ACADEMY OF FINLAND

RESEARCH, DEVELOPMENT AND INNOVATION PROGRAMME ICT 2023: Energy-efficient ICT systems of the future

DECEMBER 2017 CALL TEXT

Applications for this thematic call of the Academy of Finland can be submitted in the Academy's online services as of 1 November 2017. **The call closes on 14 December 2017 at 16.15 local Finnish time.** The deadline is non-negotiable. The call is a single-stage call.

The Academy's preliminary funding budget for this call is a total of 5 million euros. The funding to be distributed through this call depends on the Finnish Parliament's decision to allocate the necessary funds to the Academy of Finland in its budget for 2018. Tekes, the Finnish Funding Agency for Innovation, will not open a parallel call for business-related projects, but Tekes funding is available under this theme through Tekes' normal application process (see www.tekes.fi/en/funding).

Research, development and innovation programme ICT 2023

The research, development and innovation programme ICT 2023 is jointly coordinated by the Academy of Finland and Tekes. The aim of the programme is to further improve Finland's scientific expertise in computer science and to promote the extensive application of ICT. The programme is based on the report *21 Paths to a Frictionless Finland* by the ICT 2015 Working Group.

Energy-efficient ICT systems of the future

Moore's Law, the prediction made by American engineer Gordon Moore that the number of transistors on integrated circuits doubles approximately every two years, still applies. However, there is a fairly general consensus today that Moore's Law will end by the early 2020s. Integrated circuit design has been facing difficulties since about 2004, due to power consumption and cooling challenges. This has led to a need to limit clock speeds and switch to parallel computing, and all transistors on a given circuit cannot be used simultaneously. More important than the number of transistors is the energy efficiency of the transistors and the logic gates and the real number of transistors and gates that can be operated at maximum clock speed.

In the field of electronics, CMOS (complementary metal-oxide-semiconductor) technology is the mainstream when it comes to constructing integrated circuits. There is as yet no valid alternative technology to CMOS. There are fundamental limits to the construction of integrated circuits (e.g. Landauer and Heisenberg), which means that the construction costs become too high. Energy management is important also because of the cooling challenges involved. There will be battery-powered base stations, because the size of the cells will continue to shrink and the need for base stations will continue to increase. Ambient-energy-harvesting systems too will become more common, whereby the power level will depend on the size of the harvester and the availability of energy (solar, wind, pressure, etc.). The size of the possible harvester also depends on the size of the base station.

Energy is required not only for various kinds of equipment but at all layers of the Open Systems Interconnection (OSI) model as the volume of computing increases. The application layer together with the physical layer, including possible screens, will consume a particularly large amount of energy. Algorithms, software and software architecture have considerable effects on energy efficiency. These effects cannot always be predicted, since more powerful (i.e. faster) software does not necessarily consume less energy. An important selection criterion for the 5G systems to be introduced in the early 2020s is the energy efficiency of the network (number of bits carried per energy unit, bit/J).

Energy efficiency is a major challenge also in many internet applications (e.g. Internet of Things). Measuring, transferring, processing and storing large datasets require energy-efficient solutions at all levels. The need for new energy sources further increases in particularly challenging conditions (e.g. cold and hot, hard-to-reach and dangerous conditions).

Thematic areas

This is a targeted call aimed at funding basic research and new research initiatives into the energy-efficiency of ICT systems. Examples of research topics:

- co-design and optimisation of energy-efficient algorithms and software and equipment architecture, tools for design and optimisation
- energy efficiency in battery-powered, long-life (10–15 years) systems
- energy-autonomous equipment and systems
- energy-efficiency-related optimisation, trade-offs (spectral efficiency, delay, reliability, information security) and overall control
- energy consumption models for algorithms, software and equipment.

Who is eligible to apply?

If you want to apply for targeted Academy Project funding, you must (in addition to being the principal investigator of the project) be a researcher at the professor or docent level.

If you do not have an employment relationship with, for example, a university or research institute, you must give an account of how your salary will be covered during the funding period. If your status changes after you have submitted your application, please notify us immediately. These details must be accounted for in the application.

The funding can be applied for by both individual research projects and consortia composed of two or several research teams. Applicants may submit only one application for ICT 2023 funding, including as consortium PI or consortium subproject PI.

Please see the general application guidelines in the Academy of Finland's September 2017 call text.

Consortium applications

If the applicant is a consortium, see detailed guidelines on our website under Guidelines for consortium application. Please note that consortium PIs can submit the consortium application only after all consortium subprojects have completed their applications. The non-negotiable call deadline also applies to consortia. Consortium compositions cannot be changed after the call deadline has expired.

Appendices to application

The obligatory appendices are listed in Appendix 1 A of the Academy of Finland's September 2017 call text. If the project involves cooperation with businesses, the application must also include a collaboration plan. The guidelines are available below.

Business collaboration

If the project involves business collaboration, that collaboration must be clearly indicated in the research plan. In addition, the application must include a collaboration plan as a separate appendix to the research plan.

Collaboration plan (no more than three pages):

- List all project parties.

- Describe the collaboration as well as the management and research duties included in the project.
- Describe the mechanisms by which the project will integrate all participating organisations and individual researchers.
- Describe, if relevant, the implementation of intersectoral researcher exchange.
- Define each PI's required input to the project, and justify why each party's expertise is necessary to achieve the project's objectives.
- Describe the complementary roles of the parties involved, and explain which research results can be jointly utilised by the participating companies.
- Describe the application potential of the results.
- Make sure that the collaboration plan's length and details are proportional to the size of the project. The plan should be extensive enough to ensure that the project parties will work together as one whole.

The potential business collaboration is entered on the application form under *Partners/Collaborators*. In the Academy's online services, enter as consortium parties only parties that are applying for funding from the Academy.

If the project involves business collaboration, please also see section 10.1 of the Academy's general conditions and guidelines for funding.

How applications are reviewed

In reviewing applications and making funding decisions, in addition to the Academy of Finland's general review criteria for research programmes (see Review criteria on the Academy's website), particular attention will be paid to the following issues:

- international engagement
  - attracting top-level young, talented researchers from abroad to Finland or hiring researchers who have recently come to Finland to work on the project
  - research visits by Finnish researchers to leading-edge foreign universities and research institutes
- business collaboration
  - cooperation between universities, research institutes and business companies
  - problem-setting in research
  - application potential of results
- intersectoral mobility of leading-edge researchers
  - mobility from universities to business companies
  - mobility from business companies to universities
- use of universities' and research institutes' own resources to carry out research
  - use of resources of the site of research and the partners
  - level of commitment and funding contribution by the site of research.

The applications will be reviewed by an international panel of experts. The reviewers will use the Academy's review form for Academy Programmes.

The threshold rating for Item 1.1 (Project's relevance to the programme) is 4 on the scale from 1 to 6. If an application fails to meet this requirement, the review will be discontinued and the applicant will only receive feedback on Item 1.1.

If an application does not receive at least rating 4 for Item 1.2 (Scientific quality and innovativeness of research plan), the review will be discontinued and the applicant will receive feedback only on Items 1.1 and 1.2.

Applicants may be invited for interviews during the review process.

Funding

When you apply for targeted Academy Project funding, you apply for funding to hire a research team. Academy Project funding can be used to cover both direct and indirect research costs of the research team arising from, for example, the following:

- working hours (salary)
- research
- travel
- national and international collaboration and mobility
- work and researcher training abroad
- preparation of international projects
- publishing (e.g. costs of open access publishing).

Draft the application so that the Academy's contribution to funding comes to no more than 70% of the estimated total project costs. Read more on our website under Full cost model.

The funding period is three years. As a rule, the funding period will start on 1 September 2018.

How to apply

This call is a single-stage call. The non-negotiable deadline for applications is 14 December 2017 at 16.15 local Finnish time. Draft the application in the Academy's online services. Select *Open calls* > ***ICT 2023: Energy-efficient ICT systems of the future***.

Programme coordination

The PIs of the projects are required to

- assume responsibility for and report on the scientific progress of the project and on the use of the funds in accordance with the Academy's instructions
- ensure that the whole research team attends all events organised by the programme coordinators, and facilitate exchange and cooperation between research teams in the programme
- take part in producing reviews, syntheses and information material around the programme, and actively disseminate information about the programme's progress and results on public and scientific forums.