EUROPEAN SCIENCE FOUNDATION
SETTING SCIENCE AGENDAS FOR EUROPE

EUROCORES Programme
European Collaborative Research

Molecular Science for a Conceptual Transition from Fossil to Solar Fuels (EuroSolarFuels)

DRAFT Call for Outline Proposals

What is EUROCORES?

The ESF European Collaborative Research (EUROCORES) Programmes offer a flexible framework for researchers in Europe to work on questions which are best addressed in large-scale collaborative research programmes.

The EUROCORES Programmes allow excellent researchers in the various participating countries to collaborate in research projects 'at the bench'. They also allow, when appropriate, colleagues in non-European countries, for example the US, to participate. The Programmes encourage and anticipate networking and collaboration between researchers in order to achieve synthesis of scientific results across the programme, to connect with related programmes, and to disseminate findings.

The EUROCORES Programmes allow national research funding organisations in Europe and beyond to support top-class research in and across all scientific areas, by matching their strategic priorities with the needs articulated by the scientific community.

Final funding decisions on the projects and the research funding remain with the national funding organisations, based on a single international peer review process operated by ESF. Financed by the participating national Funding Organisations, ESF also provides support for networking between the researchers and for the scientific synthesis of research results and their dissemination. In this way, the EUROCORES Scheme complements the EC Framework Programme and other collaborative funding schemes at European level.

For further information see:
http://www.esf.org/eurocores

Molecular Science for a Conceptual Transition from Fossil to Solar Fuels (EuroSolarFuels)

Following agreement with XX funding organisations in *Country A, Country B, Country C, Country D, Country E, Country F, Country G, Country H, Country I, Country J, Country K, Country L, Country M, Country N, Country O and Country P* the European Science Foundation is launching a Call for Outline Proposals for Collaborative Research Projects (CRPs) to be undertaken within the EUROCORES Programme EuroSolarFuels. The Programme aims to support high quality multidisciplinary collaborative research in Europe, with involvement of leading scientists from outside Europe, when appropriate.

The research phase of EuroSolarFuels will run for three years and includes national research funding as well as support for networking and dissemination activities. The research grants are provided directly to the eligible and successful Principal Investigators by their respective national funding organisations. The networking and dissemination support, also financed by the national organisations, is centrally managed by the ESF.

Outline Proposals are to be submitted by xth March 2010. It is expected that Full Proposals will be invited by xth April 2010 with xx May 2010 as expected deadline for submission.

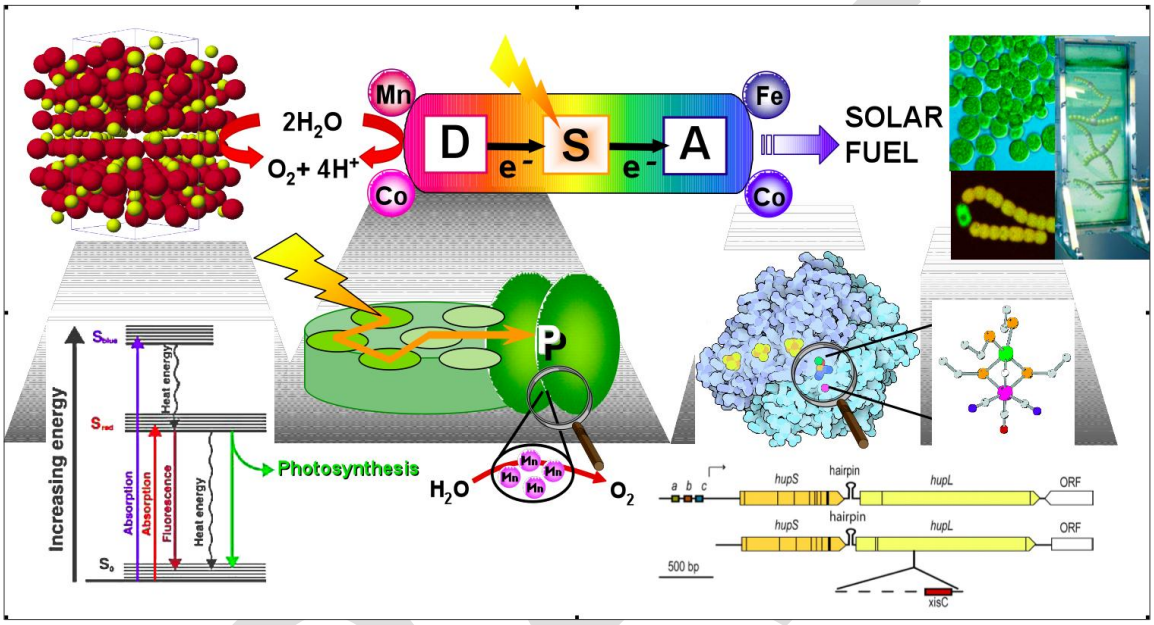
A Programme-specific website can be consulted for the latest updates at **http://www.esf.org/eurosolarfuels**

Background and objectives

Europe (and most of the individual countries) depends heavily on outside energy resources. These are dwindling and their supply can easily be jeopardized. Many dominating energy carriers are connected to environmental and social factors that clearly affect the quality of life. In particular this concerns fossil fuels with severe availability constraints, pollution problems and fast growing CO_2 emissions. Many citizens worry about large, future nuclear-power programs. Therefore, a strong need is felt for heavy development of and investments in solar energy research. The term ´'solar fuels' is becoming established since the beginning of the new Millennium. This introduction of the concept for solar fuels is spurred by worries for global warming and decreased availability of oil and gas. The promising perspective of solar fuels as important future energy carriers makes this a central theme that quickly moves up on the global research agenda. The EuroSolarFuels programme intends to accelerate the research on solar fuels on a pan-European scale.

Environmentally friendly fuel production is of strategic importance for both medium and long-term research. This is recognized worldwide and coincides with the goals of the research in this EuroSolarFuels programme. To succeed and to meet the scientific challenges, integration of science from many fields and a targeted multidisciplinary approach in chemistry, physics and biology are critical elements. The different scientific elements are described in scheme 1.

The raw material for the fuel is the second, equally important key aspect. EuroSolarFuels targets water. Thus, EuroSolarFuels gathers molecular science with the aim to provide a CO_2 lean fuel based on solar energy and water. The vision is that extensive development and increased use of solar fuels shall be a major path to follow to alleviate the effects of climate change caused by extensive use of fossil fuels.



Scheme I. Upper part: the solar fuel forming subfields (i) Right; Photobiological solar fuel production in green algae and/or cyanobacteria (ii) Middle; Artificial photosynthesis in molecular systems using a photosensitizer (S) linked to light-driven molecular catalysts made from Mn, Co and Fe, to left; (iii) Left; Nanostructured and semiconductor-based systems symbolized by the hematite (Fe) structure. Lower part: The science integrates studies of photosynthetic reactions centers (middle - Photosystem II), hydrogen metabolizing enzymes (right Ni-Fe hydrogenase). Genomics and strong (bio)physical knowledge are key elements. Shaded triangles symbolize areas created in EuroSolarFuels with fruitful synergies.

A solar fuel is always made using solar energy as the only energy source. Huge amounts of solar energy are available everywhere and often abundant where population is dense. Even in northern Europe there is enough solar energy to contribute substantially to the energy system in the summer with the long days. However, it is lacking in winter when energy demand is high. If this abundant solar energy could be converted into a storable energy carrier (fuel), solar energy could become an important energy source also in very northern countries.

The intended solar fuel can be different and there are only a few ideas for solar fuels that are pursued internationally. EuroSolarFuels assembles the available molecular science in Europe, *in vivo* and *in vitro*, that is key to advancing several promising routes for fuel production from solar energy and water. Driven by intentions in for example the European road map to the hydrogen society (where hydrogen should be non-carbon based at 2050) many scientists target hydrogen. This is a natural choice when water is the raw material. However, ideas for reduced carbon based fuels are also invited, as long as the electrons come from water and the energy comes from the sun.

Scientific goals

The aim of EuroSolarFuels is to develop molecular science to produce a CO_2 lean solar fuel to accomplish the grand challenge of phasing out fossil fuels. A key word in the research is solar energy conversion. All parts of the program aim for direct conversion of solar energy to chemical energy (a fuel). The solar fuel shall be formed from water as electron source, using visible light in direct processes involving i) Photobiological solar

fuel production in green algae and/or cyanobacteria that excrete the fuel; (ii) Artificial photosynthesis in molecular systems and (iii) Solar fuel production in nanostructured and semiconductor-based systems. To meet these goals, EuroSolarFuels has the ambition to develop solar fuels research to a powerful European field in shorter time than possible with only individual or national initiatives. The program is inclusive and joins all scientists active in relevant fields in Europe.

Research topics

Project proposals formulated in response to this call should address the general objectives outlined above. The focus should be on the following topics:

(i) Photobiological solar fuel production in green algae and/or cyanobacteria that excrete the fuel

(ii) Artificial photosynthesis in molecular systems

(iii) Solar fuel production in nanostructured and semiconductor-based systems

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(i) Photobiological solar fuel production in green algae and/or cyanobacteria that excrete the fuel

Contents/scope:

This subtopic targets molecular science where green algae and cyanobacteria harvest solar energy to directly produce a fuel as a dominating product in high yield. This fuel shall be excreted from the organism. Targeted basic research will be promoted that enhances the capacity of the organism to direct electron and energy flow to critical metabolic processes for solar fuel production. This also includes research on down regulation of complete photosynthesis/competing pathways, redesign of the light harvesting antenna, and managing environmental constraints.

The research strategies combine efforts in molecular biology, biochemistry and biophysics of relevant enzymes, metabolic engineering and synthetic biology to insert new enzymatic pathways.

Expected impact:

Successful projects shall promote fundamental science efforts towards highly efficient processes for direct solar radiation conversion into high quality fuels in living green algae or cyanobacteria.

(ii) **Artificial photosynthesis in molecular systems**

Contents/scope:

This subtopic targets molecular science where artificial photosynthesis in supramolecular systems is developed to make a fuel from solar energy and water. The system will connect a photosensitizer to molecular catalysts made from abundant elements like Mn, Co, Ni and Fe. Targeted basic research will be promoted that aims at the development of molecular photosensitizers using visible light and light-driven catalysts for water oxidation, proton reduction, or direct formation of carbon-based fuels.

The research strategies involve both biomimetic and non-biomimetic efforts for chemical design and synthesis, and biochemistry and biophysics to facilitate bio-mimetic approaches. Functional characterization and theoretical abstraction are key elements. Critical issues include light-driven proton-electron management and multi-electron catalysis. It is recognized that light-driven water splitting is a bottleneck.

Expected impact:

It is becoming increasingly accepted that a transition from fossil dependence to solar-fuels can be based on entirely man-made systems. Successful projects shall promote fundamental science efforts towards highly efficient processes for direct solar radiation conversion into high quality fuels in molecular systems.

(iii) Solar fuel production in nanostructured and semiconductor-based systems

Contents/scope:

This subtopic targets science for direct solar fuel production via photoelectrochemical water splitting in the visible range by semiconductor-supported supramolecular catalysts in composite nanostructures. The system will connect photo-active materials and catalysts (including molecular systems), both made from abundant elements avoiding sparse metals. Targeted basic research will be promoted aiming at materials capable of harvesting visible light to accomplish the generation of oxygen or hydrogen by reaction of the photogenerated charge carriers with water. The systems design and development of composites that combine molecular elements on a scale between 1-100 nm for water oxidation, proton reduction, or direct formation of carbon-based fuels will play a crucial role in enhancing the performance of these cells.

The research strategies involve identifying semiconductor materials with the desired optical and photoelectrochemical properties. To obtain

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high conversion efficiencies, it is of central importance to shape materials into nanostructures and to interface them with fast catalytic systems. Functional characterization and theoretical abstraction are key elements. Critical issues include light-driven proton-electron management and multi-electron catalysis. It is recognized that light-driven water splitting is a challenging task.

Expected impact:

It is becoming increasingly accepted that a transition from fossil dependence to solar-fuels can be based on entirely man-made systems. Successful projects shall promote fundamental science efforts towards highly efficient processes for direct solar radiation conversion into high quality fuels in nanostructured and semiconductor based systems.

***Additional information* (subtopics i, ii and iii)**

Synergistic approaches targeting and bridging several of the subtopics (i-iii) are encouraged. Advances will be accelerated from tight links with high-level biochemical and biophysical knowledge of efficient enzymes like hydrogenases and photosynthetic reaction centers. Integration of *in vivo* and *in vitro* science with the knowledge from functional natural systems is valuable.

EuroSolarFuels develops science aiming for direct conversion of solar energy to solar fuels. It does not include fuel production from biomass, the electrolysis of water, or other indirect processes. EuroSolarFuels only includes science dealing with visible light conversion into a solar fuel using water as raw material. Involved catalysts must be based on abundant elements like Mn, Co, Ni, Fe, avoiding noble metals and sparse elements where abundance limitations will prevent scale up of the proposed process.

Programme deliverables

The Programme aims at the following deliverables:

i) to build a joint continental field in molecular solar fuels research, involving a wide range of sciences with a common goal.

ii) to accelerate and focus the European science in this challenging field with global impact more efficiently than can be achieved by national or individual efforts. Each subfield (i-iii) has internal, traditional scientific milestones and these are at this stage equally important.

iii) to build upon Europe´s success in cross-border research by pooling of the national research funds. This will promote bridging from the current status of independent national programs into future Joint Programming by a bottom-up approach.

Programme synergies

The science in EuroSolarFuels is broad. All methods depend on molecular chemistry at modest temperatures and mild conditions. It is expected that much progress will be achieved in the new interfaces between seldom interacting scientists that will be involved in EuroSolarFuels.

One core activity will be to develop and exploit these synergies. This involves joint workshops between subfields where synergies are emerging or already strong. A useful development would be the creation of a European conference line.

Collaborative Research Projects in EuroSolarFuels should create multinational and multidisciplinary networks where the synergistic profile, interconnecting several subfields, is high. This is a proven method to accelerate critical scientific advances in an emerging field where not all corners in the research are “set” yet.

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Guidelines for applications

(Outline and Full Proposals)

This Call for Proposals is for Outline Proposals for Collaborative Research Projects (CRP). Proposers should be individual scientists (or research groups represented by individual scientists) who are eligible for funding from a national funding organisation participating in the EUROCORES Programme EuroSolarFuels.

Scientists or groups not applying for or not eligible to apply for funding from such an organisation can be associated to a proposal when their scientific added value can be demonstrated. Participation of Associate Partners in a project must be fully self-supporting and will not be financially sponsored by the participating funding organisations.

Proposals are only eligible if they fulfil all of the following **criteria**:

- Proposals must involve, as a minimum, three eligible Principle Investigators (PIs) from **three different countries.**
- A maximum of 50% of the total number of Individual Projects (IPs) in a Collaborative Research Project (CRP) can come from one country.
- Proposals must involve more PIs than Associated Partners (APs).

Applications should envisage three years of research. Taking into account the two-stage proposal selection and approval process (described below), the successful projects are expected to begin their research phase activities in **April 2011**.

Online submission of applications

Outline and Full Proposals will be submitted online. Applicants should follow the proposal structure as indicated in the application template for Outline Proposals available on the Programme website at:
http://www.esf.org/eurosolarfuels

Links to information on national funding eligibility and requirements as well as to a EUROCORES Glossary and Frequently Asked Questions (FAQs) are available on the Programme website.

Prior to submitting Outline Proposals, all applicants must contact their national funding organisations in order to verify eligibility and to ensure compliance with their national grant requirements and regulations. The list of participating organisations and their nominated contact persons is included on the last page of this document.

At the time of the online submission of the Outline Proposal, the Project Leader will be asked to confirm on behalf of the consortium that all the Principal Investigators in the CRP have consulted their national funding organisations and are eligible for funding from these organisations.

Outline Proposals

Outline Proposals are invited by xth March 2010.

Outline Proposals will be examined by the participating funding organisations for formal eligibility. Therefore, it is crucial that all applicants requesting funding contact their national funding organisation prior to submitting their proposals.
In compliance with the rules and regulations of the participating national funding organisations, the requested funds under the EUROCORES Programme EuroSolarFuels may include salaries for scientific and technical staff, equipment, travel costs and consumables within the project. The amounts requested from each funding organisation participating in the call must be clearly specified. National policies may also require the proposal to contain specific additional information. Applicants should be aware that the participating funding organisations can make adjustments to the requested funds in order to bring these in line with their normal grant regulations and standards.

As described below, applications will be reviewed according to specific assessment criteria in a two-stage procedure. The goal is to select scientifically excellent proposals which fit well within the scope of the programme and have significant potential to add value to its achievements.

At the outline stage, the Review Panel will select proposals based on the following criteria:

- Relevance to the Call for Proposals
- Novelty and originality
- European added value (scientific)
- Qualifications of the applicants

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An Outline Proposal must comprise:

- A short description of the CRP (max. 1200 words, including objectives, milestones, methodologies (e.g. experiments and fieldwork);
  - Short description of how (and why) the partners contributing to the CRP will work together and how their contributions will be integrated;
- Short CVs of Project Leader (PL), all PIs and Associate Partners, including five most relevant publications (max. one page each);
- Estimated budget (consistent with the rules of relevant national funding organisation), tabulated according to a provided template.

Associated Partners (APs) are also considered part of a CRP and will be assessed as such at both the Outline and Full Proposal stage.

It will be assumed that arrangements for the handling of Intellectual Property Rights (IPR) will be in place within projects, following the applicable national legislation and national funding organisation's regulations. Applicants are strongly urged to have such arrangements in place, covering all research groups (including any associated groups) before the start of the projects. It is expected that the results obtained by the projects supported under this EUROCORES Programme will be placed in the public domain, through standard scientific dissemination activities.
It is also expected that compliance with all other relevant national or international regulations on research (for example ethics) will have been affirmed before funding is granted. It is the responsibility of applicants to clarify any such matters (if applicable) with their national contact points.

Full Proposals

Full Proposals will be invited following the recommendations of the Review Panel. The deadline for Full Proposals will be announced later, but is expected to be around xxth May, 2010.

Please note that only applicants who have submitted an Outline Proposal can submit a Full Proposal.

For the Full Collaborative Research Project (CRP) Proposals, the most important selection criterion is "scientific quality". Other criteria include interdisciplinarity (according to the scope of the call), qualifications of the applicants, level of integration and collaboration, feasibility and appropriateness of methodologies, European added value, relation to other projects (complementarities versus risk of overlaps and double-funding) and suitability of the requested budget.

The Full Proposals will be assessed by at least three independent external expert referees selected by the ESF. The expert referees are selected from a pool of scientists suggested by the participating funding organisations, the Review Panel and the ESF office. The names of all referees used in the international peer review of EUROCORES programmes, together with the names of those who have contributed to the peer review process in other ESF instruments, will be published on the ESF website once in a given year.
The referee reports will be made available (anonymously) to the applicants for their information and if necessary for their comments and clarifications. The Review Panel will rank all Full Proposals based on the assessment of the Full Proposal, the anonymous referee reports and the applicant's responses to these.
The Review Panel will create a rank-ordered list of the strongest Full Proposals and will subsequently make recommendations to the Management Committee for the funding of these proposals. The Management Committee assigned to each programme comprises representatives of all the participating funding organisations.

The actual granting of the funds to the Individual Projects will be based on the Review Panel's ranked list. The funding cut-off will be determined based on the total amount of funds available in each participating Funding Organisation and how the Individual Projects figure on the list. The use of funds in a project will be subject to the national requirements and regulations of each participating Funding Organisation.

Full proposals must include sound and well-argued scientific cases both at the level of the consortium's collective objectives and in terms of the expected contributions of each of the Individual Projects in the consortium. Full Proposals must also include a list of all participants and their contact information and shorts CVs, detailed tabulated budgets for the

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whole CRP and for each project within it. Full Proposals could include other necessary supporting information. A coherent and common scientific case must be made throughout the proposal to demonstrate a collective and collaborative aim and for scientific synergy and integration of multinational expertise. In addition, the amount requested from each national funding organisation has to be clearly and separately specified. Detailed instructions on requirements and how to complete the application forms will be made available when inviting Full Proposals.

The **Project Leader** (PL) will be the main point of contact between the ESF and the CRP for the whole duration of the project. He/she will be responsible for the flow of information and communication between the ESF and all the participants in the CRP. The PL will represent the Collaborative Research Project in relation to its participation in programme activities and for the fulfilment of reporting requirements for the CRP as a whole and for the contributions of the individual Principal Investigators in the CRP.

In addition to their normal scientific and collaborative activities within the CRP, all **Principal Investigators** will be responsible for dealing with the requirements concerning the contributions of their national funding organisation, and for supporting the Project Leader in the overall progress of the CRP, including organising and participating in networking activities and in the fulfilment of reporting requirements.

Programme Structure and Management

Programme Structure

The overall responsibility for the governance of each individual EUROCORES programme lies with a *Management Committee*, whose members include one representative from each participating funding organisation in the programme (usually a senior science manager), together with an ESF representative.

Proposal assessment and selection are the responsibility of an international, independent *Review Panel*. The members of this panel are leading scientists, appointed by the ESF following suggestions from participating Funding Organisations. The membership of the Review Panel will be available on the Programme website for information. The Review Panel is also expected to monitor the overall scientific progress of the programme.

The Scientific Committee is formed by the Project Leaders of all funded CRPs and will be responsible for the overall scientific progress of the programme, including for the preparation of a work plan for the overall programme activities, including networking and dissemination. The Scientific Committee will also advise and support the EUROCORES Programme Coordinator in the coordination of the programme.

Programme Networking

Networking activities are designed to strengthen the scientific objectives of the EUROCORES Programme by promoting coherence and synergy in the activities of the scientific community involved. This will help to produce the European added value which is a main objective of all EUROCORES Programmes.

Networking and collaboration within EUROCORES Programmes take place at two levels:

1. Between the various Individual Projects within each Collaborative Research Project (CRP) (intra-CRP activities), and;
2. Between the funded CRPs in the programme (cross-CRP activities).

The intra-CRP activities must be supported through the individual research grants the participants receive from the national funding organisations in the given CRP.

The cross-CRP activities are centrally funded by the ESF through contributions from the participating organisations to the EUROCORES Programme.

The intra-CRP collaboration is motivated by the nature of the CRP's research objectives, i.e. by the scope and the complexity of the questions it deals with. In a CRP, the participating groups have the opportunity to gather the required critical mass to successfully address the objectives and challenges of their project.

The cross-CRP networking and collaboration is inspired by the aims and the nature of the EUROCORES Programme as a whole. The themes of EUROCORES Programmes are selected because they demonstrate a clear need for collaboration in the proposed field. The funded CRPs will collectively establish and streamline

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this new collaboration. To this end, the CRPs will engage the programme participants and, when of clear benefit, colleagues from outside the programme in joint activities such as:

- Programme-wide meetings or conferences;
- Working group meetings for the exchange of information and results across the CRPs;
- Joint scientific meetings or summer schools;
- Short term visits;
- Development and delivery of joint training programmes;
- Seminars, workshops, symposia, invited sessions either stand-alone or as part of other larger events;
- Common web-facilities and publications.

Through active participation of scientists in the above mentioned activities, not only can existing collaborations be enhanced, but new and strategic partnership opportunities may also be identified.

Furthermore, these activities may provide opportunities to explore aspects of the programme which are not covered by the funded research projects.

The integrating activities between the CRPs should help to strengthen the field by building coherence within the existing and emerging research communities and will serve as platforms for the dissemination and outreach of the research conducted in the programme.

Project members are expected to participate annually in at least one cross-CRP activity.

When submitting your proposal, please note that the costs for networking within your CRP should be included in your proposal as part of the costs of meetings, travel and subsistence. Funds for networking between the CRPs will be centrally managed by the ESF through contributions from the participating funding organisations.

Programme evaluation

A mid-term evaluation involving the Review Panel will assess the overall progress of the Programme. The Review Panel may also comment on the CRPs' work plan in relation to the objectives of the overall Programme. A final evaluation at the end of the Programme will assess the overall achievements of the whole EUROCORES Programme.

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Contacts in the participating organisations

As it is currently not known which Funding Organisations will support this programme, please contact your National Funding Organisation or Research Council to inquire about this programme.

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[1] The European Science Foundation (ESF) provides a platform for its Member Organisations to advance European research and explore new directions for research at the European level.
Established in 1974 as an independent non-governmental organisation, the ESF currently serves 80 Member Organisations across 30 countries.

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