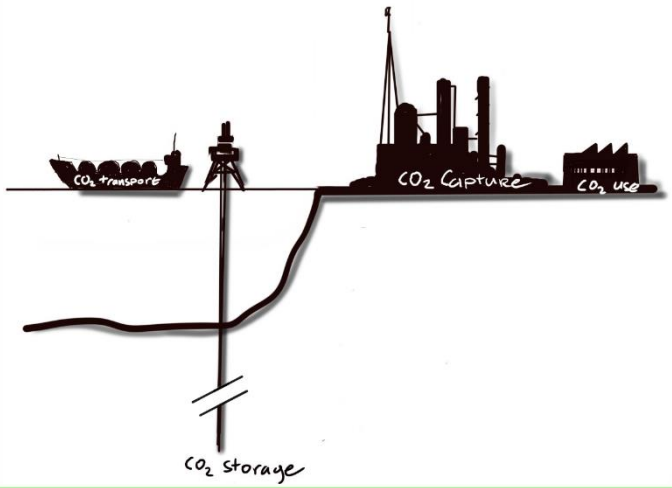
The European CCUS Research Infrastructure

ECCSEL ERIC

2020

ANNUAL REPORT



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DIRECTOR'S HIGHLIGHTS OF 2020

Due to the Covid-19 pandemic, 2020 was an exceptional and challenging year for the whole scientific community.

Since March 2020 lockdowns and travel restrictions have strongly limited operational activities on the ECCSEL Research Infrastructure. Especially transnational access to the research facilities has been impossible.

Still, thanks to the Horizon 2020 ECCSELERATE project and other ongoing EU and national funded projects, our staff and partners have been busy strengthening and widening our services as well as communication strategy and efforts.

This work has resulted in several collaboration initiatives on calls/proposals involving both industry and research organisations. One outcome being the successful European Green Deal joint proposal on energy storage; StoRIES.

Moreover, ECCSEL has widened its services with new complementary facilities, among others for research on CO_2 utilisation.

Although our increased efforts to attract new countries to join ECCSEL ERIC has not yet given results, we are quite optimistic that we will have more countries onboard soon.

Finally, I want to thank our staff, partners, users, owners and funders for your effort and support throughout these difficult times.

Looking forward to being back in normal operation soon.

Sverre Quale, Director, ECCSEL ERIC
Photo: Vibeke Ann Pettersen, NTNU

Sverre Quale
Director, ECCSEL ERIC

ECCSEL EVENTS IN 2020

Impressions from some events in 2020

ECCSEL exhibition stand, brochures and promotional material at "Teknas CO_2 conference 2020", a major national CCUS conference in Norway, 14-15 January 2020, Scandic Hotel Fornebu, Oslo

"CO_2 capture technology by membranes, sorbents and solvents", webinar one organised by ECCSEL under the ECCSELERATE project, 13th October 2020

"Research for safe and efficient CO_2 transport and injection", the second webinar organised by ECCSEL under the ECCSELERATE project, 16th December 2020.

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OUR MISSION

ECCSEL vision:

Enabling low to zero CO_2 emissions from industry and power generation to combat climate change.

Main objectives:

- Coordinate, operate and develop a world-class distributed CCUS Research Infrastructure in Europe
- Provide access to integrated, upgraded and newly constructed CCUS research facilities
- Enhance European science, technology development, innovation and education in the field of CCUS
- Enable spin-off activities and generation of new business

ECCSEL RESEARCH INFRASTRUCTURE

ECCSEL has implemented, operates and develops a distributed, integrated European Research Infrastructure (RI) based on a selection of the best research facilities in Europe for Carbon Capture, Transport, Utilisation and Storage (CCUS). The current over 80 individual research facilities which are part of the ECCSEL ERIC RI are located in 5 countries and are owned by 23 different facility operators. The number of countries, operators and facilities will increase over time.

Examples of transnational collaboration and use of ECCSEL facilities

Facilities belonging to the ECCSEL RI have been used for many different research projects during 2020 even though most of those were internal projects due to Covid-19. A selection of those are listed on the ECCSEL website. Here are also some examples of transnational use of ECCSEL facilities:

Collaboration between Sotacarbo and the Indian Institute of Technology Madras (IITM)

Sotacarbo and Indian Institute of Technology Madras (IITM) are pursuing a joint research activity on Catalysts for CO_2-to-methanol and syngas-to-methanol, with the aim to develop and simulate mesoporous functional catalysts for CO_2 and syngas conversion into methanol and liquid fuels. The study combines lab-scale experiments, Density Functional Theory (DFT) and the microkinetic modelling techniques to obtain fundamental insights and develop detailed kinetic models. Reduction of CO_2 carried out in the **Sotacarbo's X-to-Liquids facility** (in a tubular down-flow fixed-bed reactor using $CuOx/ZnOx/ZrOx/Al_2O_3$ catalyst, and H_2/CO_2 ratio of 2.98 at different conditions) demonstrates the sensitivity of methanol selectivity on the reaction temperature. A mean-field microkinetic model with more than one type of active site was developed for this system, and simulations are carried out at IITM using the ANSYS-CHEMKIN® software package.

The 'Plug Flow Reactor' model in CHEMKIN® can emulate the reactor used in the experiment as the flow characteristics are similar. The reaction model has the pre-exponential and the activation energies of all elementary events in the microkinetic model calculated using the

Density Functional Theory. The 'Parameter Study' function can be used to run the reactor simulations at different reaction conditions, and the processed results can be taken as output in an excel file for analysis. The Cu/ZnO/ZrO_2 catalyst used in the experiment is modelled with a Zr_1Zn_2O cluster on Cu (111) surface to represent the inverse catalyst. Periodic DFT calculations were carried out using Vienna Ab-initio Simulation Package (VASP) using the Perdew-Burke-Ernzerhof (PBE) exchange-correlation functional.

The X to Liquid facility

Three different pathways for methanol formation were identified - Formate pathway, Carboxyl pathway, Direct CO_2 dissociation pathway. Based on the energetics obtained from the DFT computations, the direct CO_2 dissociation pathway is dominant. This multi-site microkinetic model can identify the optimum reaction conditions to facilitate the reaction in the desired pathway. The experiments and the developed model in combination help us understand the system better for process optimization and catalyst design.

H2020 SECURe Project

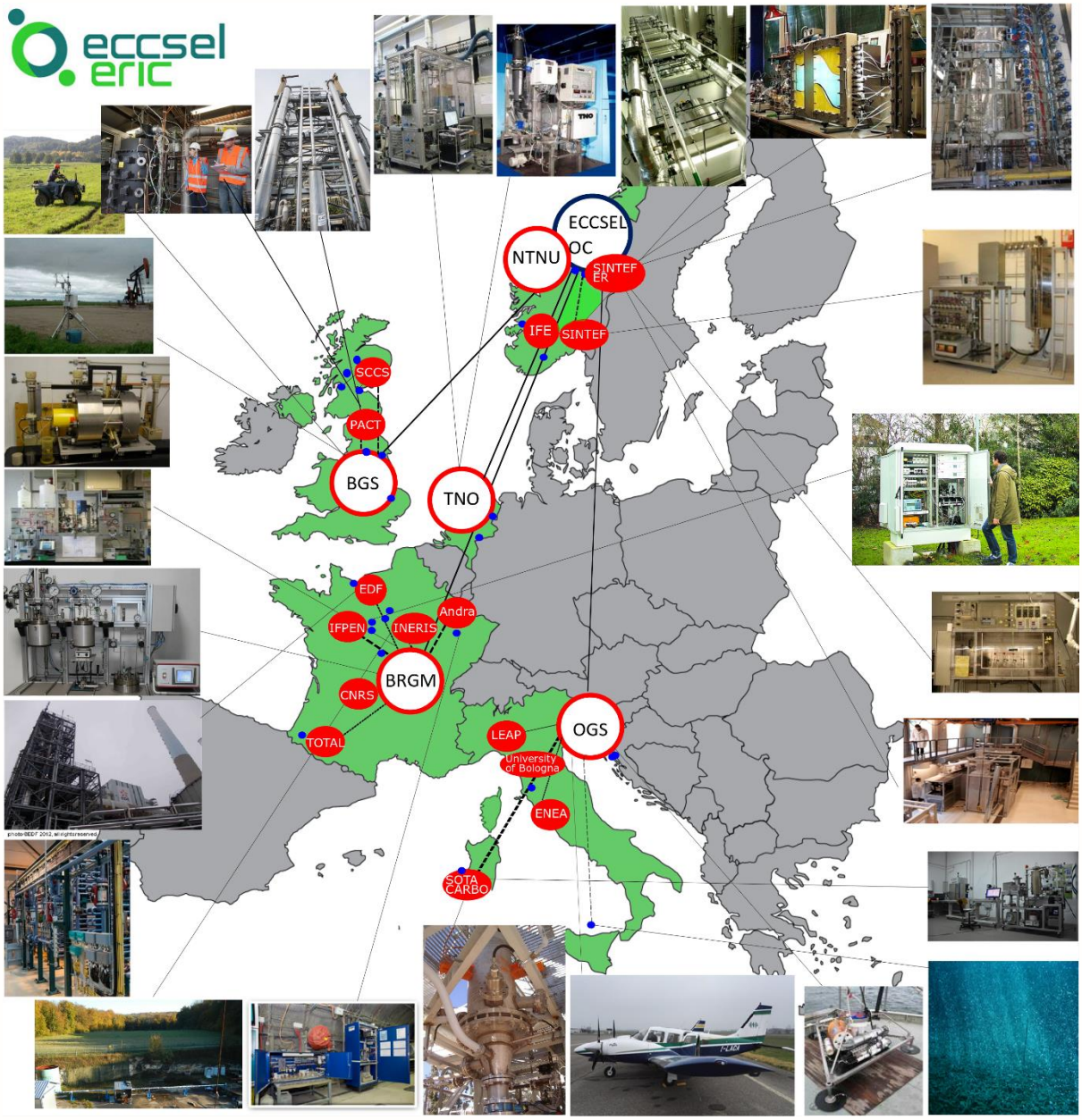
Photo: BGS Near-Surface Gas Monitoring

The EU H2020 SECURe project (2018-2021) evaluates risk in CO_2 storage and shale gas projects, including seeking examples of monitoring good practice from across the world. The SECURe consortium includes several ECCSEL facility owners (e.g. BRGM, SINTEF, TNO, Univerisity of Edinburgh/SCCS and BGS) and a number of ECCSEL facilities were involved in delivering SECURe project science. In particular the BGS **HTL**, **Gas Monitoring** and **Geomicrobiology** facilities produced experimental and environmental monitoring data for the project during 2020.

Norwegian CCS Research Centre (NCCS) and CO_2Mix

Safety is paramount when working with toxic components

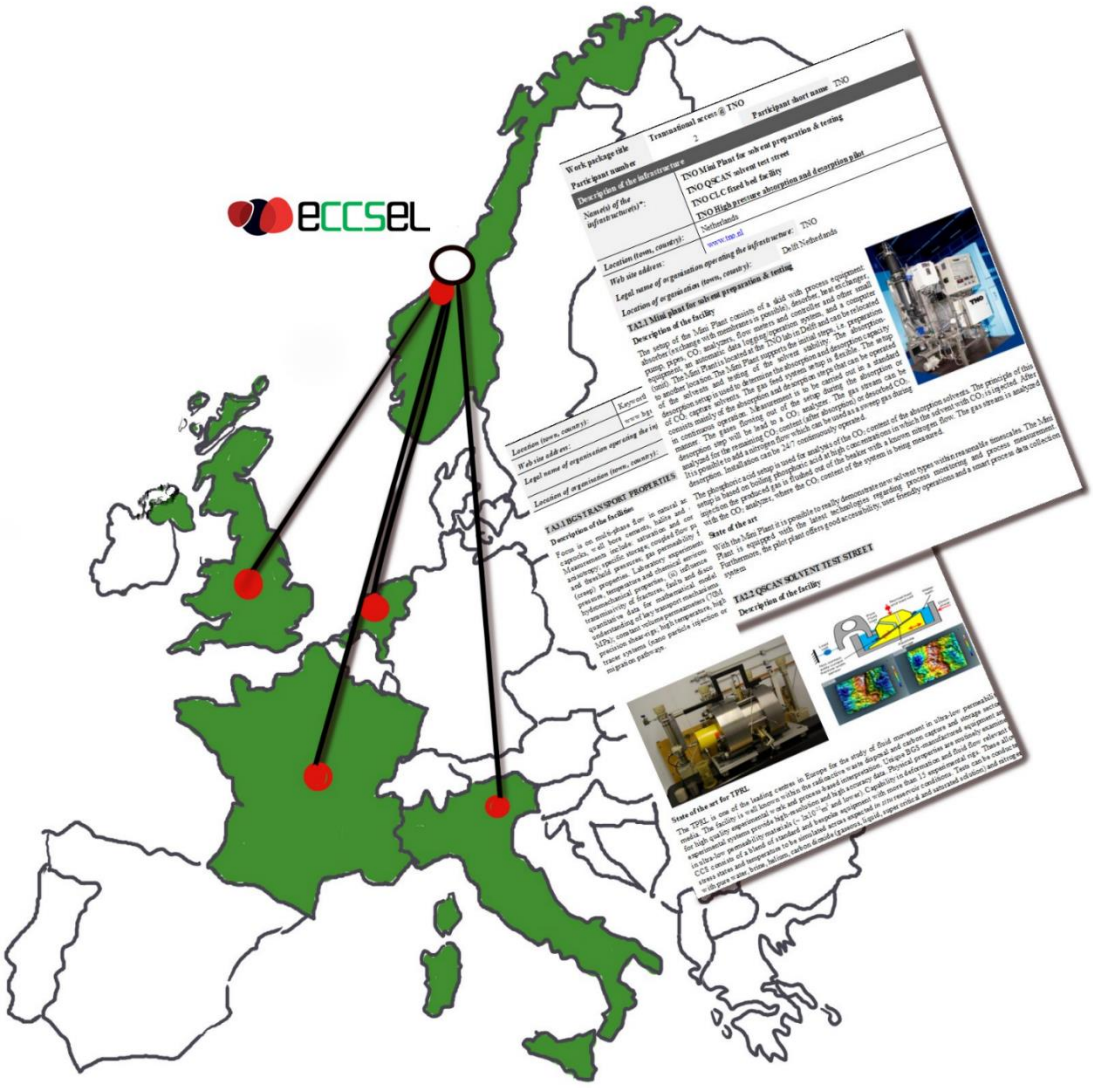
The research of NCCS is performed with help from multiple ECCSEL facilities. The CO_2Mix facility is purposely made for investigation of phase equilibria relevant for CCS. Many visiting scientists have contributed to measurements from CO_2Mix. In 2020, a visiting PhD candidate from University of Western Australia prepared measurements on phase equilibria of CO_2 + SO_2, leading to a publication at the Trondheim CCS conference.



ECCSEL ERIC, nodes and facility locations (2020)
Photos © respective facility owners

OUR RESEARCH FACILITIES

The ECCSEL ERIC Research Infrastructure consists of research facilities from Universities, Research Institutes and the Industry in the five ECCSEL member countries. ECCSEL ERIC provides researchers across the globe easy access to all those facilities through its website as well as it coordinates facility upgrades and new builds.



Detailed fact sheets are available for all ECCSEL ERIC facilities.

Category	Technology
Capture	Membranes
	Solvents
	Sorbents
	Combustion
	Cryogenic
	Full chain systems
Transport	Security/troubleshooting
	Fluid characterisation
	Flow characterisation
	Material testing
	CO_2 pipeline transport and integrity
	Shipping of CO_2
Storage	Pressure/injection
	Migration
	Caprock/well integrity
	Leakage mitigation/remediation/impact
	Micro-seismicity
	Reactivity/mineralisation
	Leakage
	Monitoring
Use	Thermochemical Conversion and Hydrogenation of CO_2
	Electrochemical and Photochemical Conversion of CO_2
	CO_2 Conversion to Solid Carbonates
	Smart integrations with carbon capture and re-use into valuable products

ECCSEL RI facilities are categorised by CCUS technology (detailed lists of the ECCSEL RI facilities and their operators / owners can be found on the ECCSEL website). More technologies are being added.

INNOVATION AND INVESTMENT PLAN

ECCSEL has produced a Research Strategy document which aims to identify key research challenges and strategic objectives for the ECCSEL Research Infrastructure for the period 2016-2026. This Strategy covers all areas of CO_2 Capture, Transport and Storage (CCS), and is currently being updated and extended with CO_2 utilisation (CCUS). It will facilitate building a technical activity plan in these areas by providing a prioritised list of research topics to meet predicted user needs in the coming five years, as well as a horizon scan, up to ten years ahead. It is currently mainly based on contributions from, and therefore reflects the views of, the 22 partner institutes based in the five current ECCSEL ERIC member countries. Input was also taken from institutes located in an additional four countries participating in ECCSEL's Implementation Phase 2015-2017 and from the ECCSEL Scientific Advisory Group. Further input from Industry workshops will also be integrated in 2021. The document is being updated regularly and a major update has commenced in 2020.

The Strategy sets out national research activities and interests before synthesising those into key research priorities for capture, transport, storage and (soon) utilisation, that will need to be addressed to facilitate broad-scale deployment of CCUS, and that are of common interest. Where appropriate, the key research facilities towards which ECCSEL could usefully focus resources, design and development efforts in the medium term are identified and, if appropriate, are ranked according to priority and shortlisted.

ECCSEL has performed a gap analysis showing current CCUS research gaps as well as related existing facility gaps. Based on the gap analysis combined with input from national CCS roadmaps, facility upgrades and new builds have been planned and, in many cases, funding has been approved, and construction has commenced. Upgraded and new capture, transport, utilisation and storage research facilities are in the pipeline to apply for becoming a part of ECCSEL over the coming 12 months. A selection of facilities known to become available is listed on the ECCSEL website and is being updated regularly.

OPERATIONS

Operations Centre

With its statutory seat in Norway, the ECCSEL ERIC Operations Centre has its offices situated on the campus of NTNU in Trondheim. Its main responsibilities and tasks are "central management and planning as well as coordination of the infrastructure access, operations and development":

- Coordinate the ECCSEL Research Infrastructure across Europe
- Coordinate and facilitate the required upgrades and new builds of research facilities in support of the scientific and technological objectives of ECCSEL
- Act as the central user entry point for researchers and scientists wanting to use the facilities which are part of the ECCSEL RI
- Strengthen the identity of ECCSEL
- Facilitate outreach as well as training and mobility for its members, users and facility operators

ECCSEL Operations Centre located on the campus of NTNU in Trondheim, Norway
Photos © NTNU

The ECCSEL ERIC Operations Centre is also leading the ECCSELERATE project, a 3-year Horizon 2020 project running until 31.12.2022. All nodes are participating and all ECCSEL facility owners are also involved.

National Nodes overview, news, innovations and investments

Italian Node

a. Overview / description of node

Italy joined ECCSEL already for its first preparatory phase in 2010 and ultimately became a founding member of ECCSEL ERIC. The active partners during these initial phases have been OGS, ENEA and Sotacarbo.

OGS was elected as the Italian representing entity in ECCSEL ERIC and coordinates the Italian National Node.

Italy currently holds seats on the General Assembly (OGS) and Research Infrastructure Coordination Committee (OGS and Sotacarbo) and provides in-kind staff contribution to the ECCSEL Operations Centre in Trondheim (OGS).

The Italian Node currently consists of seventeen CCS facilities owned and operated by five Italian institutes:

OGS	Eight CO_2 storage research facilities	OGS National Institute of Oceanography and Applied Geophysics
Sotacarbo	Two CO_2 capture facilities, one CO_2 use facility, one CO_2 capture and use facility and two CO_2 storage research facility	SOTACARBO SUSTAINABLE ENERGY RESEARCH CENTRE
ENEA	One CO_2 capture and use facility	ENEA
The University of Bologna (DICAM)	One CO_2 capture facility	ALMA MATER STUDIORUM A.D. 1088
LEAP	One multicategory facility	LEAP Laboratorio Energia e Ambiente Piacenza

The high-level expertise of the five members of the nodes is very complementary and allows Italy to be well represented in the ESFRI context and in the CCUS panorama. All the partners are internationally recognized institutes in the field of CCUS, coordinating international projects and representing Italy in European and international boards.

The Italian National Node is about to be expanded both in the number of facility owners and of facilities. Contacts with Politecnico of Milano and IIT (Italian Institute of Technology) are ongoing, for the inclusion of some relevant facilities in the fields of capture and utilization.

b. News / activities in 2020

ECCSELERATE project started in January 2020, including OGS and Sotacarbo as project partners and ENEA and UNIBO-DICAM as third parties. In 2020 all the Italian project partners worked at the various WPs, contributing to activities such as capacity building, industry engagement, National Node implementation, facilities implementation plan, Transnational Access.

The Italian National Node is actively involved in the Italian Energy cluster, grouping all the energy actors and discussing about energy issues. Outcomes from the cluster are addressed to implement ECCSEL ERIC Research Strategy.

The link with ICDI, the Italian initiative connected to EOSC, has been maintained and reinforced, to better align strategies and policies on data at a national and a European level. OGS has some representatives in the shadow working groups (landscape, fair) representing both the institute and RIs, among which ECCSEL.

Contacts with EPOS and EMSO ERIC have been maintained, to enhance collaboration and to promote the joint use of facilities. Agreements with them will be formalised soon at the ERIC level.

The Italian National Node plays an important role also in the European and the international contexts. Particularly worthy to mention are EERA-CCS JP, CO2GeoNet, Mission Innovation and SET-PLAN. Several partners of the Node are part of EERA-CCS JP, actively contributing to CCUS activities, strategies and projects. OGS hosts the CO2GeoNet Secretariat. Several partners from the Node actively contribute to Mission Innovation, interacting with the national representative. ECCSEL interacts with SET Plan IWG9 also through the two Italian representatives, who are Sotacarbo researchers.

c. Facility innovations and investments in 2020

The IPANEMA project (Implementation of Panarea Natural laboratory of ECCSEL and MArine observatory), is running. Funded by the Italian Ministry of University and Research (MUR), it is dedicated to the implementation of the Panarea NatLab and CTMO ECCSEL facilities, with new and innovative equipment. The project budget is 8.8 M€ over a 3 years' period. Project partners are INGV, INFN and SZN from Italy. In 2020 OGS continued the purchase process of the equipment dedicated to the two facilities. Several instruments mainly dedicated to biology and metrology are now available for the facilities' users when assessing the two laboratories.

The support from the Italian Ministry of Economic Development (MISE) and of Sardinia Region has been relevant for the development and valorisation of Sotacarbo's activities and facilities in Carbonia. €4.7M have been issued by Sardinia Region in 2018-2020 (FSC 2014-2020 funds) with the aim to implement its "Excellence Centre for Clean Energy" and further €2.0M have been issued to complete the research infrastructure in 2021. LEAP and Politecnico of Milano continue their collaboration with Sotacarbo in this project. MISE annually issues €2.2M through the Electric System Research funds, in order to finance activities on CCUS-related technologies; from 2019 these funds are mainly dedicated to the development of chemical energy storage technology (power-to-fuels) through CO_2 Utilisation, in collaboration with ENEA. The collaboration between Sotacarbo and UniBO within the "Centre of Excellence on Clean Energy" project converged into the following publication: Benedetti F.M.; De Angelis M.G.; Degli Esposti M.; Fabbri P.; Masili A.; Orsini A.; Pettinau A., Enhancing the separation performance of glassy PPO with the addition of a molecular sieve (ZIF-8): Gas

transport at various temperatures, «MEMBRANES», 2020, 10, pp. 1 – 34.

Sotacarbo has continued the construction of the Sotacarbo Fault Lab, a field facility to study CO_2 leakage through fault and to develop advanced monitoring systems for CO_2 storage sites. The facility – funded by the Regional Government of Sardinia within the "Centre of Excellence on Clean Energy" project, will be completed in 2021 but it is already partially available for several research activities.

Sotacarbo's IOSTO pilot unit for H2S conversion into H2SO4 in flue gas from oxy-combustion) is currently being dismantled.

d. Major research projects in 2020

SFERO (Systems for Flexible Energy via Reuse of carbon) project is investigating the use of renewable electricity excess for the valorisation of CO_2 via Plasma assisted Catalysis (PAC) processes. These produce a mixture of building blocks: CO and H_2 for fuels production (e.g. methanol and kerosene) avoiding the need of electrolyser with the associated inefficiencies. Process innovation will include innovation in the fields of electrification, energy mix and hydrogen, capture and use of CO_2, CO and circular materials. SFERO will address the need for a step-change in reducing the energy penalty associated with the deep decarbonisation by proposing an efficient reuse of captured CO_2 for storing excesses of power and heat. The project, launched within the Italian Research Programme "Piano Triennale della Ricerca di Sistema Elettrico 2019-2021" with a budget of approximately 1.4 M€, is coordinated by ENEA.

The CLEANKER project aims at demonstrating at TRL7 the Calcium Looping (CaL) concept, one of the most promising technologies for CO_2 capture in cement plants, in a configuration highly integrated with the cement production process, making use of entrained flow reactors. It is coordinated by LEAP and integrates 13 research organizations from 7 countries. On 9th October 2020 the Vernasca pilot plant was officially opened and is now in operation; it is a CaL demonstration system that captures the CO_2 from a portion of the flue gas of the cement plant operated by Buzzi Unicem, using as CO_2 sorbent the same raw meal used for clinker production. This facility is very promising and will be included in ECCSEL ERIC in the future.

The UniBO research group on carbon capture has converted part of the experimental apparatuses during the Covid-19 emergency period for surgical mask testing. The joint laboratory has been designed and created by a multidisciplinary team (chemical engineers, medical doctors and microbiologists) to test mask prototypes according to the European standard norm EN 14683:2019, supporting thus the industrial reconversion of some industries to face the sanitary emergency (https://site.unibo.it/open_mask_lab/en). The characterization included air permeation tests (breathability) and filtration tests (bacterial filtration efficiency), thus taking advantage of the long experience of the group in membrane separation, and some experimental facilities, during the emergency. The lab has tested over 600 prototypes, with nearly 1200 tests carried out overall.

e. Outlook / plan for 2021 and beyond (news and activities, upgrades, new builds, new owners, future projects)

The Italian Ministry of University and Research has been supporting OGS activities with an annual contribution dedicated to research infrastructures, specifically to the two natural laboratories of Panarea and Latera (ECCSEL NatLab – Italy project). Contribution in 2020 was 500K€ and is supposed to be confirmed in 2021.

In the frame of the IPANEMA project, highly innovative and high-tech instruments are

foreseen to be purchased in 2021 and 2022. They are an AUV, a ROV and a drone, plus advanced laboratory equipment dedicated to the Panarea NatLab and CTMO. A new marine observatory will start being implemented off-shore in 2021 by project partners, with the aim to better monitor CO_2 emissions.

The IPANEMA HR proposal, submitted and approved in 2020, connected to the IPANEMA project, is aimed at reinforcing human resources operating in the Panarea NatLab and CTMO facilities. 21 research grants, some starting in 2021, some in 2022, will be dedicated to hire personnel with expertise in CCS, RIs, engineering, geophysics, biology. The total investment, over a 3 years' period, will be 2M€ and it will be financed by the Italian Ministry of University and Research (MUR).

The Italian National Node is planning to expand with the inclusion of two relevant new partners: Politecnico of Milano and IIT (Italian Institute of Technology). Their relevant facilities about capture and utilization will be included in ECCSEL.

LEAP and Politecnico di Milano are going to carry out new tests for new refrigerant mixtures with low GHG potential, in order to replace current working fluids in heat pumps and refrigeration cycles.

French Node

a. Overview / description of node

France has been involved in the development of the ECCSEL Research Infrastructure since 2008, and from 2017, the year of ECCSEL ERIC creation, the French node (ECCSEL-FR) has been officially constituted and structured around four public research institutes (ANDRA, IFPEN, INERIS, BRGM) and two private companies (EDF, TOTAL).

The French node is coordinated by BRGM through a partnership agreement and on the behalf of the French Ministry of Research.

In 2020, as in 2019 and 2018, the French node provided in-kind contribution to the ECCSEL ERIC Operations Centre (25% of a full-time position of a BRGM scientist).

The French node ECCSEL-FR has the largest number of national members with six facility owners/providers, providing access to seven operational facilities (Category 1) since its creation. An eights facility is still at the project level (Category 3) and is not yet accessible. A ninth facility has been added end 2020 (MIMAROC, Category 3). These facilities cover the whole CCS chain:

EDF	CO_2 capture pilot at a coal power plant – currently unavailable for access. EDF is looking to move it to another type of industrial facility	
INERIS	SAFETY experimental platform (CO_2 transport) CATLAB (CO_2 leakage simulation at the near surface)	

TOTAL	COOTRANS transport loop (CO_2 transport) - planned	
URL-Andra	Underground Research Laboratory (CO_2 storage)	
BRGM	BIOREP Reactor for Deep Environments (CO_2 storage) MIMAROC Multiscale characterisation of the mechanical properties of rock (CO_2 storage) – construction started	
IFPEN	ESCORT Mobile equipment for CO_2 monitoring GasGeoChem Laboratory for gas analyses	

b. News / activities in 2020

In January 2020, the French node conducted a self-evaluation of Frances' participation in ECCSEL ERIC and decided on an action plan for 2020 in order to increase its involvement and the benefits for France, while boosting ECCSEL ERIC. The action plan consisted in seeking to expand the French node with new members and new research facilities, notably by expanding to include the utilisation of CO_2.

Close contacts have been established with the CNRS since January 2020. This led the French node to propose 8 CNRS facilities (CO_2 storage, Category 1) to the ECCSEL ERIC, which were validated at the General Assembly at the end of 2020. The contractual procedures between CNRS and ECCSEL ERIC on the one hand, and CNRS and the French node on the other hand, were then initiated. In addition, promising contacts have been established with MinesParisTech and the CEA.

ECCSEL-FR has also contacted the French Club CO_2 (https://www.club-co2.fr/fr) to make a presentation at its general assembly in March 2020, in order to promote ECCSEL and to propose to organise jointly a national seminar on CCUS and a tour of the French regions. All this was validated. However, the national seminar and the first regional event could not be organised in 2020 because of the Covid-19 pandemic.

The French node undertook in 2020 other actions to increase the visibility of all ECCSEL research facilities and foster their use, by participating in the following events, which turned into 100% online events due to the pandemic:

- 9 June, online: Back2Business event organised by Pôle AVENIA;
- 30 June, online: AXELERA technical day on the utilisation of CO_2;
- 8-9 October, Dunkirk & online: European conference "CO_2, Industries and Territories";
- 15 October, Nancy & online: DEEPSURF Seminar " Carbon storage";
- 16 November, online: Conference "CO_2: Waste or Raw Material of the Future?";
- 18 & 19 November, online: "Les Rendez-vous Carnot 2020", a national business convention at which companies with innovation needs have the opportunity to meet R&D providers.

There was an ECCSEL booth in the 'Village of research infrastructures' and B2B meetings were organised.

In addition, the French node has been approached for the preparation of the StoRIES proposal on energy storage (call H2020 LC-GD-9-1-2020) for submission in January 2021, with ECCSEL ERIC as a partner. BRGM and CNRS are involved as linked 3rd parties to give access to one of their facilities which were selected by the partners for their suitability for energy storage research.

In November 2020, the French Ministry of Higher Education, Research and Innovation launched the renewal process of the National Roadmap for Research Infrastructures. The last edition was published in 2018. The next one will be published in spring 2022. Initial discussions were held to extend the scope of ECCSEL-FR to include underground energy storage, with the hope that ECCSEL ERIC would do the same for a simpler articulation.

In December 2020, the French node decided to extend France's membership to ECCSEL ERIC beyond the first 5 years (2017-2021) and started to prepare the amendment to extend the ECCSEL-FR partnership agreement, to take effect from 1st January 2022.

c. Facility innovations and investments in 2020

IFPEN's ESCORT facility has been enhanced with new features.
The construction of BRGM's MIMAROC facility started in 2020 and should be completed by the end of 2021.

d. Major research projects in 2020

No research projects involving French ECCSEL facilities were carried out in 2020. Nor does it appear that French researchers and engineers have used ECCSEL facilities from the other four countries. This is due in particular to the Covid-19 pandemic that hit Europe from January.

e. Outlook / plan for 2021

French node's action plan for 2021 is to:

- Finalise the administrative procedures to formalise the entry of CNRS into ECCSEL-FR;
- Continue to grow the French node by including additional research facilities and their owners;
- Finalise the amendment to extend the ECCSEL-FR partnership agreement beyond the first 5 years (2017-2021) of ECCSEL ERIC, to take effect from 1 January 2022;
- Relaunch the organisation of the CCUS national seminar and the regional event, which could not be held in 2020 because of the pandemic;
- Provide users with access to some French facilities. In particular, some BIOREP accesses are planned for 2021 and 2022.

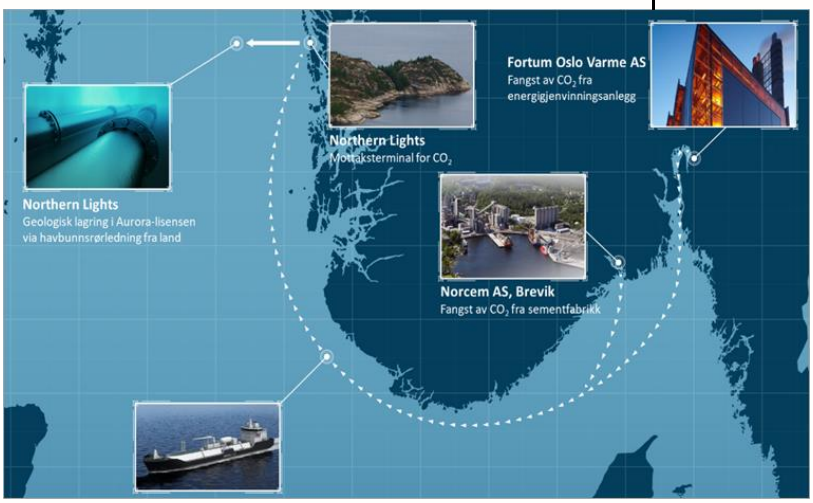
Norwegian Node

a. Overview / description of node

The Norwegian government sees Carbon Capture and Storage (CCS) as very important. The main goal of its CCS policy is to identify measures that can contribute to CCS technology development and cost reductions. The government has an ambition to realise a cost-effective solution for full scale carbon capture, utilisation, transport and storage (CCS) in Norway, provided this will result in technology development internationally.

In September 2020, the Norwegian government launched ‘Longship’, in Norwegian 'Langskip', a project for carbon capture and storage (CCS) in Norway. The Government plans to first implement carbon capture at Norcem’s cement factory in Brevik. In addition, the Government also intends to fund Fortum Oslo Varme’s waste incineration facility in Oslo, providing that the project secures sufficient own funding as well as funding from the EU or other sources.

Longship also comprises funding for the transport and storage project Northern Lights, a joint project between Equinor, Shell and Total. Northern Lights will transport liquid CO_2 from capture facilities to a terminal at Øygarden in Vestland County. From there, CO_2 will be pumped through pipelines to a safe geological storage location, a reservoir beneath the sea bed, close to the Troll oil and gas field.



Credit: Gassnova

This has been followed through in fundamental research, technology development and demonstration projects.

Norway is also doing research on alternative use of CO_2 (utilisation) and cooperating internationally to speed up CCUS implementation. ECCSEL is one of the instruments supporting this. CLIMIT, ACT, FME are other measures implemented to boost research.

Norway, represented by NTNU and SINTEF together with the Research Council of Norway (RCN) and the Norwegian Ministry of Research and Higher Education (KD), were the initiators of ECCSEL that was included on the ESFRI Roadmap in 2008 as one of three new RIs within the energy domain. Since 2011, NTNU has coordinated the development of ECCSEL. NTNU was the host of the inauguration ceremony of ECCSEL ERIC that took place in Trondheim on 12th June 2017 and is also the coordinator of ECCSEL-Norway, the Norwegian node of ECCSEL.

ECCSEL-Norway is continuously working to expand and attract additional Norwegian universities, research institutes and the industry through national meetings/workshops and research project collaboration.

ECCSEL ERIC is included in the Norwegian Roadmap for Research Infrastructures. Counting soon available new facilities together with the existing ones, the partners of the Norwegian node of ECCSEL will soon be operating more than 30 research facilities within CO_2 capture, transport, storage and utilisation, that are made available for the research community worldwide through ECCSEL ERIC.

The Norwegian node of ECCSEL consists currently of 3 research institutes and one university:

NTNU (Norwegian University of Science and Technology)	Three CO_2 capture facilities	NTNU
SINTEF Industry (merger of former SINTEF Materials and Chemistry and SINTEF Petroleum)	Six CO_2 capture facilities and five CO_2 storage facilities	SINTEF
SINTEF Energy Research	Three CO_2 capture facilities and five CO_2 transport / cross-cutting facilities	SINTEF
Institute for Energy Technology (IFE)	One CO_2 storage and one CO_2 transport facility	IFE Institute for Energy Technology

b. News / activities in 2020

ECCSEL-Norway is participating in the ECCSELERATE project with NTNU, SINTEF Energy Research and SINTEF AS as project partners and IFE as linked third party.

c. Facility innovations and investments in 2020

The Research Council of Norway (RCN) has funded investments in upgrades and new facilities in two phases. Of the 8 facilities (upgrades / new builds) financed by the Phase 1 project, seven are now operational (Capture Laboratories -Absorption: 'Extension of lab scale absorption equipment', 'Extension of absorption pilot'; -Membranes: 'Extension of polymer membrane lab', 'Extension of high temperature membrane lab'; -Solid sorbents: 'Extension of solid sorbent lab'; -Combustion: 'Oxy-GT'; Transport labs 'Depressurisation facility'). So far, the new and upgraded facilities have been mainly used in internal projects and there have been only a few users coming from organisations other than those owning them (NTNU, SINTEF Energy Research, SINTEF Industry).

Of the 15 facilities (upgrades / new builds) financed by the Phase 2 project, around half are still in build or test phase. Already operational are Capture Laboratories -Absorption: 'Flexible flue gas source for CO_2-capture pilot facility'; -Membrane laboratories: 'Low temperature membranes', 'High temperature membranes'; -Low temperature separation laboratories: 'Low temperature separation pilot'; Storage Laboratories -Storage integrity laboratories: 'Geochemistry Labs at IFE'. An additional five facilities have become operative in 2020 (Capture Laboratories -Combustion: 'High pressure combustion facility'; -Solid sorbents laboratories: 'Lab scale moving bed temperature Swing Adsorption'; Storage Laboratories -Monitoring laboratories: 'Upgrading of the CO_2 Field Laboratory at Svelvik'; -Storage integrity laboratories: 'Well integrity lab facilities'; -Reservoir laboratories: 'Test tank for trapping mechanisms').

A third project for Norwegian ECCSEL infrastructure development started in 2020,

ECCSEL Research Infrastructure for Norwegian Full-Scale CCS (ECCSEL NFS). ECCSEL NFS, which is also funded by the Research Council of Norway, will lead to 5 new facilities and upgrades on CO_2 transport (corrosion, flow assurance, safety systems), capture (medium pressure absorption pilot), and storage (fiber optic surveillance). Two of the upgrades are of existing ECCSEL facilities (FALCON and Tiller Pilot). In addition, a design basis has been developed for a large-scale test facility for fiscal metering. The project was presented for ECCSEL ERIC and other stakeholders in industry and research at a kick-off meeting in May 2020.

d. Major research projects in 2020

The absorption facility at NTNU has been used in two EU-funded projects: ALIGN-CCUS and LAUNCH-CCUS and several national projects including NCCS, SUBPRO and 3GMC. The combustion lab is host for the ANNULIGhT project, which is an Innovative Training Network (ITN) on instabilities, ignition and blow-off in annular gas turbine combustors. It is funded by EU under Marie Sklodowska-Curie Actions.

The ECCSEL facilities in SINTEF Industry have played a crucial role in implementation of several national and European research and innovation projects. For example, the Horizon 2020 project GENESIS has developed new types of CO_2 separation membranes based on hybrid polymer/inorganic systems. In another H2020 project, eCOCO2, a membrane reactor for direct conversion of CO_2 into chemical energy carriers is developed. As part of the Norwegian CCS Research Centre (NCCS), the ECCSEL facilities have been used to study the electrical and catalytic properties of high temperature membrane reactors. Finally, in a Norwegian project, the facilities have been used to develop technology to convert methane in cowsheds to CO_2 to reduce the climate impact of cattle farming.

Norwegian CCS Research Centre remains an important engine for CCS research in Norway. From SINTEF Energy Research are also multiple ECCSEL facilities utilised in NCCS, e.g. NO2.3 CO2MIX - VLE, NO2.6 VISC-DENS, NO2.5 DEPRESS, NO2.4 SEPPIL. The ERA ACT project Elegancy completed in 2020, utilising the DEFACTO facility.

e. Outlook / plan for 2021

RCN had a new call for national research infrastructures in autumn 2018 and supported by ECCSEL an application for new CCUS infrastructure funding was sent by SINTEF Energy Research together with the partners (SINTEF Industry, IFE, NORSAR, University of Oslo). The application was successful and negotiation for the final funding agreement has been completed in 2020.

Agreed to be added to the ECCSEL RI once constructed:

Name of research facility (Phase 1 & 2) – already accepted to ECCSEL RI	Funding phase	Upgrade / new	Focus	Operational
Well Integrity Lab facility at SINTEF Industry	P2	new	Storage	since 2020
Lab Scale Moving Bed Temperature Swing Adsorption at SINTEF Industry	P2	new	Capture	7/2020
Viscosity Apparatus at SINTEF Energy Research	P1	new	Transport	9/2021

DEFACTO- Test rig for solid phase and low-temperature phase equilibria at SINTEF Energy Research	P2	new	Transport	9/2021
Test tank for CO_2 monitoring studies at NTNU	P2	new	Storage	10/2021
Test tank for trapping mechanisms at SINTEF Industry	P2	new	Storage	10/2021
High pressure / complex phase equilibria apparatus at SINTEF Energy Research	P2	new	Transport	10/2021
CO_2 flow labs at SINTEF Industry	P2	new	Storage	10/2021
FALCON – Upgrade of a closed loop test facility for studying pipeline flow phenomena related to CO_2 transport at IFE	P3	upgrade	Transport	2022

Financing agreed, construction started, to be approved for inclusion in the ECCSEL RI:

Area	Type	Owner	Name & description (Phase 3)	Completion
Capture	Upgrade	SINTEF Industry	MPSolv - Upgrade for higher pressures operation of Tiller CO_2 test facility	2022
Transport	New	SINTEF Energy Research	FMet - Industry-scale fiscal metering test facility	Phase 1 (design) 2020. Phase 2 (build-critical components) proposal submitted 2020
Transport	New / upgrade	SINTEF Energy Research	FASafe - Flow assurance in safety systems / highly instrumented vent pipe. Will use same CO_2 tank as DEFACTO (existing).	2022/Q4
Transport	upgrade	IFE	DPCI – Upgrade of a facility for testing corrosion and chemical reactions in CO_2 transport systems.	2021
Storage	new	NORSAR	CODAS – Portable CO_2 injection monitoring using Distributed Acoustic Sensing.	2023

UK node

a. Overview / description of node

The UK has participated in ECCSEL since 2010 and became a founding member of ECCSEL ERIC in 2017. The UK holds seats on the General Assembly (BGS and Department for Business, Energy & Industrial Strategy (BEIS)) and Research Infrastructure Coordination Committee and provides in-kind staff contribution to the ECCSEL Operations Centre in Trondheim. The UK node, coordinated by BGS, has been proactive in engaging and promoting ECCSEL to policy and research stakeholders, potential RI users and UK CCS facility owners. ECCSEL's ambitions, activities, opportunities, strategy and future plans have been communicated regularly throughout ECCSEL's evolution at national and international CCS events. The UK has a busy schedule of biannual CCS research and policy events. Aligning with these opportunities has proved extremely successful in securing

engagement, participation and buy-in amongst ECCSEL's UK stakeholders.

With the start of the ECCSELERATE project in 2020, the UK formally included a further fourteen facilities from five new facility owners through Scottish Carbon Capture & Storage (https://www.sccs.org.uk/); discussions with other UK institutes and facilities are ongoing.

The UK node currently consists of twenty-five CCS facilities owned and operated by seven UK institutes:

British Geological Survey (BGS) (UK Node Coordinator)	Five CO_2 storage research facilities	
Translational Energy Research Centre (TERC) - formerly PACT	Seven pilot-scale CO_2 capture facilities	
Scottish Carbon Capture & Storage (SCCS)	Fourteen multicategory facilities from five Scottish facility owners, coordinated by Scottish Carbon Capture & Storage	

b. News / activities in 2020

In October 2020, the Natural Environmental Research Council (NERC) commissioned the British Geological Survey (BGS) to deliver a scoping study to develop UK investment options in a globally unique subsurface CO_2 storage research laboratory. The objective is to create a world-leading research facility.

c. Facility innovations and investments in 2020

<u>UK funding landscape and policy developments</u>

Building on the UK government announcement setting out its approach to CCS in 2019 (Clean Growth Strategy), the March 2020 budget committed a minimum of £800M investment through its CCS Infrastructure Fund to support the development of two CCS clusters during the 2020s; a major funding commitment specifically for commercial scale CCS deployment. In addition, six deployment projects along with six cluster plans (roadmaps) were funded through Phase 1 of the £170m Industrial Decarbonisation Challenge in the spring of 2020, and in the autumn the £1bn CCS Infrastructure Fund was announced to help establish four CCS clusters (North East and North West, Humber, Scotland and Wales) by 2030. National funding has also been announced for CCS, including up to £100m for DAC.

d. Major research projects in 2020

There has been little national access to UK facilities for CCS work, and no transnational access, due to the COVID-19 pandemic making

UK landfall in early March 2020. It has still been possible to complete important laboratory-based CCS project work however. Three facilities (RMPL, HTL, GML) were able to continue to provide data and outputs for the ERA-NET ACT project REX-CO2. The Rock Mechanics and Physics Laboratory and the HydroThermaL Laboratory together worked on applying HP-HT chemical treatment to cement samples and measured the impact on their strength for offshore borehole simulations. In the meantime, the GeoMicrobiology Laboratory developed a screening protocol to identify the best microbial population for MICP as a remediation solution for leakage in borehole. More details can be found here: https://rex-co2.eu/.

e. Outlook / plan for 2021

As part of the scoping study for the UK CO_2 storage research facility, in early 2021, BGS will complete the first phases of consultation, which include interviews with key stakeholders in the international CCUS landscape, and a wider written consultation. This consultation will inform the development of the strategic science case for a larger investment. In 2021 and beyond, BGS will continue to engage with other members of ECCSEL in developing the science objectives for the testbed to ensure it complements and contributes to the wider international research agenda for CO_2 storage.

Dutch Node

a. Overview / description of node

The Netherlands has been involved in the development of the ECCSEL Research Infrastructure since 2008, and from 2017, the year of ECCSEL ERIC creation, the Dutch node has been officially constituted and structured within TNO in conjunction with the support from RVO. As such the Dutch node is coordinated by TNO and RVO.

TNO	Five CO_2 capture research facilities Two CO_2 storage research facilities	TNO innovation for life

b. News / activities in 2020

The Dutch node undertook in 2020 actions to improve the industrial involvement and visibility of all ECCSEL research facilities and have organised Pan European workshops with industrial sectors. The workshops have been coordinated via the country nodes to attract the key industrial stakeholders per industrial sector. The aim is to develop a tailor-made portfolio of research and technology development services, Integration of the existing ECCSEL ERIC innovation management tools. The outcomes of the workshops will be translated into services for industrial stakeholders and will be used for the renewal of the current strategy and research priorities.

Service	Activities	Cement	Steel	Petrochemistry	Waste-to-Energy
Community and outreach	Community building				
	Market intelligence		CCUS		CCUS
	Knowledge sharing				
	Representation		At EU level	At EU level	At EU level
Research	Joint research				
	Contract research				
	Technical support				
	Facilities				
	Testing and validation				
Skills, Capacity building and Project development	Capacity Building				
	Project development				
	Consortium development	EU funding	EU Funding	EU funding	

Figure: Industrial workshop resulting matrix on services.

	Carbon Capture			Utilization		
	Adsorption	Absorption	Membrane / Others	Direct usage	Fuel production	Building block
Cement	Calcium looping (TRL 7)	Post-combustion capture using amine systems (TRL 7)	Oxy fuel combustion (TRL 6) Indirect heating (TRL 6) Heating with hydrogen (TRL 6)		Methane with added hydrogen (TRL 6-7)	Mineralisation to cementitious material (TRL 6)
Petrochemistry		Amine based capture of SMR outlet (TRL 7) physical absorption of ATR/POX outlet (TRL 9)	Heating with hydrogen (TRL 6)	Delivery to greenhouses (TRL 8)		
Iron & Steel	Sorbent based capture on the off gases with additional hydrogen recovery (TRL 6)	Amine based capture on the off-gases (TRL 7)	Direct reduction of iron with low-carbon hydrogen (TRL 7)		Methanol with hydrogen (TRL 6), Ethanol (TRL 8)	Naphtha from CO and hydrogen (TRL 6) Urea (TRL 9) Direct conversion of off-gases to polyol intermediates (TRL 4-6)
Waste-to-Energy	-	Post-combustion amine based capture (TRL 7)	Membrane separation of CO_2 (TRL 4)	Delivery to greenhouses (TRL 8)		Production of sodium bicarbonate (TRL 7)

Figure: Industrial involvement CO_2 capture and utilisation projects

In addition, the Dutch node contributed to the preparation of the StoRIES proposal on energy storage (call H2020 LC-GD-9-1-2020) for submission in January 2021, with ECCSEL ERIC as a partner. TNO are involved directly to give access to some of their facilities which are also suitable for energy storage research.

c. Facility innovations and investments in 2020

At TNO both of our mini plants are being modified. Both have been extended with water wash systems to allow more volatile solvents to be tested. One of them is also placed in an ATEX proof container so that it can also be used at refineries.

Figure Modified mini plants, placed in an ATEX proof

d. Major research projects in 2020

In 2020 Dutch Facilities in ECCSEL have been extensively used. Both Mini plants were 100% occupied for the ACT projects LAUNCH en NEWEST, the H2020 project REALISE and 3GAIN, which is a national funded project. Our ECCSEL aerosol characterisation equipment was used at various Waste to Energy plants as part of national projects. A campaign was also done at RWE in LAUNCH. The ECCSEL solvent test street equipment was used to investigate new CO_2 capture solvents in 3GAIN.

Dutch researchers and engineers have not used ECCSEL facilities from the other four countries. This is due in particular to the Covid-19 pandemic that hit Europe from January.

e. Outlook / plan for 2021

Dutch node's action plan for 2021 is to:

- Update ECCSEL strategy
- Establishment of a ECCSEL community and organise on a regularly network events
- Continue to grow the Dutch node by including additional research facilities and their owners;
- Both mini plants are actually being used 24/7 in 2021. For 2022 there is also industrial interest in using the mini plant.
- Now the borders are opening up again we are planning to ship it abroad for measurements.
- The solvent test street is being upgraded with new vessels and more precise sensors to improve accuracy and quality of measurements.

FACILITY ACCESS

Due to Covid-19, there was only limited Transnational Access to our Research Infrastructure during 2020.

On the ECCSEL website you can see the majority of the research projects carried out in 2020 using facilities which belong to the ECCSEL Research Infrastructure. National and European Projects and Initiatives (Horizon 2020, ACT (Accelerating CCS Technologies) ERA-NET Cofund, NCCS (Norwegian CCS Research Centre) and others) provided funding for projects using ECCSEL facilities for their research projects in 2020. In addition, self-funded projects were carried out.

LOOKING AHEAD

The pandemic has lasted longer and impacted the operational activities on the ECCSEL infrastructure much worse than anyone could foresee. Latest development however, indicates that travel restrictions are going to be lifted during summer 2021, so that transnational access again will be possible from September/October. By then our H2020 ECCSELERATE Project will announce Calls for funded transnational access to a large number of our world-class research facilities.

Besides coordinating ECCSELERATE, ECCSEL ERIC will be involved as partners in three other H2020 projects, ERIC Forum and RITrain, as well as in the EU Green Deal project StoRIES on Energy Storage. We are also going to seek partnerships for relevant proposals on the first round of Horizon Europe calls, preferably together with industry partners.

In accordance with our investment plans, we will continue to expand the infrastructure with upgraded and new research facilities.

As CCUS is increasingly acknowledged by non-ECCSEL member countries as technology needed to meet net zero CO_2 emission targets by 2050, we expect the benefits and value of joining ECCSEL ERIC will become clearer.

In other words, the coming years will be busy for us, contributing to closing CCUS technology gaps on the way to zero CO_2 emissions from industry and power generation.

Projects

In 2020, ECCSEL received funding from the European Union's Horizon 2020 research and innovation programme

ECCSELERATE:
ECCSEL is project leader of the ECCSELERATE project (grant agreement no. 871143) which is aimed at increasing the use and ensuring the long-term sustainable operation of the ECCSEL ERIC RI.

ERIC Forum Implementation Project:
ECCSEL is a beneficiary of the ERIC Forum project (grant agreement no. 823798) which brings together 20 established European Research Infrastructure Consortia (ERICs) and 3 ERICs in preparation to strengthen their coordination and enhance their collaborations.

More information on past and current projects can be found on the ECCSEL website.

Horizon 2020

FINANCIAL SUMMARY

The Annual Financial Statements for 2020 which can be found in Annex I of this annual report, were prepared by the Authorised Accountant "SpareBank 1 Regnskapshuset SMN AS", Kjøpmannsgata 50, 7010 Trondheim, Norway.

All accounts have been audited by the External Auditor "BDO AS", Klæbuveien 127B, 7031 Trondheim, Norway. BDO AS was reappointed as auditor by the ECCSEL ERIC General Assembly during their sixth meeting on 29th November 2019 held in Edinburgh, UK. The Report of the External Auditor is in the Annex of this annual report.

The Annual Financial Report 2020 highlights the financial status of ECCSEL ERIC. There were no unexpected income or expenses in 2020.

Budget

The Budget for the financial year 2020 was agreed on during the sixth ECCSEL ERIC General Assembly meeting on 29th November 2019.

The approved budget for 2020 was €480,000. Norway, as the hosting country of the ERIC, has agreed to pay 1/3 of the total membership fees. The remaining 2/3 are being split equally between the other member countries.

It was approved that four countries would provide in-kind personnel contributions at/to the OC (Italy, France, the Netherlands and the UK would provide a 25% position as contribution each). The membership fee would accordingly be discounted by €25,000 for the four countries providing a 25% position in-kind contribution in 2020 (value of the in-kind contribution).

Foreseen total cash income (from membership fees) was, therefore, €380,000. Membership fees were divided as per the table below.

In addition, ECCSEL is a beneficiary in the EU Horizon 2020 ECCSELERATE project as well as the ERIC FORUM project. In 2020, the company has been awarded a grant from the EU for the two projects. Earned grants in 2020 are €28,672.

Against those earnings, expenses of €480,000 were foreseen. Of those were €380,000 cash expenses and €100,000 for in-kind personnel contributions. Those in-kind contributions and their costs are not visible on the balance sheet as they were accounted for by member fee reduction.

Budgeted expenses for 2020 (excluding project contributions) and foreseen breakdown into main expense categories are displayed in the table below.

Projects

ECCSELERATE project: ECCSELERATE has a budget of 3.529,- Million € over three years. Of that, 297.000,- € is allocated to the ECCSEL ERIC Operations Centre and 3.232,- Million € is for the 10 other project partners and 10 linked 3rd parties (all associated to ECCSEL) in the five ECCSEL countries.

ERIC FORUM project: ECCSEL ERIC is a participant in that 1.495,- Million € project with 21 ERICs participating. ECCSEL holds a budget of 5000 € (for travel expenses) and contributes in kind to the projects activities.

2020 Budget - Membership fees (EURO)					
Member / Category	**Cash income and expenses - expected**	**Cash - actual**	**In-kind - expected**	**In-kind - actual**	**Total**
Income					
Norway (1/3 as host)	160 000	160 000			160 000
France*	55 000	55 000	25 000	25 000	80 000
The Netherlands*	55 000	55 000	25 000	25 000	80 000
Italy*	55 000	55 000	25 000	25 000	80 000
UK*	55 000	55 000	25 000	25 000	80 000
Other (interest, exchange gains or losses)		0			
Total Income	380 000	380 000	100 000	100 000	480 000
Expenses					
Operations Centre personnel**	310 000	297 642	100 000	100 000	397 642
IT system***	10 000				
Office renting***	17 835	6 091			
Travel	15 000	17 014			
Outsourced services	20 000	11 000			
Total Expenses	372 835	331 747	100 000	100 000	397 642
* 4 countries providing a 25% in-kind position each at/for the OC, paying a reduced membership fee in cash					
** Start-up with secondment of Director and administrative personnel from NTNU plus in-kind contributions from other countries					
*** Office renting, general administrative support and IT from NTNU					

Planning Period	2021	2022	2023	2024	2025	2021-2025
	5 years ECCSEL ERIC Budget build-up from 2021					
EXPENDITURES						
Permanent Operations Centre personnel*	390 000	390 000	490 000	590 000	690 000	2 550 000
IT system	10 000	10 000	10 000	15 000	15 000	60 000
Office renting	10 000	10 000	10 000	15 000	15 000	60 000
Travel	20 000	40 000	45 000	50 000	50 000	205 000
NTNU support and Outsourced services**	130 000	170 000	115 000	80 000	80 000	575 000
Total Expenditures (€)	560 000	620 000	670 000	750 000	850 000	3 450 000
INCOME						
Hosting Country (Norway)	150 000	180 000	210 000	250 000	283 333	1 073 333
Member & Observer States	300 000	360 000	420 000	500 000	566 666	2 146 666
External funded projects (ECCSELERATE ++)	80 000	80 000	40 000			200 000
Total Income (€)	530 000	620 000	670 000	750 000	850 000	3 420 000
COSTS PER MEMBER						
Number of Members (excl. host)	4	5	6	8	10	
Costs per Member (€)	75 000	72 000	70 000	62 500	56 667	336 167
*) In 2021 secondment of Director and Manager from NTNU + 1 In-kind person-year split in 4 25% positions						
**) Includes NTNU support/service; EU/Communication adviser, Adm Coordinator., HR, etc + Auditor, Accounting,						
**) Gap of EUR 30 000 from 2020 "carry-over" to be allocated for professional communication/marketing services/assistance						

5-year future budget prediction 2020-2024

The table above shows the forecasted annual costs and income contributions (€) for the coming 5 years of operation of ECCSEL ERIC, as per December 2020.

Actual Income and Expenses

The annual accounts have shown a total operating revenue of €410,487 and total operating expenses of €314,805 for ECCSEL ERIC in 2020.

€380,000 of the total operating revenue of €410,487 came from membership fees. The remaining other operating income of €28,672 originated from grants from the EU for the two above mentioned projects. The remaining amount originated from foreign exchange gain related to the operational revenue. There was no extraordinary income.

In addition, ECCSEL National Nodes and facility owners funded directly a number of national activities and conferences as well as facility owners and national funding authorities financed facility upgrades and new builds of ECCSEL facilities. This is not visible on the ECCSEL income and expense statements as payments were made directly and not to or through ECCSEL.

All membership fees for 2020 are paid in full.

Total operating expenses for 2020 were €314,805. This was below the budgeted expenses mainly due to lower than budgeted expenses for travel, meetings, conferences, website development (due to delays) and office rental. This was due to exceptional circumstances in 2020 (Covid-19 impact). Office rental charges were slightly lower than budgeted because less office space than planned was used and charged for. Due to exceptional circumstances was the personnel cost in 2020 lower than anticipated. The main expense for 2020 was salary, which accounted for €287,446. This was for the secondment of Sverre Quale (100%), Volker Röhling (100%), Sina Blix Prestmo (100% from November 2020) and Debbie Koreman van den Berg (35% in average). This amount covers salaries and related costs (like insurance and pension), IT systems and support and some travel expenses.

Other operating expenses (€27,359) accounted for office rental, marketing activities, conference participation, meetings (meeting room and catering costs), travel of OC staff (main part of OC staff travel costs of the main OC staff is included in salary costs above), payment to the auditor (€2,274) and accountant, for the use of the online accounting system and costs for banking services in relation to the bank accounts of ECCSEL.

The stated financial income and financial expenses are related mainly to the accounting of the project prepayment for the EU projects.

Financial income amounted to €333,296 and financial expenses to €348,354. The difference of €15,058 resulted from negative interest charges for the ECCSEL Euro account, costs related to the processing of the EU pre-payment, exchange rate losses.

In 2021, operating costs are expected to be significantly higher and more in line with the total budgeted amount. Travel, meeting and other related expenses however are still foreseen to be low due to COVID-19 restrictions. However increased marketing activities and OC personnel increase are planned for 2021 and 2022.

It has proved to be valuable to have a solid financial buffer to bridge eventual delays in member fee payments and delays in claiming back Value Added Tax. Additionally, some reserves for planned and unplanned irregular future expenses are required.

Other Income

No other income was generated in 2020 apart from the one mentioned above.

As of 31 December 2020, the company has received an advance payment ('prepayment') for the two EU projects' grants of EUR 580,124.

Procurement and Tax Exemption

According to Article 16 of the Statutes, shall ECCSEL ERIC shall treat procurement candidates and tenderers equally and in a non-discriminatory way, independent of whether they are based in the European Union, or not. During 2020 no major investments or purchases were made. Office space was made available from NTNU and is a minor expense. There was a payment of €6,091 in 2020 for the office space used by ECCSEL ERIC.

In accordance with the ERIC Regulation (Official Journal L 206, 2009) and the Norwegian ERIC

law (“ERIC loven”) shall an ERIC benefit from tax exemption. Article 16 of the ECCSEL ERIC Statutes states that tax exemptions based on the Norwegian Act relating to value-added tax of 19. June 2009 No. 58, § 10-3 be limited to the value-added tax for such goods and services which are for official and exclusive use by ECCSEL ERIC and are wholly paid and procured by ECCSEL ERIC or by Members States of ECCSEL ERIC.

ECCSEL ERIC requests quarterly the refunding of charged value-added tax. For 2020, ECCSEL ERIC got refunded the in Norway paid value-added tax.

KEY FACTS AND FIGURES

ECCSEL ERIC Member States, Representing Entities and National Nodes

Member State	Member States' Representing Entity	National Node Coordinator
Norway (ERIC statutory seat)	Norwegian University of Science and Technology (NTNU) cooperating with SINTEF Energy Research (SINTEF ER)	Morten Grønli (NTNU)
France	The French Geological Survey (BRGM)	Isabelle Czernichowski-Lauriol (BRGM)
Italy	National Institute of Oceanography and Applied Geophysics - OGS	Michela Vellico (OGS)
The Netherlands	Netherlands Organisation for Applied Scientific Research (TNO)	Jan Hopman (TNO)
United Kingdom	British Geological Survey (BGS)	Helen Taylor-Curran (BGS)

ECCSEL General Assembly

Member Country	Name	From	Type	Role
United Kingdom	Jonathan Pearce	BGS	Representing Entity	GA Chair
Norway	Sverre Quale	ECCSEL ERIC	ERIC Management	ECCSEL ERIC Director
France	Xavier Montagne	Ministry of Education, Higher Education and Research (MESRI)	Ministry	Vice Chair
France	Isabelle Czernichowski-Lauriol	BRGM	Representing Entity	Member
Italy	Grazia Pavoncello replaced Salvatore La Rosa in 2020	Ministry of Education, University and Research (MIUR)	Ministry	Member
Italy	Michela Vellico	OGS	Representing Entity	Vice Chair
The Netherlands	Gerdi Breembroek	Netherlands Enterprise Agency (RVO)	Ministry	Member
The Netherlands	Jan Hopman	TNO	Representing Entity	Member
Norway (ERIC statutory seat)	Åse Slagtern (shared with Espen Bernhard Kjærgård)	The Research Council of Norway (RCN) Norwegian Ministry of Petroleum and Energy (OED)	Ministry	Member
Norway	Nils Røkke	SINTEF ER	Representing Entity	Member
United Kingdom	Brian Allison (Matthew Taylor from February 2021)	Department for Business, Energy and Industrial Strategy (BEIS)	Ministry	Member
United Kingdom	Helen Taylor-Curran	BGS	Representing Entity	Member

ECCSEL Research Infrastructure Coordination Committee (RICC)

The task of the Research Infrastructure Coordination Committee is to strengthen the cooperation between the facilities and their contributions to experimental research. This is done by overseeing the implementation of ECCSEL ERIC's strategies and plans, by contributing to them, and by proposing measures that can enhance the functioning of ECCSEL ERIC.

Member State	Institute	ECCSEL ERIC main RICC members
Norway (ERIC statutory seat)	Norwegian University of Science and Technology (NTNU)	Morten Grønli (NTNU)
France	The French Geological Survey (BRGM)	Sébastien Dupraz (BRGM), RICC Vice-Chair
Italy	National Institute of Oceanography and Applied Geophysics – OGS	Cinzia de Vittor (OGS)
The Netherlands	Netherlands Organisation for Applied Scientific Research (TNO)	Peter van Os (TNO)
United Kingdom	British Geological Survey (BGS)	Audrey Ougier-Simonin / Simon Gregory(BGS) Mohamed Pourkashanian (UoS-TERC)

OTHER ECCSEL ADVISORY BOARDS AND COMMITTEES

Ethics and Environmental Advisory Board (EEAB)

The EEAB is a group of three to five eminent, independent and experienced scientists. Its main tasks are:

- Review and approve a document with Ethics guidelines which apply as a minimum standard to all facilities that are part of ECCSEL as well as to all research being done through ECCSEL.
- Review any ethics and environmental issues that arise during research performed through ECCSEL national or transnational access.

Name	Country	Institute	Involvement
Behnam Taebi (Ph.D.)	The Netherlands	Delft University of Technology	Associate Professor Ethics of Technology, Faculty of Technology, Policy and Management, Delft University of Technology http://ethicsandtechnology.eu/taebi/ Associate, Belfer Center for Science and International Affairs, Kennedy School of Government, Harvard University http://www.belfercenter.org/person/behnam-taebi Member of The Young Academy of the Royal Netherlands Academy of Arts and Sciences (KNAW)

Derek Taylor	Belgium / UK	DMT Energy Consulting sprl	DMT Energy Consulting sprl & Honorary Professor of Geo-Energy (Nottingham University)
Øyvind Mikkelsen	Norway	NTNU	Chair of "The National Committee for Research Ethics in Science and Technology (NENT)

Industry Advisory Group (IAG)

The IAG consists of senior industry representatives. Its role is to provide an effective interface between the industry group and the ECCSEL community, to provide guidance on industrial topics and priorities and to report progress to the ECCSEL Operations Centre.

Name (First, Last)	Institute / Company / University	Country
Oscar Graff	Aker Solutions	Norway
André Marblé	TOTAL	France
Valérie Czop	EDF	France
Hege Rognø	Equinor	Norway
Mouloud Behloul	Lafarge	France
Fulvio Canonico*	Buzzi Unicem	Italy
Barthold Schroot	EBN	The Netherlands
Chris Gittins*	Taqa Energy BV	The Netherlands

Scientific Advisory Board (SAB)

The Scientific Advisory Board is a permanent Committee that reports through the Director to the General Assembly. Its main task is to provide input to the GA through (solicited and unsolicited) advice on the scientific quality of the services offered by ECCSEL ERIC, the RI´s scientific policies, procedures and future plans.

Name (First, Last)	Institute / Company / University	Country
Axel Liebscher	BGE Bundesgesellschaft für Endlagerung mbH	Germany
Adam Smolinski	Central Mining Institute GIG (Główny Instytut Górnictwa)	Poland
Sergio Persoglia	Independent	Italy
Eric Favre	University of Lorraine	France

ECCSEL Operations Centre (OC)

Name	Role	Organisation
Sverre Quale	Director	ECCSEL ERIC
Volker Röhling	Manager	ECCSEL ERIC
Sina Blix Prestmo	European funding and communication advisor	ECCSEL ERIC
Debbie Koreman van den Bergh	50%	NTNU / ECCSEL ERIC
Helen Taylor-Curran	25% position (in kind)	BGS
Michela Vellico	25% position (in kind)	OGS
Sébastien Dupraz	25% position (in kind)	BRGM
Robert de Kler	25% position (in kind)	TNO

The European CCUS Research Infrastructure

APPENDIX

- FINANCIAL REPORT
- AUDITORS REPORT
- Acronyms and Abbreviations

2020

Legally signed by
Sverre Qvale
16.06.2021

Financial Statements 2020
for
Eccsel European Research Infrastructure Consortium

Organization no. 919298243

Prepared by:
Sparebank 1 Regnskapshuset Smn AS
Authorised accountant company
Søndre gate 4
7011 TRONDHEIM
Organization no. 936285066

Income statement

	Note	2020	Budget 2020	2019
OPERATING REVENUE AND EXPENCES				
Operating revenue				
Revenue	1	381 815	480 000	381 452
Other operating income	2	28 672	0	0
Total operating revenue		**410 487**	**480 000**	**381 452**
Operating expenses				
Employee benefits expense	3	270	0	1 712
Other operating expenses	3	314 535	480 000	330 035
Total operating expenses		**314 805**	**480 000**	**331 747**
OPERATING PROFIT OR LOSS		**95 682**	**0**	**49 705**
FINANCIAL INCOME AND EXPENSES				
Financial income				
Other interests		51	0	63
Other financial income		333 245	0	841
Total financial income		**333 296**	**0**	**904**
Financial expenses				
Other interests		18 976	0	315
Other financial expense		329 378	0	960
Total financial expenses		**348 354**	**0**	**1 275**
NET FINANCIAL INCOME AND EXPENCES		**(15 058)**	**0**	**(371)**
ORDINARY RESULT BEFORE TAXES		**80 624**	**0**	**49 334**
Tax on ordinary result		0	0	0
ORDINARY RESULT		**80 624**	**0**	**49 334**
TO MAJORITY INTERESTS		**80 624**	**0**	**49 334**
APPLICATION AND ALLOC.				
To/from other equity	4	80 624	0	49 334
TOTAL APPLICATION AND ALLOCATION		**80 624**	**0**	**49 334**

Eccsel European Research Infrastructure Consortium

Balance sheet pr. 31.12.2020

	Note	31.12.2020	31.12.2019
ASSETS			
CURRENT ASSETS			
Receivables			
Trade receivables		108 465	207 240
Other short-term receivables	5	28 829	31 652
Total receivables		**137 294**	**238 892**
Bank deposits, cash in hand, etc.	6	841 240	126 151
TOTAL CURRENT ASSETS		**978 534**	**365 043**
TOTAL ASSETS		**978 534**	**365 043**
EQUITY AND LIABILITIES			
EQUITY			
Retained earnings			
Other equity	4	254 359	182 371
Total retained earnings		**254 359**	**182 371**
TOTAL EQUITY		**254 359**	**182 371**
LIABILITIES			
CURRENT LIABILITIES			
Accounts payable		143 425	149 327
Other currents liabilities	2,5	580 751	33 345
TOTAL CURRENT LIABILITIES		**724 175**	**182 672**
TOTAL LIABILITIES		**724 175**	**182 672**
TOTAL EQUITY AND LIABILITIES		**978 534**	**365 043**

Trondheim ___/___.2020

Sverre Quale
CEO

Eccsel European Research Infrastructure Consortium

Notes 2020

Accounting principles

The annual financial statements have been prepared in accordance with the Accounting Act and Good accounting practice for small enterprises.

Current assets and current liabilities
Current assets and current liabilities generally include items due for payment within one year after the last day of the accounting year, as well as items related to the product cycle. Current assets are valued at the lower of cost and assumed fair value.

Fixed assets and long-term liabilities
Fixed assets comprise assets intended for permanent ownership and use. Fixed assets are valued at acquisition cost. Tangible fixed assets are capitalized and depreciated over the expected economic life of the asset. Tangible fixed assets are subject to a written-down to recoverable amount in case of impairment, which is not expected to be temporary. The write-down is reversed when the basis for the write-down is no longer present.

Recognition
Revenue from the sale of goods and services takes place at the time of delivery. The share of sales revenues related to future services is capitalized as unearned income and is subsequently recognized as income in accordance with delivery of the service.

Receivables
Trade receivables are capitalized at nominal value after deduction of deposition for expected losses. Deposition for expected losses are made based on an individual assessment of the individual receivables. In addition, for other accounts receivable, an unspecified deposition is made to cover expected losses.

Tax
The company is not taxable.

Notes 2020

Note 1 - Member Countries

Member Country	Member Countries Representing Entity
Norway (ERIC Statutory seat)	Norwegian University of Science and Technology (NTNU) together with SINTEF Energy Research (SINTEF ER)
France	The French Geological Survey (BRGM)
Italy	National Institute of Oceanography and Experimental Geophysics (OGS)
The Netherlands	Netherlands Organisation for Applied Scientific Research (TNO)
United Kingdom	British Geological Survey (BGS)

Operating revenue provided by ECCSEL ERIC annual member fees.

Note 2 - Public grants

In 2020, the company has been awarded a grant from the EU for two projects. Earned grants in 2020 are EUR 28 672.

As of 31 December 2020, the company has received an advance payment for the grants of EUR 580 124.

Notes 2020

Note 3 - Other operating expenses

	This year	Last year
Other salary-related benefits	65	1 712
Sosial security contributions	205	0
Total	**270**	**1 712**

The company has four employees seconded from NTNU in 2020. Two of the employees are hired in for a full time position, and the two other are hired on an hourly basis. In 2020, the employees on hourly basis worked for ECCSEL equivalent to a 35% position. The paid salary cost is EUR 287 446 excl. VAT.

The company has paid remuneration to the auditor with the following amounts:

	2020
Audit	2 274
Total	**2 274**

Note 4 - Other equity

	Other equity	Total equity
Pr. 1.1.	182 371	182 371
Applied from annual result	80 624	80 624
Currency differences	(8 636)	(8 636)
Pr 31.12.	**254 359**	**254 359**

Notes 2020

Note 5 - Receivables and debt

	2020	2019
Receivables due later than one year after the balance sheet date	0	0
Liabilities due later than five years after the balance sheet date	0	0

Note 6 - Bank deposits

The bank deposits do not include any restricted funds.

BDO AS
Klæbuveien 127B
7031 Trondheim

Independent Auditor's Report

To the General Meeting in Eccsel European Research Infrastructure Consortium

Report on the Audit of the Financial Statements

Opinion

We have audited the financial statements of Eccsel European Research Infrastructure Consortium.

The financial statements comprise:	In our opinion:
• The balance sheet as at 31 December 2020 • The income statement for 2020 • Notes to the financial statements, including a summary of significant accounting policies	The accompanying financial statements are prepared in accordance with the law and regulations and give a true and fair view of the financial position of the Company as at 31 December 2020 and its financial performance for the year then ended in accordance with the Norwegian Accounting Act and accounting standards and practices generally accepted in Norway.

Basis for Opinion

We conducted our audit in accordance with laws, regulations, and auditing standards and practices generally accepted in Norway, including International Standards on Auditing (ISAs). Our responsibilities under those standards are further described in the Auditor's Responsibilities for the Audit of the Financial Statements section of our report. We are independent of the Company as required by laws and regulations, and we have fulfilled our other ethical responsibilities in accordance with these requirements. We believe that the audit evidence we have obtained is sufficient and appropriate to provide a basis for our opinion.

The responsibilities of the Board of Directors and the Managing Director for the Financial Statements

The Board of Directors and the Managing Director (management) are responsible for the preparation and fair presentation of the financial statements in accordance with the Norwegian Accounting Act and accounting standards and practices generally accepted in Norway, and for such internal control as management determines is necessary to enable the preparation of financial statements that are free from material misstatement, whether due to fraud or error.

In preparing the financial statements, management is responsible for assessing the Company's ability to continue as a going concern, disclosing, as applicable, matters related to going concern. The financial statements use the going concern basis of accounting insofar as it is not likely that the enterprise will cease operations.

Auditor's Responsibilities for the Audit of the Financial Statements

Our objectives are to obtain reasonable assurance about whether the financial statements as a whole are free from material misstatement, whether due to fraud or error, and to issue an auditor's report that includes our opinion. Reasonable assurance is a high level of assurance, but is not a guarantee that an audit conducted in accordance with ISAs will always detect a material

misstatement when it exists. Misstatements can arise from fraud or error and are considered material if, individually or in the aggregate, they could reasonably be expected to influence the economic decisions of users taken on the basis of these financial statements.

For further description of Auditor's Responsibilities for the Audit of the Financial Statements reference is made to:
https://revisorforeningen.no/revisjonsberetninger

Report on Other Legal and Regulatory Requirements

Opinion on Registration and Documentation

Based on our audit of the financial statements as described above, and control procedures we have considered necessary in accordance with the International Standard on Assurance Engagements (ISAE) 3000, «Assurance Engagements Other than Audits or Reviews of Historical Financial Information», it is our opinion that management has fulfilled its duty to produce a proper and clearly set out registration and documentation of the company's accounting information in accordance with the law and bookkeeping standards and practices generally accepted in Norway.

BDO AS

John Christian Løvaas
State Authorised Public Accountant
(This document is signed electronically)

Note: Translation from Norwegian prepared for information purposes only.

The financial report is digitally sigend by the director of ECCSEL ERIC, Sverre Quale.

The auditor’s report is digitally sigend by the auditor, BDO.

The digitally signed financial report and auditor’s report can be downloaded from the ECCSEL website from the **annual report section** under **news**.

Acronyms and Abbreviations

CCS:	Carbon (Dioxide) Capture, Transport and Storage
CCUS:	Carbon (Dioxide) Capture, Transport, Utilisation and Storage
ECCSEL:	European Carbon Dioxide Capture and StoragE Laboratory Infrastructure
EEAB:	Ethics and Environmental Advisory Board
ERIC:	European Research Infrastructure Consortium
ESFRI:	European Strategy Forum for Research Infrastructures
GA:	General Assembly
IAG:	Industry Advisory Group
Node:	ECCSEL ERIC country node responsible for coordinating activities at country level
OC:	ECCSEL Operations Centre
RI:	Research Infrastructure
RICC:	ECCSEL Research Infrastructure Coordination Committee
SAB:	Scientific Advisory Board

The European CCUS Research Infrastructure

ECCSEL European Research Infrastructure Consortium (ERIC), was approved by the European Commission in June 2017 (Commission implementing decision (EU) 2017/996 of 9. June 2017)

ECCSEL ERIC is registered in Norway in the Company Registry with the organisation number 919298243

In 2020, ECCSEL received funding from the European Union's Horizon 2020 research and innovation programme:

- being project leader of the ECCSELERATE project (grant agreement no. 871143)
- being a partner, a beneficiary of the ERIC Forum project (grant agreement no. 823798)

Horizon 2020

ESFRI, the European Strategy Forum on Research Infrastructures