (excl. VAT), with ESS.

What type of products and services were supplied to ESS? (you may select more than one option)

- Goods
- Services
- Consultancy
- Other

Which year was your most recent low-value supply to ESS?

- 2009 or earlier
- 2010
- 2011
- 2012
- 2013
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020

What was the innovation level of the products and services supplied to ESS? (Select at most 2 options)

- Off-the-shelf products and/or services
- Minimal changes to off-the-shelf products and/or services (small improvements including new features)
- Highly customised products and/or services (requiring substantial resources)
- New and advanced products and/or services (requiring research & development or co-design with ESS staff)

Communication and relationship with ESS

	Strongly disagree	Disagree	Agree	Strongly Agree	Not applicable
The product/service specifications were clear with no need for further input from ESS					
Your company had a key contact person(s) at ESS for additional information					
When your company had questions or concerns, ESS was always responsive					
The frequency of communication with ESS met your expectations					

7. Current communication and relationship with ESS

	Strongly disagree	Disagree	Agree	Strongly Agree	Not applicable
Working with ESS is easy					
We are satisfied with our relationship with ESS					
We would work with ESS again in the future					
We would be interested in working with ESS through our country's In-Kind Partner					

8. Prior experience and new customers

Before becoming a supplier to ESS, your company had previous experience...

- In working with MAX IV
- In working with other large scale facilities like ESS (excl. MAX IV)
- In working with universities and research institutes
- In working with non-science related customers (industries within e.g. consumer products and services, logistics and transportation, construction, etc)
- Industrial firms
- None of the above

Since becoming a supplier to ESS, we have become a supplier to any of the following organizations for the first time, based on products or services similar to those developed for ESS

- MAX IV
- Other large-scale facilities like ESS (excl. MAX IV)
- Universities and research institutes
- Industrial firms
- None of the above

Since becoming a supplier to ESS, we have become a supplier to any of the following organizations for the first time, based on technologies similar to those developed for ESS

- MAX IV
- Other large-scale facilities like ESS (excl. MAX IV)
- Universities and research institutes
- Industrial firms
- None of the above

9. Economic benefits

Because of the work with ESS, we...

	Yes	No	Not applicable
Increased overall profitability			
Established a new R&D team/unit			
Started a new business unit			
Entered a new market			
Experienced some financial loss			
Faced the risk of bankruptcy			

Due to our work with ESS to date, we...

	Yes	No	Not applicable
Have strengthened an existing relationship with a sub-contractor			
Have worked with a new sub-contractor			
Have expanded our sub-contractor relationships to a new country (i.e. a new sub-contractor in a new country)			
Have internalised the work of one or more of our subcontractors, so that we can now produce the same product or service in-house.			

10. Innovation

Due to our work with ESS to date, we were able to... (you may select more than one option)

- Develop new products
- Develop new services
- Develop new technologies
- Apply for a patent, copyright, or other intellectual property rights
- Develop new patents, copyrights, or other intellectual property rights (successful application)
- Acquire new knowledge about market needs and trends
- Improve technical know-how
- Improve the quality of products and services
- Improve production processes
- Improve R&D production capabilities
- Improve management/organizational capabilities
- Other _____
- None of the above

11. Business profile

Has your company registered a business profile with the ESS supplier portal?

- Yes
- No

Do you intend to register a business profile for the ESS supplier portal?

- Yes
- No

12. End of survey

If you have any additional comments, please leave them here:

_____

_____

_____

_____

_____

_____

May we contact you for further clarification regarding this study?

- Yes
- No

Last question: ESS is currently in the processes of categorising their suppliers by the type of products or services that they supply, within their procurement system. Would you like to help categorise your company?

- Yes, I have a few mintues more.
- No, I would like to end the survey now.

13. Application domain

Please choose the areas that apply to your company. You may select more than one. Similar product types are grouped. The number codes are for internal use. Thank you for your help!

- 010000 Petroleum products, fuel, electricity and other sources of energy.
- 011000 Fuels.
- 012000 Petroleum, coal and oil products.
- 013000 Electricity, heating, solar and nuclear energy.
- 020000 Mining, basic metals and related products.
- 021000 Sand and clay.
- 022000 Chemical and fertiliser minerals.
- 023000 Salt and pure sodium chloride.
- 024000 Related mining and quarrying products.
- 025000 Metal ores and alloys.
- 026000 Basic metals.
- 027000 Miscellaneous non-metallic mineral products.
- 028000 Recovered secondary raw materials.
- 060000 Chemical products, Gases, dyes, organic and inorganic, etc
- 061000 Gases.
- 062000 Dyes and pigments.
- 063000 Basic inorganic and organic chemicals.
- 064000 Fertilisers and nitrogen compounds.
- 065000 Plastics in primary forms.
- 066000 Fine and various chemical products.
- 070000 Office and computing machinery, equipment and supplies
- 071000 Office machinery, equipment and supplies
- 072000 Computer equipment and supplies.
- 080000 Electrical machinery, apparatus, equipment and consumables; Lighting.
- 081000 Electric motors, generators and transformers.
- 082000 Electricity distribution and control apparatus.
- 083000 Insulated wire and cable.
- 084000 Accumulators, primary cells and primary batteries.
- 085000 Lighting equipment and electric lamps.
- 086000 Electrical equipment and apparatus.
- 087000 Electronic, electromechanical and electrotechnical supplies.
- 090000 Radio, television, communication, telecommunication and related equipment.
- 091000 Transmission apparatus for radiotelephony, radiotelegraphy, radio broadcasting and television.
- 092000 Television and radio receivers, and sound or video recording or reproducing apparatus.
- 093000 Networks and equipment
- 094000 Telecommunications equipment and supplies.
- 120000 Security and fire-fighting equipment
- 121000 Emergency and security equipment.
- 122000 Individual and support equipment.
- 130000 Laboratory, Measuring, optical and precision equipments
- 131000 Measuring instruments.
- 132000 Instruments for checking physical characteristics.
- 133000 Checking and testing apparatus.
- 134000 Optical instruments.
- 135000 Miscellaneous evaluation or testing instruments.
- 160000 Industrial machinery.
- 162000 Machinery for food, beverage and tobacco processing and associated parts.
- 164000 Lifting and handling equipment and parts.
- 161000 Machinery for the production and use of mechanical power.
- 161100 Turbines and motors.
- 161200 Pumps and compressors.
- 161300 Taps, cocks, valves and similar appliances.
- 161400 Gears, gearing and driving elements.
- 161500 Nuclear reactors and parts.
- 161600 Boiler installations.
- 163000 Industrial or laboratory furnaces, incinerators and ovens.
- 163100 Furnace burners.
- 163200 Waste incinerators.
- 163300 Smelting furnaces.
- 163400 Non-domestic ovens.
- 163500 Cremators.
- 163600 Parts of furnace burners, furnaces or ovens.
- 165000 Cooling and ventilation equipment.
- 165100 Heat-exchange units, air-conditioning and refrigerating equipment, and filtering machinery.
- 165200 Ventilation equipment.
- 165300 Parts of refrigerating and freezing equipment and heat pumps.
- 166000 Machine tools.
- 166100 Machine tools operated by laser and machining centres.
- 166200 Lathes, boring and milling machine tools.
- 166300 Metal-working machine tools.
- 166400 Machine tools for working hard materials except metals.
- 166500 Pneumatic or motorised hand tools.
- 166600 Soldering, brazing and welding tools, surface tempering and hot-spraying machines and equipment.
- 166700 Parts and accessories of machine tools.
- 167000 Miscellaneous general and special-purpose machinery.
- 167100 Distilling, filtering or rectifying apparatus.
- 167200 Machinery for cleaning bottles, packing and weighing and spraying machinery.
- 167300 Centrifuges, calendering or vending machines.
- 167400 Machinery for the heat treatment of materials.
- 167500 Parts of general-purpose machinery.

167600	Command and control system, Printing, graphics, Office automation and Information-processing equipment.
167700	Parts of dishwashing machines and of machines for cleaning, filling, packing or wrapping.
167800	Gas generators.
167900	Miscellaneous special-purpose machinery.
170000	Machinery for mining, quarrying, construction equipment.
171000	Earthmoving and excavating machinery, and associated parts.
172000	Construction machinery and equipment.
173000	Parts of machinery for mining, quarrying and construction.
174000	Machinery for metallurgy and associated parts.
175000	Workshop equipment.
180000	Construction structures and materials; auxiliary products to construction (excepts electric apparatus).
185000	Tools, locks, keys, hinges, fasteners, chain and springs.
186000	Tanks, reservoirs and containers; central-heating radiators and boilers.
187000	Paints, varnishes and mastics.
188000	Stone for construction, limestone, gypsum and slate.
181000	Construction materials and associated items.
181100	Construction materials.
181200	Sewer mains.
181300	Products related to construction materials.
181400	Pipeline, piping, pipes, casing, tubing and related items.
181500	Plates, sheets, strip and foil related to construction materials.
181600	Miscellaneous construction materials.
182000	Structural products.
182100	Structures and parts of structures.
182200	Builders' joinery.
182300	Builders' carpentry.
183000	Cable, wire and related products.
183100	Wire products.
183200	Cable and related products.
183300	Bars, rods, wire and profiles used in construction.
184000	Miscellaneous fabricated products and related items.
184200	Goods used in construction.
184300	Armour plating.
184400	Bearings.
184500	Mild steel.
184600	Props and mining struts.
184700	Cast-iron products.
184800	Miscellaneous fire-protection equipment.
200000	Software package and information systems.
201000	Industry specific software package.
202000	Networking, Internet and intranet software package.
203000	Document creation, drawing, imaging, scheduling and productivity software package.
204000	Business transaction and personal business software package.
205000	Communication and multimedia software package.
206000	Database and operating software package.
207000	Software package utilities.
208000	Information systems and servers.
209000	Miscellaneous software package and computer systems.
210000	Repair and maintenance services.
211000	Repair, maintenance and associated services related to personal computers, office equipment, telecommunications and audio-visual equipment.
212000	Repair and maintenance services of medical and precision equipment.
213000	Repair and maintenance services for pumps, valves, taps and metal containers and machinery.
214000	Repair and maintenance services of building installations.
220000	Installation services (except software).
221000	Installation services of electrical and mechanical equipment.
222000	Installation services of equipment for measuring, checking, testing and navigating.
223000	Installation services of communications equipment.
224000	Installation services of medical and surgical equipment.
225000	Installation services of machinery and equipment.
226000	Installation services of computers and office equipment.
227000	Installation services of fire protection equipment.
228000	Installation services of metal containers.
229000	Installation services of guidance and control systems.
240000	Supporting and auxiliary transport services; travel agencies services.
241000	Cargo handling and storage services.
242000	Travel agency, tour operator and tourist assistance services.
250000	Postal and telecommunications services.
250000	Postal and telecommunications services.
251000	Post and courier services.
252000	Telecommunications services.
290000	Architectural, construction, engineering and inspection services.
291000	Architectural and related services.
292000	Engineering services.
293000	Urban planning and landscape architectural services.
294000	Construction-related services.
295000	Technical testing, analysis and consultancy services.
296000	Monitoring and control services.
297000	Consulting services for water-supply and waste consultancy.
298000	Laboratory services.
300000	IT services: consulting, software development, Internet and support.
301000	Hardware consultancy services.
302000	Software programming and consultancy services.

303000	Data services.
304000	Internet services.
305000	Computer-related services.
306000	Computer support and consultancy services.
307000	Computer network services.
308000	Computer audit and testing services.
309000	Computer back-up and catalogue conversion services.
310000	Research and development services and related consultancy services.
311000	Research and experimental development services.
312000	Research and development consultancy services.
313000	Design and execution of research and development.
320000	Administration services.
320000	Administration services.
321000	Administration services.
322000	Compulsory social security services.
350000	Business services: law, marketing, consulting, recruitment, printing and security.
351000	Legal services.
352000	Accounting, auditing and fiscal services.
353000	Market and economic research; polling and statistics.
354000	Business and management consultancy and related services.
355000	Office-support services.
356000	Recruitment services.
357000	Investigation and security services.
358000	Printing and related services.
359000	Miscellaneous business and business-related services.
030000	Food, beverages, and related products.
040000	Occupational Clothing, footwear, luggage articles and accessories.
050000	Printed matter and related products.
100000	Medical equipments, Miscellaneous medical devices and products.
110000	Transport equipment and auxiliary products to transportation.
140000	Office furniture and furnishings
150000	Collected and purified water.
190000	Construction work.
230000	Transport services (excl. Waste transport).
260000	Public utilities.
270000	Financial and insurance services.
280000	Real estate services.
330000	Services related to the oil and gas industry.
340000	Agricultural, forestry, horticultural, aquacultural and apicultural services.
360000	Education and training services.
370000	Sewage-, refuse-, cleaning-, and environmental services.

APPENDIX 4: IN-KIND PARTNER SURVEY

Name of organisation

Country

Postal code

Name of person filling in the survey

E-mail of person filling in the survey

Position of the respondent within the organisation

1. Organisation

Organisation type

- University
- Research facility
- Other _____

Employees (Number of employees at your organisation)

- 1-9 employees
- 10-49 employees
- 50-249 employees
- 250-449 employees
- 500-999 employees
- 1000+ employees

Approximately how many employees at your organisation are working on the ESS In-Kind Contribution?

- 1-9 employees
- 10-19 employees
- 20-49 employees
- 50+ employees

Has your organisation hired new staff to work on the ESS project throughout the duration of the partnership?

- Yes
- No

How many employees were hired to work on the ESS project? (optional)

_____

What is the percentage of women amongst your staff working on the ESS project?

- 0-20%
- 21-40%
- 41-60%
- 61-80%
- 81-100%

2. In-Kind Contribution to ESS

To what sub-project(s) is your organisation contributing? (You may select more than one option)

- Accelerator Systems
- Integrated Control System
- Neutron Scattering Systems
- Target Systems
- Experimental Instrument
- Other _____

3. Inventions, innovation and entrepreneurship

The following questions concern your organisations' experiences with inventions, innovation and entrepreneurship with relation to your In-Kind Contribution to ESS.

Please select the options that reflect your organisations' experiences with inventions to date. (You may select more than one option)

- Staff from our organisation has applied for a patent based on some part of our ESS In-Kind Contribution.
- Staff who has worked on the ESS contribution, from our organisation, has become an inventor within or after the duration of our partnership (with relation to the ESS In-Kind Contribution).
- None of the above

What is the innovation level of the In-Kind Contribution to ESS? If your In-Kind Contribution involves multiple items, you may select any option that applies.

- Off-the-shelf products, technologies and/or services
- Minimal changes to off-the-shelf products, technologies and/or services (small improvements including new features)
- Highly customised, technologies and/or services (requiring substantial resources)
- New and advanced products, technologies and/or services (requiring research & development or co-design with ESS staff)

Please select the options that reflect your organisations' experiences with entrepreneurship to date. (You may select more than one option)

- Staff from our organisation has started a spin-out/start-up based on the technologies used in the ESS contribution.
- Staff who has worked on the ESS contribution, from our organisation, has become an entrepreneur within or after the duration of our partnership (with relation to the ESS In-Kind Contribution).
- None of the above

Is there anything more that you would like to include about your organisations' experiences with relation to inventions, innovation & entrepreneurship, and the ESS project?

_____

4. Interaction with ESS

This section is based on your perception of your interactions with ESS.

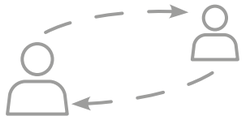
Communication throughout your entire relationship with ESS (overall experience)

	Strongly disagree	Disagree	Agree	Strongly Agree	Prefer not to answer
Our organisation is given enough notice when reports or updates are requested.					
Our organisation keeps ESS fully informed of the progress of the Scope of Works within reasonable time frames.					
The General Coordinator (as stated in the IKC Agreement) for ESS is always responsive to our organisation.					
The General Coordinator (as stated in the IKC Agreement) from our organisation is always responsive to ESS.					

Current communication with ESS (over the last 12 months)

	Strongly disagree	Disagree	Agree	Strongly Agree	Prefer not to answer
Our organisation is given enough notice when reports or updates are requested.					
Our organisation keeps ESS fully informed of the progress of the Scope of Works within reasonable time frames.					
The General Coordinator (as stated in the IKC Agreement) for ESS is always responsive to our organisation.					
The General Coordinator (as stated in the IKC Agreement) from our organisation is always responsive to ESS.					

Cooperation throughout your entire relationship with ESS (overall experience)



	Strongly disagree	Disagree	Agree	Strongly Agree	Prefer not to answer
ESS and our organisation participate in all critical decisions, together.					
There is mutual trust between ESS and our organisation.					
Our partnership with ESS meets our organisations' ambitions and expectations.					

Cooperation between our organisation and ESS has improved throughout our partnership.

- ☐ Yes
- ☐ No
- ☐ Prefer not to answer

Do you have further comments on your interactions with ESS?

_____

5. Collaboration with others

First time collaborations with new partners. Due to our work with ESS, we have collaborated with...
(You may select more than one option)

- ☐ One or more large-scale research facilities that we have never worked with before on any other projects, excluding ESS, with relation to the ESS In-Kind Contribution.
- ☐ One or more large-scale research facilities that we have never worked with before on any other projects, excluding ESS, on other projects.
- ☐ Universities or research institutes that we have never worked with before on any other projects, with relation to the ESS In-Kind Contribution.
- ☐ Universities or research institutes that we have never worked with before on any other projects, on other projects.
- ☐ Other (with relation to the ESS In-Kind Contribution) _____

6. Subcontractors

In order to carry out the ESS project(s), did your organisation use a subcontractor?

- ☐ Yes (skip "Why not?")
- ☐ No

Why not?

_____

How would you judge the innovation level of products/services provided by your subcontractors? (You may select more than one option)

- ☐ Off-the-shelf products, technologies and/or services
- ☐ Minimal changes to off-the-shelf products, technologies and/or services (small improvements including new features)
- ☐ Highly customised technologies and/or services (requiring substantial resources)
- ☐ New and advanced products, technologies and/or services (requiring research & development or co-design with your organisation)

7. End of survey

May we contact you again with further questions concerning this survey?

- ☐ Yes
- ☐ No

If you have any additional comments, please leave them here:

_____

_____

_____

_____

_____

_____

_____

LIST OF TABLES

LIST OF FIGURES

Snow-covered ESS site, February 2021

EUROPEAN
SPALLATION
SOURCE

European Spallation Source ERIC
Odarslövsvägen 113, Lund, Sweden

ess.eu