



SWEDISH FOUNDATION *for*
STRATEGIC RESEARCH

SSF Call for Proposals

SSF Multidisciplinary Research Center

CO₂ Capture, Transformation, and Utilization (CCU)

The Swedish Foundation for Strategic Research (SSF) announces 60 million SEK in a national call for proposals for a Multidisciplinary Research Centre (MRC) that meets the highest international scientific standards. The call aims to stimulate truly multidisciplinary research collaboration between academia, research institutes, industry, and society.

SSF seeks to fund one (1) MRC application for reducing the content of carbon dioxide in the atmosphere through carbon-lean process innovation and CO₂ capture, transformation, and utilization (CCU).

The MRC will be granted up to 40+20 million SEK in total including overhead costs for a period of six years. Full funding will be contingent upon a successful midterm evaluation.

This year, the Foundation celebrates 30 years of operations, and presents this Jubilee Call on CCU for promoting climate care and the green transition for a more sustainable development, as well as for the betterment of Sweden's industrial competitiveness.

SSF Multidisciplinary Research Centers (MRC)

Multidisciplinary research is defined here as coordinated research efforts in which several scientific competences, presumably not all from the same department or faculty, each outstanding in their field, work together to solve a major societal problem.

A Multidisciplinary Research Center (MRC) should be characterized by the added scientific value that arises from multidisciplinary research. The potential for an MRC to find new solutions through multidisciplinary and synergistic approaches is a key evaluation criterion.

The research by the MRC should be based on a clear scientific question centered on gaps in knowledge related to a important problems and opportunities. Moreover, the MRC should have explicit plans for the implementation and/or knowledge transfer of research results into industry and society in a long-term perspective, including for sustainable development aspects.

Another MRC characteristic should be its strong presence in international research initiatives (e.g., *EU Horizon Europe*), leveraging the SSF-funding with international funding for increased thrust. The potential for an MRC to constitute an internationally leading research center is a key evaluation criterion.

Aims and Scope

The Call aims to promote research breakthroughs and innovation on carbon dioxide handling with cutting-edge research and sustainable development merits. For resource management in the present century, decarbonization and dematerialization are imperative activities.¹ The establishment of a Multidisciplinary Research Center with this orientation – MRC CCU – should consolidate a necessary knowledge base and establish Sweden at a leading international position in the field.

Much of the global climate change is caused by greenhouse gas emissions, mostly CO₂, from human activities. Carbon capture, utilization, and storage (CCUS) technologies are considered as a way to mitigate CO₂ accumulation in the atmosphere, according to the Intergovernmental Panel on Climate Change (IPCC)². Most of today's CO₂ conversion and utilization pathways are, however, at a nascent stage. Also, the costs for CCUS technology remain high. Thus, research breakthroughs and faster uptake of adaptation of science are needed for progress, not the least for the perspective of CCUS being one of the bridging technologies towards a decarbonized future energy economy. Advanced materials and green chemistry with catalysis are likely to be enabling factors in this transition.

The SSF MRC CCU concerns a multitude of applications through which the amount of CO₂ that is generated in industrial processing is reduced, captured, transformed, and used either directly or indirectly (i.e. chemically altered) in various products. The proposed research center should have a system optimization perspective for a sustainable development. Research areas may include one or several of the following below listed research topics. These are intended as relevant examples for research and innovation, but are not exclusive:

- Research to invent and develop new advanced materials and optimize capture processes for a cost-effective technology, as thermodynamics stipulates that CO₂ is best captured from concentrated (point) sources such as power plants or industry like steel, refinery, pulp & paper, and cement plants (flu gas). Different flows can be considered for i) post-combustion, ii) pre-combustion (with syngas like CO and H₂) capture, and iii) Oxy-fuel combustion capture.
- Exploring syngas for CO₂-less (green) steel production, like direct reduced iron.
- Research on electrofuels (eFuels) using captured carbon dioxide or carbon monoxide, together with hydrogen obtained from water split by low-carbon electricity sources such as wind, solar and nuclear power. An example of systemic approach is to use the oxygen generated in hydrolysis for e.g., oxygenation of sea floors.
- Using the potential chemical energy (stored solar energy) in biomass including residues from forest felling to produce syngas (CO+H₂). Here, EU regulations steer towards CCU of biogenic sources.
- Producing eco-fuels like methanol for maritime transport and sustainable aviation fuels (SAF).

¹ UN Environment Program: Global Resources Outlook 2024, International Resource Panel.

² IPCC Climate Change 2023 Synthesis Report

- Use captured or syngas CO₂ as the carbon source to carburize steel.
- Exploit syngas and side reactions to CO₂ utilization to make ammonia as alternative routes to the Haber-Bosch process. Opportunity also lies in producing hydrogen peroxide.
- CO₂ separation technology by physical or chemical methods, each of which can be subdivided into absorption (ionic-liquid, chemical, physical, mixed) and adsorption (porous materials, metal-organic frameworks or C-based materials). Membrane separation technologies in various CO₂ separation technologies, cryogenic separation of CO₂, with distillation of gas or using electrochemical reactions to separate CO₂ from a mixture, by absorbing and releasing CO₂ in electrolyte solution.
- Conversion of captured CO₂ into products for chemical (chemicals, materials, fuels, plastics), biological (food, feed, fertilizer) or geological (fuels, petroleum, natural gas, water, minerals) utilization, CO₂ hydrogenation, targeting methanol, olefin, and fuel synthesis (from CO₂), or carbonation/calcination, for example to CaCO₃ and MgCO₃.
- Green(er) catalysis processing based on more efficient catalysts or the development of catalysis processes to replace noble metals and rare earths.

SSF encourages innovative, multidisciplinary collaborations to propose novel ideas for carbon capture, transformation, and utilization.

Research on CO₂ transport and storage are not part of the present Call, not to make it too broad, and to keep focus on the sources of CO₂ emission and to reduce these upstream.

Applicants should apply a process systems engineering perspective and proposed projects should target Technology Readiness Levels (TRL) 1-5, and liaison with partners to bridge over to TRL 6 and 7. Impact statements should elaborate on the feasibility of upscaling the proposed technology to industry with potential for handling tens of thousands of tons CO₂ per year. Applicants must also estimate capture and utilization capacity of your proposed processing.

The proposal must also present the significance of the project for sustainable development, in a broad system perspective. The energy and material efficiency for the proposed technology should also be demonstrated, including an appraisal of emissions to water and air of hazardous chemicals or other materials as well as managing of critical raw materials.

Eligibility

An MRC consists of applicants from one hosting Higher Educational Institution (HEI) and applicants from one to three other HEIs or research institutes (RI), supported by at least two industrial and/or societal partners. The partners should complement each other and compensate for relative shortages.

Each HEI and each RI may be represented by its employees in maximum of one (1) application as main applicant in this call. There is no limit to the number of applications in which the given HEI or RI is represented by an employee as co-applicant. The HEI and RI are expected to be selective and make strategic framing of their centers.

The main applicant (Center Director) must have international standing as a research leader in her/his field, must be actively employed by the hosting Swedish HEI to at least

fifty percent of full time and must be prepared to assume operative responsibility for the MRC during the entire grant period.

The co-applicants are the researchers employed to at least fifty percent of full time by the collaborating HEI/RIs, including the hosting HEI. The total number of co-applicants should not exceed seven (7) persons, and gender equality must be considered in the team.

Each industrial and/or societal partner may be represented in maximum of two (2) applications in this call. Applications with industrial and/or societal partners registered in Sweden are prioritized.

International research organizations may participate only by their own means, apart from international researchers that becomes employed by the MRC through the participating Swedish HEIs/RIs.

The MRC must have a Governing Board, approved by SSF, having a majority of industrial/societal representatives. The Board, with a chair from industry/society, shall have the mandate to recommend SSF to terminate the funding, in whole or in parts, or to change the management of the MRC. A tentative Board should be stated in the application.

The MRC must assign an international Scientific Advisory Committee (SAC), proposed in the application.

A provisional Center Agreement signed by all partners will be required from the consortium behind the application, if and when it is selected for a hearing. The period for this contract is recommended to be at least three years, *i.e.*, until the mid-term evaluation.

Successful applicants should be connected internationally, for example to European Commission initiatives. For a strong impact, the proposed MRC should also be connected to research branches that are complementary to natural science and engineering sciences through collaborations.

Applications not conforming to the above eligibility criteria will not be considered by SSF. It is the responsibility of the main applicant to inform all co-applicants and industrial/societal partners, and to check the proposal for compliance before submission.

Grant

SSF-funding is available only to Swedish universities or research institutes, where one HEI is the administrative organization for the grant. The industrial/societal partners and international partners must support the MRC by their own means.

The proposed budget from SSF shall be up to 60 million SEK in total during six years.

The budget allocation from SSF will be a decision of 40 million SEK in conjunction with the MRC's start. Up to 20 million SEK will be decided and distributed by SSF after a mid-term evaluation. Three percent (3%) of the grant will be reserved by SSF for supporting utilization/exploitation efforts of the research results proposed by the Center Director.

The universities/research institutes can use the grant for salaries (senior researchers, postdocs, PhD students, *etc.*), research tools/infrastructure, and running costs according to the needs of the MRC. The application must demonstrate how the SSF grant will be adequately distributed among the HEIs/RIs, *i.e.*, with adequate budget for each organization. It must also clearly display any co-funding (in-kind, cash, lab usage, research infrastructure, *etc.*) from the industrial/societal partners.

A maximum of twenty-five percent (25%) of the overall grant may be used for salaries for the Main applicant (Center Director) and/or for the Co-applicants (*i.e.*, these individuals) taken together. However, no more than twenty-five percent (25%) of the salary of each applicant (*i.e.*, the same individuals) may be covered by the SSF grant. A maximum overhead cost of twenty-five percent (25%) is allowed.

Proposal and submission

A complete application must contain, among other data specified in SSF's online application portal, a full description of the MRC research plan and details of the relevant and complementary expertise of each of the participants. The multidisciplinary approach to the research problem should be clearly described.

Each proposal must clearly describe the international state of the art within the research area(s) addressed, and present how the MRC would be scientifically competitive and relevant to a sustainable development. In addition, the proposal should clearly state the resources available and to demonstrate that the proposed participating organizations will be effective to reach the MRC goals. The plan and potential for international cooperation and leverage should be clearly described.

The application should contain a clear account of the strategic significance of the research, including an IPR plan and a plan for utilization/exploitation of the results in Sweden during the MRC's research operations as well as after completion of the MRC.

The MRC participants must themselves propose a concise set of long/short term Key Performance Indicators (KPI) upon which the MRC can be evaluated in the mid-term evaluation. These indicators must cover scientific, managerial, and business qualities and substance as well as strategic relevance impact. Each of the KPIs should be elaborated in the research plan and tightly connected to the MRC goals.

The following KPIs are mandatory for all MRCs:

- the volume of co-authored papers by the collaborating research groups and partners
- mobility in person-years between the collaborating research groups and partners
- international presence, *e.g.*, grants from EU and/or other international initiatives (state also the starting values of these for base line)

Include a sustainability assessment of the devised technology.

The application should be elaborated jointly by all the MRC participating organizations and must be submitted by the Centre Director (main applicant). All participating organizations must attach Letters of Intent (LoI) signed by the highest management level in the organizations (head of research, or equivalent). The vice-chancellor of the hosting HEI must also sign the application.

The proposal must be written in English and submitted via the SSF online application portal at: <http://apply.strategiska.se>. Note that in order to get a complete view of all data required for submission it is necessary to consult the portal. Please log on to the portal well in advance of the deadline. Please also submit the application in due time before the deadline. When the application is submitted, the system will reject it if some data fields are missing. It is possible to submit and re-submit as needed before deadline.

Applications must be submitted by January 28, 2025, 14:00 hours CET. No additional material will be considered after this deadline, unless explicitly asked for by SSF.

Evaluation

Applications will be assessed by an evaluation committee and a hearing committee consisting of national and international experts from industry, academia, and research institutes as well as by international peer reviews.

The applications will be evaluated using the following criteria:

- Conformity to scope and eligibility as outlined above.
- Constituting an internationally leading research constellation.
- Scientific quality; originality, strengths, weaknesses, and feasibility of research plan.
- Added value of multidisciplinary and synergistic approaches.
- Degree of internationalization.
- Strategic relevance to Swedish industry and/or society as well as explicit long-term impact of the proposed research.
- Qualifications of the applicants and composition of the research team, including previous achievements (science, innovation, and entrepreneurship), international experience and networks, gender balance and leadership/management.
- Level of engagement from all participating organizations, including evidence of anchoring of the application to top management (including Letter of Intent, Lol).

Timetable

Call announced: September 2, 2024

Last date for applications: January 28, 2025, 14:00 hours CET

The applications will be evaluated in stages:

- Selection of maximum three applications for hearings **April 16, 2025**
- Hearings **May 2025**
- Selection of one application for funding. Contract negotiations.
- Decision by the SSF Board **June 17, 2025**
- Center start: From **July 1, 2025** and no later than **January 1, 2026**

Please note that the Foundation is subject to the Principle of Public Access to Official Records (*Offentlighetsprincipen*). Thus, applicants should avoid submitting material that they do not wish to be made public, e.g., information that could prevent patenting.

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