Call for proposals within the programme Electricity from the sun – Full call text

General information

The Swedish Energy Agency calls for proposals within the research and innovation programme “Electricity from the sun”. The available budget is approximately SEK 30 million. This call welcomes project proposals within all programme areas. The closing date for applications is **31 March 2017 24:00.**

The aim of “Electricity from the sun” is to contribute to the conversion to a renewable energy system through research and development regarding solutions, systems and issues related to the production of electricity from solar irradiance.

The programme shall contribute to the following impact goals:

- **Resource-efficient and system-friendly expansion of solar electricity**
  In 2030, solar electricity provides a significant contribution to the Swedish energy system, and expansion is resource-efficient and contributes to attractive sustainable communities. Relevant knowledge that is useful for planning processes and regulatory design is disseminated and used. Solar electricity contributes several added values for both users and the electricity system, such as greater robustness and new system services. Together, this supports a cost-effective, environmentally friendly and system-friendly implementation in Sweden.

- **Solar innovations that are utilised on several markets**
  In 2030, Sweden has a strong innovation environment in the area of solar electricity at both component and system levels, which leads to internationally competitive products. New products and services are permeated by long-term sustainability perspectives – ecological, economic and social.

- **Excellent research**
  Sweden’s strong position in research and development within the programme’s various strategic research and innovation areas is maintained or enhanced by 2030. Sweden has several groups with world-leading research and innovation, which partly finds expression through publications of very high quality and through relevant international research collaboration.

The call is addressed to all actors, both public and private, which can contribute to the achievement of programme objectives by means of research, development and innovation projects. The call welcomes project proposals specialising in both humanities and social sciences and in technology and natural sciences as well as interdisciplinary project proposals.

Note that the programme only covers projects directly related to solar electricity production and that the programme does not include the research and development of components for thermal electricity production that are not specific to thermal solar electricity. Nor does the programme include projects concerning solar heating and solar fuel since these technologies are not for the purpose of electricity production. As the novelty value of a project is one of the call's assessment criteria, it is important that you check that your project proposal differs from projects already approved. You will find already approved projects here.

The Swedish Energy Agency wants to promote diversity and gender equality and therefore would like to see these issues observed in the composition of the project group, in the choice of project manager and in the project's implementation, content and desired effects.

Time plan and reporting

Projects that are granted aid can start no earlier than 1 July 2017 and continue no later than 31 December 2020. Decisions regarding received applications are planned no later than during week 26.[1]

Note that all projects that are granted aid are obliged to report on project progress and finances upon request by the Swedish Energy Agency, and to submit a final report for the project to the Swedish Energy Agency. This report will be made openly available via the Swedish Energy Agency's project database. Since the report is a compulsory part of the project, it is important to set aside some time for writing the report.

Conditions for granted projects

The Swedish Energy Agency's decision regarding aid is based on an agreed project and cost plan. In order for aid to be disbursed to granted projects, the beneficiary must confirm that it has taken note of the Swedish Energy Agency's decision and that it accepts the conditions for the aid. A more detailed description of the conditions is found in Bilaga 1 - Villkor för beviljade projekt.

In addition to the conditions described in the appendix, there might also be further conditions concerning, for example, forms for the dissemination of results or the appointment of reference groups.

[1] If the proposed project is a continuation of a project that has already been granted aid from the Swedish Energy Agency, a decision might be issued after week 26. In this case, the project's start date must also be postponed since the project may not commence before a decision has been made.

The call's categories and assessment criteria

Applications within the call for proposals are to be submitted within one of the following categories. Please note that all category-specific requirements must be fulfilled.

Category A - Innovations

This category covers projects for the development of new products, processes, services or concepts in the area of solar electricity. These may have the aim of commercial application or use, but it is not a prerequisite. Routine or periodic changes made to existing products, production lines, manufacturing processes or services are not included. Commercialisation is also not included.

Category-specific requirements	The project group must be part of at least one organisation through which commercialisation or other utilisation is intended to take place. A reference group of intended users must be appointed. All project activities are to be categorised as experimental development or industrial research pursuant to Ordinance SFS 2008:761 in the Swedish Code of Statues.
Maximum permitted funding level for the project as a whole	50%
Maximum permitted funding amount per project	SEK 4 000 000

Category B – Research and studies

This category covers projects that do not have the direct aim of commercial application or use, but have the goal of using increased knowledge and skills to contribute to the expansion of solar electricity in Sweden or globally, in the long or short terms. Projects within this category can have potential in the longer term to lead to innovations that can be commercialised and some patents can be sought for the results produced in the project, but the results are mainly to be made public.

Category-specific requirements	The results from the project are to be made public to a great extent. All project activities are *either* to be categorised as basic research or industrial research pursuant to Ordinance SFS 2008:761 in the Swedish Code of Statues *or*

	implemented completely without the aim of commercial application or use.
Maximum permitted funding level for the project as a whole	100%
Maximum permitted funding amount per project	SEK 6 000 000

Funding level refers to the proportion of the project's total eligible costs financed by the Swedish Energy Agency. The maximum permitted funding level for the project as a whole is based on the project's total eligible costs. In addition to this, the maximum possible funding level per participating organisation is limited by Ordinance SFS 2008:761 in the Swedish Code of Statues. Read more about which costs are eligible and which funding levels that are possible under the heading Projektets budget och stödnivåer or under Legal prerequisites for receiving aid on the Swedish Energy Agency website.

Assessment criteria

The projects will be assessed on the basis of the following criteria.

- *The project's potential to contribute to one or more of the programme's impact goals*¸ including the need for and benefits of the project's results.
- *The project's novelty value and/or degree of innovation*, such as the extent to which new knowledge is produced or existing knowledge is implemented in a new context, how the project relates to the state of international knowledge, how unique the project is, the novelty value of an intended product and the product's potential value on a market.
- *The project's potential for utilisation and dissemination* through e.g., knowledge building, publications, new products, services, processes or commercialisation.
- *The project's feasibility*, such as whether participants have the right expertise for the project, whether there is a clear plan for implementation, reporting of existing risks and how these are managed and whether the goal and budget are reasonable.

The application shall clearly explain how the project fulfils the assessment criteria.

How to apply

Applications shall be written in accordance with Instructions for application and submitted via the Swedish Energy Agency's electronic application tool E-channel.

Since it can take a few days to have your user permission approved, the application should be made well in advance.

The project application shall be written so as to enable those who are not familiar with the subject to understand what the project is about. The application shall describe the project's energy relevance and contain clear interim and final goals. The goals should be measurable and formulated in such a way that they can be fulfilled over the course of the project. The project description shall also contain background and analysis of the research front, the state of the market or knowledge, method description, cost calculation, summary budget and plan for the dissemination of results.

The application shall in the first instance be written in Swedish. However, applications within Category B are to be supplemented with a summary in English describing the project in 3-6 pages. The text shall be written so as to enable those who are not familiar with the subject to understand what the project is about. A Swedish text is to be supplemented with an English summary and vice versa. Appended files may cover no more than 20 pages.

Applicants do not have the right to supplement their application after the call for proposals has closed. It is therefore important that the application is filled in completely before submission. The Swedish Energy Agency may, however, request supplements as necessary.

The full application shall be submitted no later than 31 March 2017 at 24.00.

Decisions regarding funding

All applications will be assessed by experts who are not employed at the Swedish Energy Agency. The experts make a recommendation to the Swedish Energy Agency concerning which projects they recommend to be funded, and this forms a basis for decisions made by the Swedish Energy Agency. When a decision has been made concerning the applications received, information is sent out to the applicants about the decision made and the reasons for this. Decisions regarding received applications are planned no later than during week 26.

The project's budget and funding levels

The maximum permitted funding level is assessed for each beneficiary individually on the basis of the costs that are eligible. If a project contains elements that do not constitute research or development, or if the project contains costs that are not eligible, these are not to form a basis for the calculation. In addition to the maximum permittable funding level per beneficiary, the total support per project is also limited by the selected category. Read more about categories under The call's categories and assessment criteria and about eligible costs and aid intensities on the page Legal prerequisites for receiving aid on the Swedish Energy Agency website.

The funding level described below are the maximum permitted. However, the Swedish Energy Agency might grant lower levels. The project's cost is always weighed against its benefits when received applications are prioritised in relation to each other.

Note that an application may not include activities that have already been started.

Organisations engaged in an economic activity

The maximum permitted basic funding levels are 100 percent for basic research, 50 percent for industrial research and 25 percent for experimental development. When the applicant is a small or medium-sized enterprise, the funding level may be increased by 20 and 10 percentage points, respectively.

Under certain circumstances, a supplement of 15 percentage points may be given when the project constitutes an actual collaboration between enterprises or between enterprises and research and knowledge-dissemination organisations (see Commission Regulation (EU) No 651/2014).

Organisations not engaged in economic activity

Organisations that are not enterprises are not subject to the above limitations on funding levels. These organisations can thus be granted funding up to 100 percent of their eligible costs. In this context, enterprise refers to any entity engaged in an economic activity regardless of the entity's legal form and regardless of how it is financed.

A description of the terms is given in Bilaga 2 - Beskrivning av begreppen.

Co-financing

Co-financing can consist of e.g., cash or in-kind contributions in accordance with The Swedish Energy Agency's guidelines for in-kind contributions.

The determining of funding amounts must take into account other state aid granted for the same purpose. The total funding may not exceed maximum permitted amounts and levels pursuant to European Commission Regulation (EU) No 651/2014. If the project has financing in the form of other state aid, this is to be added to the funding sought from the Swedish Energy Agency when the funding level is calculated.

Programme background

The aim of "Electricity from the sun" is to contribute to the conversion to a renewable energy system through research and development regarding solutions, systems and issues related to the production of electricity from solar irradiance.

The programme aims to maintain or enhance Sweden’s strong position in research and development, to ensure that Sweden has a strong innovation system in the area of solar electricity that is utilised by Swedish performers and to ensure that solar electricity production in Sweden makes a significant contribution to the Swedish energy system. The programme thus targets research, development and implementation of solar electricity and related issues.

The programme covers seven research, development and innovation areas: high-efficiency solar cells; competitive thermal solar electricity; innovative flexible solar cells and building-integrated photovoltaics; integration in the electricity system; integration in attractive and sustainable cities; the prosumer perspective; and resource efficiency, the environment and sustainability.

The programme is run by the Swedish Energy Agency in the form of an internal programme. The first stage of the programme runs for the period 05/06/2016 to 31/12/2020 and covers a total of SEK 160 million.

Contact

Linn Sjöström

016-542 06 43

Maria Olsson

016-542 06 29

Appendix 1- Conditions for funded projects

The conditions that apply to funded projects are listed in the Swedish Energy Agency's funding decision. A description of the conditions follows below.

General conditions

The Swedish Energy Agency's funding decision is based on an agreed project plan and budget. The part of the costs not covered by funding from the Swedish Energy Agency shall be covered by resources or funds provided by another financier. The beneficiary is responsible for covering the extra costs that occur during the project period. When the Swedish Energy Agency's funding decision covers funding outside of the current financial year, the decision only applies provided that the Swedish Energy Agency receives/has at its disposal the required funds in the following years.

The shifting of costs between cost categories is accepted up to 10 per cent within each cost category, provided that the total budget does not change. Larger changes require approval from the Swedish Energy Agency.

§ 1 Payment of grants

The grants are disbursed without a requisition form, in the middle of the project period for each budget year, unless otherwise stated in the funding decision. Grants only cover value added tax when it occurs as net cost for the beneficiary (only applies to universities and university colleges). Verifications for accounted expenditures must, upon request, be submitted to the Swedish Energy Agency. Funds that have not been used shall be repaid. Advances can be provided, up to 30 per cent of the total grant provided (only applies to universities and colleges). 15 per cent, or another percentage set out in the funding decision, of the grant provided can be withheld until final reporting in accordance with § 4 has been submitted and approved by the Swedish Energy Agency.

§ 2 Employer relationship

The Swedish Energy Agency is not the employer or principal of the beneficiary or anyone else he/she engages in the project. Accordingly, the Swedish Energy Agency does not make deductions for taxes, social security contributions, etc.

§ 3 Notification obligation regarding other funding

The beneficiary is obliged to immediately notify the Swedish Energy Agency in writing, if funding for the project in the application process have been applied for or granted by anyone other than the Swedish Energy Agency.

§ 4 Reporting obligation

Reports and surveys as set out below shall be submitted in accordance with the Swedish Energy Agency's instructions. If additional special reports are required, it is stated in the funding decision.

Annual report
Universities and university colleges are obliged, for each budget year, at the request of the Swedish Energy Agency, to submit annual reports concerning the complete activities of the department and/or research team.

Progress report
The progress report concerning the project's activities shall be provided at the request of the Swedish Energy Agency. The progress report shall include a description of the existing activities and results of the project as well as a financial reporting. In addition, the Swedish Energy Agency may request that the report shall include a technical status report. The progress report shall be submitted to the Swedish Energy Agency at the latest on the date stated in the funding decision.

Financial Accounting – only applies to companies
Financial accounts shall be submitted once or twice a year using a specific form provided by the Swedish Energy Agency or downloaded from the Agency's website (www.energimyndigheten.se). The account shall be submitted at the latest on the date stated in the funding decision.

Final report
The final report shall include the project results and contain a description of the implementation of the project and the fulfilment of objectives. Furthermore, the report shall contain a summary of the project results in English of no more than 200 words. The report shall be submitted to the Swedish Energy Agency at the latest on the date stated in the funding decision.

A specific final financial accounting shall be submitted no later than on the date stated in the funding decision using a specific form provided by the Swedish Energy Agency or downloaded from the Agency's website (www.energimyndigheten.se).

Survey

As a beneficiary, you need to complete a survey at the end of each year and submit this to the Swedish Energy Agency. We collect, on behalf of the Government, details from all beneficiaries in order to present a number of results in the form of indicators form in our annual financial statement.

§ 5 Changes

Significant changes within project and budget approved by the Swedish Energy Agency must be reported in advance to the Swedish Energy Agency for evaluation and approval. The beneficiary must immediately notify the Swedish Energy Agency if circumstances of significant importance occur that result in the cancellation or delay, etc. of the project. The beneficiary is obliged to immediately report any changes in name or address.

§ 6 Publication

The project results shall be published. Publication shall take place in accordance with international best practice for the publication of research results.

The beneficiary is entitled to protect the results by patents or other intellectual property rights and in doing so postpone publication until any application for such property rights has been submitted to the relevant patent office. The Swedish Energy Agency must be notified if the beneficiary intends to protect the results. Applications to the patent office must be submitted without delay. The written approval of the Swedish Energy Agency must be obtained in each individual case if the beneficiary wishes to delay publication for reasons other than those stated above or refrain from publishing certain results.

All presentations of the project must state that the work has been conducted with the support from the Swedish Energy Agency (when presentation is held in Swedish, the name should be reproduced as Energimyndigheten).

§ 7 Rights to results

The beneficiary or the rights holder of the results has the commercial right of use of the project results and is entitled to make available or transfer the rights to others.

If the rights to the project results are transferred to a company that runs economic activities, compensation corresponding to the market price for the rights shall be paid (only applies to universities and university colleges).

§ 8 Right to review

The Swedish Energy Agency or person/persons appointed by the Swedish Energy Agency (e.g. certified accountant) are entitled to follow-up the work and study documents that can provide information about the technical and economic development of the project. The Swedish Energy Agency is entitled to issue special instructions for reporting in order to enable the review.

In addition, the Swedish Energy Agency has the right to follow-up completed projects through requesting follow-up reports, that are to be structured and submitted in accordance with the Swedish Energy Agency’s instructions. Such reports can be requested on three occasions within a ten-year period as of the day of the final report.

§ 9 Amendment to the decision

At the request of the beneficiary, the Swedish Energy Agency may grant well-motivated amendments to the project.

§ 10 Annulment of the decision

The Swedish Energy Agency may decide that unused funds shall be withheld alternatively that disbursed funds, that have not been used, shall be repaid if:

a) the conditions for the project’s financing have changed

b) the project is not run according to the agreed project plan

c) there is no prospect of achieving a satisfactory result within a reasonable timeframe (for example, due to significantly changed project or market conditions) or if the project's planned continuation cannot be considered secure (for example, due to insolvency in case the beneficiary is a company)

d) the beneficiary fails to sign and resend a copy of the conditions appendix to the Swedish Energy Agency.

§ 11 Recovery of amounts paid

The disbursed grant along with interest rate of 8 % (eight per cent) above the applicable reference interest rate may be reclaimed with immediate effect if:

a) the beneficiary does not provide the obligatory reports according to § 4

b) the beneficiary uses the grant for purposes other than what is stated in the agreed project plan

c) the project is not run according to the agreed project plan

d) the beneficiary does not otherwise satisfy the obligations according to the conditions in this Appendix or the special conditions in the funding decision.

§ 12 Retention of grant

The Swedish Energy Agency is entitled to stop further payment of funds until a decision is made to refuse payment or to reclaim granted funds according to paragraphs 10 and 11. Such a stop to further payment of funds may affect payments to other projects administered by the same department, company or corresponding administrative unit, if the Swedish Energy Agency so decides.

§ 13 EU State aid rules

As a condition for aid, funding measures may be repealed or changed and the grant reclaimed if the European Commission through judgements which have entered into force or the Court of Justice of the European Union has found the aid to be unlawful pursuant to Article 107 of the Treaty on the Functioning of the European Union. The decision to repeal or change the funding measures is taken by the Swedish government. In this context the conditions for repayment of aid are determined in each individual case.

Consent pursuant to the Swedish Personal Data Act and concession to making information available.

The Swedish Energy Agency makes information about projects financed by the Agency available on the Agency's website: www.energimyndigheten.se. Here the general public can search for information about on-going and completed research projects based on different keywords, such as research subject, research organisation, project title, project manager.

As the project manager and authorised signatory sign the conditions, the project manager agrees to publishing personal data (name and organisation), and the authorised signatory to non-confidential information and reports of the project, on the public domain on the Agency's website. The beneficiary is responsible for that the copyright holder has given its consent to this publication and shall ensure that the copyright holder is entitled to enter agreements in each individual case.

Public documents and secrecy

Essentially all post and e-mail sent to the Swedish Energy Agency become public documents. Among other things, this means that the public and mass media may request to view their contents. Official letters and decisions sent from the Swedish Energy Agency are also public documents. The right to view public documents is part of the Public Access to Information and Secrecy Act, and the Freedom of the Press Act.

However, the Swedish Energy Agency is not permitted to disclose information covered by secrecy in accordance with the Public Access to Information and Secrecy Act. This means that a document or certain information in a document may be protected by secrecy. A secrecy assessment is therefore made on a case-by-case basis before a document is disclosed.

Secrecy applies to information on an individual's business or operating conditions, inventions or research findings, for example, if it can be assumed that the individual will suffer damages if the information is disclosed.

Appendix 2 - Description of the terms

Enterprise	An enterprise is considered to be any entity engaged in an economic activity, irrespective of its legal form. This includes, in particular, self-employed persons and family businesses engaged in craft or other activities, and partnerships or associations regularly engaged in an economic activity.
Small and medium-sized enterprises	The assessment of whether an enterprise is small, medium or large mainly considers the number of employees, turnover and balance sheet total. It is data from the latest approved accounting period that are to be taken into account. For commercial enterprises, the data can often be obtained from the annual report most recently registered by the Swedish Companies Registration Office. In order for a threshold to be considered passed, the enterprise shall have had higher or lower values for two consecutive years. A small enterprise may not have more than 50 employees and a medium-sized enterprise may not have more than 250 employees. The term employee here refers not only to salaried workers but also to owners working in the enterprise without being employees and consultants who are in a position of dependence on the enterprise, such as when an assignment constitutes the consultant's entire and sole activity. Students on work experience in the enterprise and employees on parental leave are not to be included in this. A small enterprise's annual turnover may not exceed EUR 10 million. For medium-sized enterprises, the annual turnover may not exceed EUR 50 million and the annual balance sheet total may not exceed EUR 43 million. Also relevant to the category to which an enterprise belongs might be the enterprise's relationship to other enterprises, primarily owners, and the degree of control exercised by such enterprises. The provisions in this respect are complicated. Such control can be exercised through means including a high ownership share, provisions in shareholder agreements or in other agreements between, e.g. owners and creditors.

Basic research	Experimental or theoretical work that is primarily aimed at the acquisition of new knowledge of the basic causes of phenomena and observable facts and that does not have the aim of any direct commercial application or use.
Industrial research	Planned research or critical investigation aimed at the acquisition of new knowledge and skills for developing new products, processes or services or for bringing about a significant improvement in existing products, processes or services. It comprises the creation of components parts of complex systems, and may include the construction of prototypes in a laboratory environment or in an environment with simulated interfaces to existing systems as well as of pilot lines, when necessary for the industrial research and notably for generic technology validation.
Experimental development	Acquiring, combining, shaping and using existing scientific, technological, business and other relevant knowledge and skills with the aim of developing new or improved products, processes or services. This may also include, for example, activities aiming at the conceptual definition, planning and documentation of new products, processes or services. Experimental development may comprise prototyping, demonstrating, piloting, testing and validation of new or improved products, processes or services in environments representative of real life operating conditions where the primary objective is to make further technical improvements on products, processes or services that are not substantially set. This may include the development of a commercially usable prototype or pilot which is necessarily the final commercial product and which is too expensive to produce for it to be used only for demonstration and validation purposes. Experimental development does not include routine or periodic changes made to existing products, production lines, manufacturing processes, services and other operations in progress, even if those changes may represent improvements.

Appendix 3 - Description of the programme's focus areas

Innovative flexible solar cells and building integration

Sweden has good opportunities to develop an industry around flexible solar cell products for building integration. Today, Sweden has excellent research within several solar cell technologies that has the potential to make a cost-effective contribution to new areas of use. Besides this, there is a strong construction industry with several enterprises operating on a global market.

Solar cells can be varied in many ways to allow a more flexible use. Bendable, differently coloured, transparent or extremely thin solar cells provide new opportunities for architects and property developers. Increasing the opportunities for flexible application also increases the opportunities for building solar cells in such a way that their design contributes to a clear added value and architectural quality. Examples of use are in solar cell façades, sunshades for windows and prefabricated roof elements.

Building integration is currently a strong trend, with a newly started working group within the IEA PVPS and with several interested enterprises. There are also interesting applications for vehicles (e.g. cars or trucks) and fixed installations (e.g. canopies over parking areas or noise protection). It is probable that integrable solar cells will go from niche market to mass market within a few years.

However, building integration places great demands on the products in that they must meet both requirements on construction components (e.g. water resistance, insulation) and requirements on solar cells (e.g. electrical safety, efficiency). As the buildings have such a long lifespan, the construction components must also as far as possible meet these lifespan requirements.

High-efficiency solar cells

Cost-effective solar cells with high efficiency could dramatically alter the field in the area of energy. Since a large part of the total costs for solar cells is linked to the size of the surface (such as installation costs, cabling, encapsulation), the efficiency, i.e., the solar cell's surface efficiency, is of great importance to the end customer's costs.

A high efficiency can be obtained by combining several layers in what is known as a multi-junction solar cell. The layers absorb different wavelengths and can be constructed of completely different types of material. For example, a molecular solar cell can be combined with a silicon solar cell.

Sweden has leading research teams that are working to make high-efficiency solar cells possible at competitive prices. A major challenge for new technologies is that current silicon solar cells have gained a kind of momentum through their great expansion. All the sectors involved have become accustomed to the

products, and it is therefore relatively easy to acquire project capital for major investments.

To enable new technologies to compete, the actors in the industry need to enhance the bankability for these actors. This should be done early in the innovation process through various kinds of demonstrations and long-term tests, preferably in collaboration with different types of actors that do not necessarily need to operate in the solar cell industry.

Historically, high-efficiency solar cells have been used in exceptional applications, such as satellites or the demonstration of extremely light solar cell aircraft. Achieving the programme objectives requires actors in this area to aim for efficiencies above what is possible with standard silicon solar cells, but with prices that do not exceed these. Then high-efficiency solar cells can become more common also for more down-to-earth applications.

Competitive thermal solar electricity

Stirling engines have become a Swedish speciality. There are currently a number of innovative enterprises in Stirling-based thermal solar electricity that already have exports to various countries with high solar irradiance.

Since the technology requires concentrating sunlight by means of optics, and that this works best in countries with high direct solar irradiance, this programme area is more focused on industrial development and technology export than on application in Sweden.

More development of components and systems is needed for thermal solar electricity to become really competitive. It is also important to look at the entire system, including energy system integration, energy storage, service and maintenance.

Attractive and sustainable communities

By simply using Sweden's best suited roof surfaces, between 20 and 40 TWh of solar electricity can be produced every year. Building-integrated photovoltaics (BIPV) entails opportunities to integrate electricity production in buildings, with a minimal negative impact on people and the local environment. According to studies by the SOM Institute, solar cells are the electricity production type that most people prefer[1]. Solar energy therefore has an important role in the conversion to sustainable cities and communities.

A series of research questions are becoming increasingly important the further solar cell expansion progresses. For this reason, the place of solar cells in architecture and sustainable transport systems needs to be studied in its context, as does the user perspective for various target groups. In certain sensitive

[1] [1] *Åsikter om energi och kärnkraft* [Opinions on energy and nuclear power], Report no. 2016:04, Per Hedberg and Sören Holmberg, SOM Institute, 2016.

environments, there is a need for knowledge of special consideration in the planning and design of the systems.

The interaction between solar electricity and urban planning is also important, such as the question of which opportunities and obstacles there are for large-scale solar electricity in both urban and rural areas. If solar cells already come in at the urban-planning phase, the orientation of roofs can, for example, be made more advantageous from a solar energy perspective.

Solar electricity in the electricity system

One of the programme's objectives is for solar electricity to become more system-friendly. Countries including Germany and Italy have seen some problems with electricity quality when solar electricity's share of total electricity production has increased. In the long term, potential risks to the national electricity systems are also seen with regard to balancing and fast frequency changes. There is thus a need for research, innovation and dissemination of knowledge in order to facilitate the integration of electricity systems, both in Sweden and globally. Swedish products could improve the opportunity to maintain cheap and reliable electricity infrastructure in developing regions, such as through a combination of micro-grids, solar cells and smart demand control.

There is a need for research studies on an increased share of solar electricity in the Swedish electricity system that are based on the latest international research findings. The parameters that could be studied include the geographical and temporal dimensions of solar electricity production, synergies with other types of energy, storage and transport systems, technical and economic conditions for smart control.

Research could, for example, also show how to calibrate inverters and substations in order to optimise the system for resource-efficient electricity production. There is a strong link to smart grids, digitalisation, flexibility and robustness/secure electricity. However, several questions about the role of solar cells still need to be clarified.

Innovation within new products and services can facilitate added value for grids and users, such as diagnostics, statistics and quality follow-up of installations. Besides this, there are system benefits at a higher level, e.g. it will be possible to monitor solar cell expansion more closely.

Prosumer needs

The programme involves an investment in interdisciplinarity and the link between technology, people and rules of the game. The area includes perspectives from the humanities and social sciences that give central place to the production and use of solar electricity by people and organisations.

For example, we need more knowledge of how people and organisations use solar electricity today and of what are important aspects (such as rules of the game and

user patterns) to take into account in order to promote a greater dissemination of solar electricity.

As regards economy, there is a strong incentive to raise the value of solar electricity by increasing the level of self-use. Some studies have been performed in this area, but more knowledge is needed. Also welcomed are comparative studies (both in time and space) of the incentives and rules of play for self-use in different countries and of the lessons that can be learned from the development of other technologies. Greater knowledge of the rules of play and the consequences of policy instruments creates greater opportunities to design policy instruments more appropriately, thus contributing to the programme's vision and objectives.

Resource efficiency with a focus on the environment and sustainability

This area runs as a cross-cutting priority over all areas and is to permeate both activities and projects within the programme. Projects within the programme should be designed from the perspective of resource-efficiency (e.g. by avoiding toxic and rare substances in products and through resource-efficient and safe installations). The programme portfolio should also include projects with a system perspective, such as life cycle analysis. Further research is needed on how to calculate environmental and climate benefits from solar electricity and more knowledge and solutions for recycling and reuse.