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## Smart infrastructure maintenance

### Funding call for a research programme

<b>Expected programme budget</b>	A total of SEK 70 million over four years.
<b>Mistra's financial contribution</b>	Up to 70% of the total programme budget, subject to a maximum of SEK 49 million.
<b>Co-funding</b>	At least 30% of the total programme budget.
<b>Length of research proposal</b>	Maximum of 40 pages + appendices (CV and certificate from programme host)
<b>Research proposals to reach Mistra not later than</b>	Monday 4 December 2017 at 4:00 pm. The application should be sent to mail@mistra.org as a single PDF file.
<b>Appendices</b>	<ol style="list-style-type: none"><li>1. <i>Prestudy: Research and development in infrastructure maintenance</i> IQ Samhällsbyggnad</li><li>2. International experts' recommendations concerning the prestudy</li><li>3. <i>Allowable costs and co-funding in Mistra projects</i></li><li>4. Budget template.</li></ol>
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## Smart infrastructure maintenance

### **Funding call for a research programme**

*The Swedish Foundation for Strategic Environmental Research (Mistra) invites research groups, jointly with relevant stakeholders in the community, to submit proposals for a new research programme. It should address the question of how to optimise maintenance of physical infrastructure, in the form of water and sewerage installations, roads and railways, to yield the greatest possible benefit both now and in the future. Ownership and the parties responsible for operation and maintenance differ among the various types of infrastructure, and this is a key starting point for the research programme. The research should aim to bring about efficient use of resources over the entire life cycle and to foster ecologically, socially and economically sustainable development. Scope for linking maintenance and refurbishment of existing infrastructure with investments in new infrastructure is to be analysed. Uncertainty and risks, and how these can be managed, will be taken into account. The programme will focus on condition assessments, forecasting and decision support, financing and business models, and processes and organisation. Opportunities of rationalising maintenance by using new technology, such as sensors and automation, should permeate the programme.*

### **Background**

There is a great need to establish stable, secure and long-term provision of knowledge and skills for maintaining infrastructure that is critical to society, such as water and sewerage (WS) systems, roads and railways, with their associated buildings and structures. Inadequate skills and knowledge are a threat to society, since infrastructure in disrepair has substantial negative effects on the economy and the environment. While investments in new infrastructure are emphasised, maintenance issues are often neglected. This applies to organisations and public debate alike. For recently graduated engineers and other occupational categories to be recruited, jobs in maintenance at public agencies and in companies must become more attractive.

WS systems, like most of the urban street network, are a municipal concern. The municipalities generally have no research funds of their own. Nor do they have the same resources as the central government to acquire expertise and benefit from research and development (R&D). It is therefore especially urgent to develop knowledge and build up skills that may be advantageous to the municipalities.

In 2016, Mistra commissioned a pre-study on 'Research and development in infrastructure maintenance' (Appendix 1) from the Swedish Centre for Innovation and Quality in the Built Environment (IQ Samhällsbyggnad). This pre-study has been scrutinised by international experts with academic expertise in the area. Four of these experts met in Stockholm on 7 March 2017. There, following an in-depth discussion, they issued joint recommendations to Mistra on the focus of this call for proposals (Appendix 2). The present call is based on IQ Samhällsbyggnad's pre-study and the international experts' assessments and recommendations.

### **Focus**

The research programme will focus on maintenance of existing infrastructure. It will adopt a comprehensive approach to Sweden's infrastructure, concentrating on WS installations, railways and roads. These three categories of infrastructure need not be treated in equal detail, but they must all be included. Municipal infrastructure must constitute an essential part.

Although every form of infrastructure can be separated into various items on which maintenance operations are performed, these items combine to make an extensive, complex system that is, in turn, connected with other technical systems and society at large. The programme must therefore have a systemic approach.

Construction and refurbishment of infrastructure usually require heavy energy and resource inputs. Infrastructure in general has a considerably longer service life than consumer goods, for example; but a life-cycle perspective must be applied to infrastructure as well, and we must think in terms of circular economy and resource efficiency. The design phase, when the potential service life and scope for effective maintenance are determined, is key. Design also affects the scope for resilience to manage disruptions due to such causes as climate change, and the degree of flexibility to allow modification as new needs arise in society. Well-maintained infrastructure can be used for longer, and use of new resources can thus be postponed. Simultaneously, existing infrastructure may impede restructuring of society – from vehicle transport to other forms of mobility, for example. The programme should be capable of providing knowledge for scenarios and models that indicate courses of action for strategic decisions on infrastructure.

The programme must contain the following research areas:

#### *1. Assessing the state of infrastructure*

An ability to take the right maintenance measures at the right time requires information about the state of existing infrastructure. It also calls for knowledge of how its state and performance are connected with society's present and future needs. Research must focus on what kind of knowledge is needed for planning and decisions; how to collect and assess the necessary information; and how new technology can serve this purpose.

#### *2. Forecasting and decision support*

For planning and decisions on maintenance measures, analytical tools and forecasting methods are needed. Research must concentrate on appropriate ways of making forecasts, both for single installations and for entire systems; modelling of infrastructure systems that take into consideration current and future performance and resource requirements; adoption of optimal strategies; how new technology can be exploited; and how to coordinate maintenance work efficiently in time and space. Possible changes in needs for infrastructure in the future due, for example, to climate adaptation, transport-policy goals and digitisation of society must be taken into account.

#### *3. Financing and business models*

Infrastructure has traditionally been seen as primarily a responsibility of the state or, regarding WS installations, the municipalities. Austerity measures in the public sector and a rising degree of privatisation change the picture. Around the world, there are examples of new solutions to finance and manage infrastructure. Research must focus on future financing opportunities, public-sector innovation procurement, the importance of various types of contracting agreement and how the public and private sectors can best cooperate, i.e. public-private partnership (PPP). The option of financing and assuming responsibility for maintenance and refurbishment of existing infrastructure combined with building new infrastructure (or new urban districts) should be considered.

#### *4. Organisation and processes*

Many people in the sector believe that the biggest problems of infrastructure maintenance are not technical in nature but, rather, due to shortcomings in organisation and control. The research should be oriented towards advantages and disadvantages of various forms of organisation; structures and processes; coordination among organisations; incentive structures; and indicators. It should also look at how organisations need reforming to more rapidly adopt and use new technology, such as digitisation and automation.

The weighting given to these four areas may vary, but they must all be included in the research programme and be well integrated with one another. Sustainable development (including ecological, social and economic aspects), uncertainty and risks, and the opportunities afforded by new technology must permeate the programme and be integrated into the areas listed above.

The programme should be planned to take four years but have an eight-year perspective. It is expected to be interdisciplinary and transdisciplinary. Academia's collaboration and communication with the central government agencies, municipalities and private and publicly owned enterprises that manage WS systems and the road and rail networks are expected to be well developed and capable of bringing about concrete results. Sector and interest organisations, too, should be associated with the programme. It is very important to involve all the business partners right from the planning stage and onward throughout the whole research process.

The programme must develop knowledge and establish skills for improved maintenance of Swedish infrastructure. It should also help to enhance the status of maintenance issues and make employment in maintenance in agencies and companies more attractive. The focus should be primarily on methodological development and system know-how. The programme should not involve performance of tasks that are the responsibility of agencies or private operators, such as collecting data on the status of infrastructure or forecasting. Although the research is oriented towards Swedish conditions, it must be innovative in an international perspective.

This funding call is part of an initiative, on the theme of circular economy, that includes both existing and planned Mistra programmes. Dialogue, sharing of experience and, where relevant, collaboration among these programmes are expected. There are also connections with Mistra's programmes on the theme of climate where collaboration should be sought.

#### **Who can apply?**

This call addresses research groups in all academic disciplines working at Swedish higher education institutions, research institutes and companies, as well as purchasers in the business and public sectors and civil society. Researchers and organisations active outside Sweden may participate, but the principal applicant and planned programme host must be a Swedish institution.

The host organisation and other organisations taking part are expected to be coordinated in a consortium and to submit a joint proposal.

## Special conditions

1. Co-funding at 30% of the total programme budget, from companies, sector organisations and government agencies, for example, is required. The co-funder's contribution may be partly in kind, such as staff involved to assist in the programme. The co-funding requirement is based on experience showing that commitment and integration in the programme are enhanced when more than one organisation contributes resources. The co-funding expected must be reported in the proposal and attested with a certificate from the planned programme host. Mistra favours further co-funding over and above the 30% requirement.
2. Current rules concerning indirect costs: see Appendix 3.

## Application process and review

The programme proposal must be written in English, except for a summary in Swedish. It should comprise the following parts and appendices, and must comply with the specified page limits. If the proposal exceeds any of the page limits it will not be processed. No other appendices other than those specified below may be attached.

The main part of the proposal (a maximum of 40 pages) must include the following parts:

### Summary in English and Swedish

1. Vision, aims and expected impact
2. Scientific, including state-of-the-art, value of the programme
3. Benefits of the programme to society
4. Organisation of the programme
5. Skills and networks
6. Description of component projects
7. Deliverables
8. Communication
9. Budget (use the budget template, Appendix 4).

The following appendices must be attached:

- I. CVs for up to 10 key people (maximum of one page per person)
- II. Certificate from planned programme host.

Note that the programme proposal must clearly specify the following: (a) preliminary programme title, (b) planned programme host, (c) planned programme director and (d) contact person for the proposal, with full contact details.

Although 40 is the maximum number of pages for the main part of the proposal, reaching this number is not a target as such. Writing concisely and readably is in every applicant's interest. If approved, the proposal will serve as the basis of the plan steering the programme.

A certificate should be attached to the proposal confirming that the planned programme host (and also the main applicant) is prepared to assume the role of hosting the programme and to make the requisite resources available, and also accepts Mistra's rules regarding indirect costs. The planned programme host must also certify that pledges on co-funding have been obtained and match the revenue budget reported. This certificate must be signed by the Vice-Chancellor,

Chief Executive or equivalent (or the person appointed by the Vice-Chancellor or Chief Executive in his or her stead).

It should be noted that heading a Mistra programme is normally a full-time commitment and that every programme is expected to have a communicator. Read the section on 'Managing Mistra programmes' (under 'About Mistra'), at [www.mistra.org](http://www.mistra.org).

Mistra intends to award research funding for one (1) of the programme proposals submitted. It is not possible to apply for funds for individual projects within the scope of this call.

Note that Mistra is subject to the principle of public access to official records. This means that all documents received by Mistra, including proposals, are public. On certain conditions, information may be treated as confidential.

The proposal should be sent as a single PDF file (including appendices) by email to [mail@mistra.org](mailto:mail@mistra.org), to reach Mistra not later than Monday 4 December 2017 at 4:00 pm.

### **Evaluation criteria**

All the proposals will be evaluated according to the following criteria, in which the potential for solving environmental problems and the expected contribution to sustainable development are crucially important:

1. Approach, i.e. how far the programme has a central, coherent idea and an innovative direction, how well the aims are formulated and how well the anticipated effects are reported (including indicators).
2. Scientific quality, i.e. how well the programme meets the high requirements in terms of skills, theoretical standards and methodological quality.
3. Benefits, i.e. how well developed the collaboration with users of the research results is (and is expected to be) and which supportive communication processes and methods will be used to attain effective implementation.
4. Management and organisation, i.e. the manner in which the programme will be integrated in the host organisation, how it will be governed and structured, and to what degree it will make efficient use of resources.
5. Competitiveness, i.e. the ways in which the programme has the potential to help promote Sweden's competitiveness and prosperity in a broad sense.

**Time schedule**

June 2017	Call opens
4 December 2017	Call closes
December–February	Evaluation of proposals
March 2018	Award decisions taken by Mistra's Board
1 July 2018	Programme start (preliminary)

**Contact**

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