Physical Sciences
STW Technology Foundation
National ICT Research and Innovation Authority (ICTRegie)

Smart Energy Research

Part of the NWO theme Basic Energy Research
Call for research proposals

The Hague, December 2009 (version 18 December 2009)
Netherlands Organisation for Scientific Research

Contents

1 Introduction

The NWO Physical Sciences, STW Technology Foundation and the National ICT Research and Innovation Authority (ICTRegie) boards invite researchers to submit applications to the 2009 call of the Smart Energy Systems research programme.

The Smart Energy Systems research programme is a joint initiative of the NWO Division for Physical Sciences, STW Technology Foundation and the National ICT Research and Innovation Authority (ICTRegie), supported by NWO's Governing Board. It is part of the NWO Theme Basic Energy Research, and addresses the energy savings and sustainability improvements by employing smart ICT systems.

A maximum of € 6 million has been made available for this call to foster research in this area.

2 Aim

The Smart Energy Systems programme aims to provide solutions for sustainability along two paths:

- *by using ICT* in order to reduce and control energy consumption in e.g. logistics, mobility, health care, lifetime-robust housing, and to enable and control decentralized energy generation, and
- *by reducing the energy consumption within ICT*, in order to reduce CO_2 emission, global warming, and to more efficiently utilize scarce energy resources and improving sustainability.

Scope of the call

Based on proven strengths in relevant Dutch research areas the following lines of research in the programme have been selected:

Smart ICT methods for energy saving, storage and generation in buildings. The research challenge is to minimize energy consumption in offices and homes e.g. using sensor networks for energy monitoring and control. For this line of research new intelligent real-time (on-line) scheduling, planning and control software plus related hardware control options need to be developed.

Smart control systems for flexible electricity networks. The generation of energy on a small scale and in a decentralized manner leads to grid topologies, that might result in increasingly complex electrical power supply networks. In order to guarantee current key performance and reliability figures of electricity systems huge challenges are created, amongst others: modelling and simulating these complex networks, visualisation techniques, developing software agent technology for maintaining the equilibrium between energy supply and demand, developing smart control systems, guaranteeing correctness and safety of the control systems, and guaranteeing stability, reliability and economic efficiency of the electrical power transmission and distribution networks in a market context.

Energy reduction in processing and storing of information. Given the fast growing amounts of information which are essential for running our society, huge volumes of data need to be processed and stored in data centres, digital libraries, etc., entailing fast rising energy consumption. Following worldwide green IT initiatives all over the world, research is needed to realise more efficient signal processor architectures and data storage strategies, addressing both the hardware and the software aspects, e.g. programming of parallel architectures with hundreds of programmable cores in an energy-efficient way. From the software point-of-view, also, energy-efficient cloud computing mechanisms can contribute to energy saving.

Energy reduction in communication networks. Exchanging these large amounts of information puts heavy demands on our communication networks, and ways need to be found to master the increasing energy consumption for the transport and routing of the data streams. A wide range of challenges arise here: a.o. technologies for provisioning of capacity and of Quality of Service tailored to actual user needs, always-on or event-controlled access connections, smart power-efficient interfaces (incl. intelligent sleep modes), power-efficient data packet routers, resource-efficient interworking of wired and wireless networks, battery-efficient user terminals.

Compartments

Researchers may submit proposals in two different ‘compartments’:

1. Application oriented research
2. Curiosity-driven research

Compartment 1, Application oriented research

Proposals submitted in this compartment should be demonstrably geared towards the application of proposed research in industry or society.
Granted projects are supervised by Technology Foundation STW.

Compartment 2, Curiosity-driven research

Proposals submitted within this compartment, prompted by theoretical scientific questions, may focus on any aspects of the four research areas described above.
Granted projects are managed by NWO Physical Sciences.

The assessment procedures and criteria applicable to the assessment of proposals in both compartments are described in section 4.
The intention is that the total available budget of 6 M€ is divided into two equal parts, with a minimum of 2.4 M€ and a maximum of 3.6 M€ for each of the compartments.

3 Guidelines for applicants

3.1 Who can apply

Applications may be submitted by researchers affiliated to Dutch universities and to NWO and Royal Netherlands Academy of Arts and Sciences institutes. The application should be submitted by one researcher (the main applicant) who is employed (assistant professor – UD, associate professor – UHD or Full professor) at one of these research institutions. This can be on behalf of a team of researchers.

Applicants should send a copy of their application to the director or dean of their institution. NWO will assume that applicants have informed their institution of their application, and that your university or institute accepts the grant terms and conditions of this competitive round. Applicants should also:

- have at least a doctoraal, ingenieur or equivalent qualification;
- have sufficient research experience;
- be in a position to remain effectively involved in the research to which the grant application refers for the duration of the period for which the grant is being requested.

Applications submitted by female candidates would be particularly welcome.

3.2 What can be applied for

The maximum amount available is € 6 million (one call). The programme will mainly subsidise research positions. Two categories of the projects are distinguished: smaller projects involving at least one researcher and a budget up to € 400,000 and larger projects involving at least two researchers and a budget up to € 750,000. A condition for the larger projects is that they have to be collaborative projects. These projects must involve two or more researchers who are employed at different research institutions.

The grant can be used to fund:

- Full-time trainee research assistants (AIOs) and/or two-year or three-year postdocs.
- Other non-scientific staff involved in the proposed research (such as programmers etc)
- Activities and equipment to support the proposed research, provided their total costs are lower than the cost provided for the salaries of researchers. The equipment must be intended exclusively for the project described in the proposal. The need for the equipment and its relationship to the project must be well substantiated;
- Travel expenses associated with the research;
- Travel and accommodation costs for guest researchers from other countries whose input is relevant to the research;

For further clarification of all of the above listed we refer to the appendices 6.4 and 6.5.

3.3 When can applications be submitted

The application procedure has two phases:

- A mandatory pre-proposal phase in which abridged research questions (pre-proposals) are submitted. The guidelines for this phase are set out in appendix 6.2. The abridged applications must be submitted before noon on 8 March 2010.
- The detailed application phase. The assessment committee will invite applicants to submit a full application. The guidelines for full applications are set out in appendix 6.3. Full applications must be submitted before noon on 24 May 2010.

3.4 Drawing up an application

All proposals (both pre-proposals and full applications) should be written in English so that foreign reviewers can be consulted. Applicants are invited to use the application form, which can be downloaded from the programme website. The proposal should be a complete document, and reference to any internal documents should therefore be avoided. Only references to the 'open literature' are permitted. Further information on how proposals should be structured can be found in sections 6.2 and 6.3.

3.5 Specific conditions

Simultaneous submission of identical or highly similar proposals is not permitted.

Successful applicants must begin their research within twelve months of the date of the grant award. Applicants who fail to do so can have their grant withdrawn.

3.6 Submitting an application

Applicants should use Iris, NWO's online grant application system. Please see https://www.iris.nwo.nl for instructions on how to use the system. The same procedure applies for the submission of the pre-proposals and full proposals.

An application consists of two parts: a fact sheet listing key data on both the applicant and the proposal, and the research proposal itself. The fact sheet should be completed and submitted online using Iris in three steps. In the first step, you are asked to give a summary of no more than 250 words, which is in the case of the full proposals identical to the English summary in the research proposal. For compartment 1 proposals you should add a similar summary of the utilisation. In the second step, you should verify your details. The third step allows you to add any co-applicants. This fact sheet will be sent to the assessment committee. The fourth step required by the Iris application system is submission of the research proposal. The research proposal should be sent as a PDF attachment.

The **fact sheet** must be completed using only ASCII symbols (plain text). It will not therefore be possible to use formulae, italics, quotes etc. They may, however, be used in the **research proposal**.

Iris helpdesk is put at the applicant's disposal during the submission process: iris@nwo.nl or 0900 - 696 4747 (11:00 – 17:00).

Reviewers

You are requested to suggest three potential foreign reviewers for your application. Please give their full name and their website and email address. Only reviewers who have no involvement with the research team and application are eligible. The assessment committee will also be asked to suggest reviewers. The SES office determines which people qualify as a reviewer and will ask them to review the application. It will consider to select reviewers from the pool of names.[1]

Experts from both science and society will be involved as reviewers. The reviewers from society are specialists coming from companies, knowledge institutes, government, etc. Societal reviewers will be involved especially when both scientific quality and utilization will be evaluated.

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[1] It is also possible (but not required) to submit the names of the (maximal three) persons who are not allowed to review. To guarantee the confidentiality you are required to submit your suggestions for the referees and non-referees per email to the programme office and **not** embedded in your application.

4 Assessment procedure

4.1 Procedure

4.1.1 Procedure for assessing pre-proposals

Based on the pre-proposals, a pre-selection will take place. The goal of the pre-selection is to select the best ranked pre-proposals (of which the sum of the requested budgets does not exceed 24 million euro) that will be invited to submit detailed proposals in the second round.

The scientific assessment of pre-proposals is carried out by an assessment committee. That committee, consisting of an international group of researchers from universities or industry, will determine whether the pre-proposal is in scope (appendix 6.1) and select and prioritise the ones suitable for a full application. Next to the scope, the assessment committee will assess the potential for innovative research, (and utilisation, for compartment 1) and the composition of the research team of the pre-proposals.

Within one month of submission of the pre-proposal applicants will receive the recommendations of the assessment committee, stating whether or not they are invited to proceed with a full application. The assessment committee may suggest that applicants intending to work on the same subject submit a joint application. The committee may also advise applicants to submit an application in the other compartment in the next phase.

4.1.2 Procedure for assessing detailed proposals

The procedure for the assessment of the detailed proposals submitted to both compartments is common. The assessment committee will rank the detailed proposals submitted in both compartments, taking into account the views of international reviewers and any rebuttal received from the applicants. The assessment committee will formulate a granting advice for the decision body (‘beslissingsorgaan’). The decision body will make the final decision about grants.

The assessment committee members will individually grade all proposals in both compartments, taking into account the external review and the rebuttal of the applicants prior to the assessment committee meeting. Based on these marks, rankings will be made for the compartments 1 and 2. The rankings are input to the meeting of the assessment committee. In this meeting, the proposals and rankings will be discussed. This will lead to the final rankings. Best ranked projects will obtain a positive granting advice until a total budget of 2.4 million euro is reached for each compartment. The remaining projects are compared in a third (common for the two compartments) ranking based on the average mark. The projects in the top of this ranking can obtain a positive granting advice up till the total programme budget of 6 million euro is reached, regardless to which compartment they belong.

If the average mark of the project is not sufficient (3.4 on the full grade scale from 1=excellent to 9=poor) the project will not be granted, regardless of the position on the rank list.

The programme committee can deviate from the above scheme for particular projects for reasons of fit in the programme and/or the programme’s coherence.

4.1.3 Decision-making

Representatives of the participating NWO divisions, as well as the Netherlands ICT Research and Innovation Authority and STW will make up the programme's decision body ('beslissingsorgaan'). The representatives of the divisions in the decision body are mandated to decide to grant the proposals in the SES programme.

4.2 Criteria

Applications are assessed on the following criteria:

1. scientific quality,
2. innovative character and
3. relevance, for compartment 2 (see 4.2.2) or
4. utilisation, for compartment 1 (see 4.2.3).

For applications in compartment 1, criteria 1 and 2 and 4 will be graded and the final mark will be extracted by the formula average(average(1,2),4). For applications in compartment 2, the criteria 1, 2 and 3 will be graded and all three will be weighted equally: the final mark will be calculated based on the formula average(1,2,3).

Compartment 1 aims at application oriented research and therefore it is mandatory to describe the utilisation aspects of the proposal. The full proposal should have a utilisation summary as well as a research summary and some dedicated sections on the utilisation plan, see sections 6.2 and 6.3. Proposals in compartment 1 will get two marks of the assessment committee, one for scientific quality and innovative character and one for utilization. In the ranking of the proposals in compartment 1, both marks will be weighted equally.

Compartment 2 aims at more basic, curiosity driven research. Still, this kind of research can have good utilisation perspectives. Those efforts will be evaluated through the relevance criterion, where thus either only relevance for science or relevance for both science and society can be described .

Proposals in both compartments will be ranked separately, but by a single assessment committee.

4.2.1 Official admissibility of applications

The programme office will not process any pre-proposal or full application to which one or more of the following applies:

- the application form has not been correctly or fully completed and the applicant has failed to respond to a request to rectify the situation;
- the application has not been submitted by a researcher at a recognised scientific institution;
- the application is not consistent with the objective of the programme;
- the application was not submitted online via Iris;
- the application was submitted after the deadline;
- the application does not meet the requirements of this call for proposals.

As soon as the situation has been rectified and the application can be declared officially admissible, it will be processed.

4.2.2 Scientific assessment

Full applications will be assessed by the assessment committee on the basis of their **scientific quality and innovative character,** for both compartments, and **relevance** in case of the Compartment 2 .

The **scientific quality** of the proposed research will be assessed on the basis of the following characteristics:

- the scientific significance of the proposal;
- the clarity of the objective;
- the competence of the research team, including in terms of cross-border research;
- the plan of work and its feasibility;
- the relationship between the research goal and the funding requested;
- the added value of the collaboration with other research groups;
- the urgency of the proposed research.

The **innovation** of the proposed research should lead to new concepts, deeper understanding or new methods. A proposal's innovative character might lie in new applications for existing methods and techniques, or in the development of new techniques.

The **relevance** of the proposed research will be assessed on the basis of whether it has a bearing on the challenges of the research theme. The potential impact of the research on science or society could be high. Some potential for long-term utilisation could also be here included.

In the event that several proposals occupy an equal position in the final ranking, preference will be given to proposals in which one or more researchers are named and available for appointment, or in which the main applicant is a woman.

4.2.3 Utilisation

For all proposals submitted in compartment 1, the utilisation will be assessed. Proposals should aim at application of knowledge as well as excellent research. The sum of activities increasing the chance of usage of research results is called utilisation. Applications in compartment 1 promote the utilisation and the transfer of knowledge to potential users.
Users of the research are defined as persons, companies or institutions (national or international) outside the research area itself who might apply the results of the research. A distinction can be made between direct users of the project results, usually companies, and end users. Solely identifying a single category of users is not sufficient.
Users can be actively involved in the application, reflected in the description of the research, the plan of work and the roles that users take in the project. Active input can involve a financial or in kind commitment.
During the project a committee of users of the project results (the users committee) will make sure that the focus remains on both utilisation and scientific quality. The (potential) users should be mentioned in the utilisation paragraph of the proposals in compartment 1.

4.3 Composition of committee

Both pre-proposals and full applications will be assessed by an international assessment committee made up of representatives of universities and industry. Membership of the committee will depend on the number and heterogeneity of the applications. The members of the committee will be listed on the website at a later stage.

The committee will assess the proposals individually on the relevant criteria. Based on the resulting rankings it will formulate an advice which proposals to grant and which not. In this advice it will take into consideration whether individual proposals fit within the programme or not. It will also consider the coherency of the programme. Based on these considerations its advice can deviate from the rankings.

5 Other information

5.1 Contact details

For further information please contact:
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The following persons are involved in this call for proposals:
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5.2 Documentation

You can download this call and other information from the Smart Energy Systems website: www.nwo.nl/ses

5.3 Timetable

18 December 2009	Launch of call
8 March 2010	Deadline for submission of pre-proposals
29 March 2010	Announcement of results of pre-proposal round
24 May 2010	Deadline for submission of full applications
1 September 2010	Applicants receive reviewers' comments and are given the opportunity to respond ('rebuttal')
8 September 2010	Deadline for submission of rebuttal
30 September 2010	Letters of award and rejection sent out

6 Appendices

6.1 Scope of the Smart Energy Systems programme

Over the past two decades, information and communications technology (ICT) has become the glue that holds our economy and our society together. Without the use of ICT, no government can function, no factory nor bank nor shop can operate, neither goods nor passengers can be transported efficiently, no stock market can operate, no salary check can be paid, and so on. On top of that, ICT has given us new ways of working, communicating and accessing information, thereby revealing the potential to create a larger degree of welfare for a larger number of people than ever before.
Unfortunately, there are also downsides. The energy consumption of ICT systems is rising at a frightening rate, thus putting an increasing pressure on already rapidly diminishing natural energy sources. Today the consumption of electricity by ICT amounts to some 156 GW, which is 8% of the global electricity consumption, of which only the Internet usage (data centres, network equipment and personal computers) already consumes some 4% [1]. It is widely expected that the share of ICT in the worldwide electricity consumption will grow further in the foreseeable future. According to various estimates, the present trends may cause the share of ICT in the worldwide consumption of electricity to become anywhere between 11% and 20% in 2020 [12].

Although much of the worldwide increase in electricity consumption is attributed to ICT, the same ICT technology can also be used to reduce the worldwide energy consumption. Efficient ICT systems can, for example, be used to control the consumption, production, transportation, and storage of electricity (smart grids). Next ICT systems can be used to control and schedule large electricity consuming and producing appliances in an optimal way.
Therefore, ICT plays an increasing role in reducing the energy intensity of the economy, thus helping to decouple growth from energy consumption and creating new opportunities while saving the environment.

Research in this programme may include issues such as e.g.

- flexible ICT systems for (decentralized) electricity management
- technologies and tools for dependable ICT systems that continue to operate when elements fail in the electricity network (smart grids),
- smart self-organizing and efficient communication systems which offer communication services at the capacity and quality tailored to actual local communication demands,
- versatile multi-purpose energy-efficient ICT systems and communication infrastructures which can handle a wide range of (future) services and safeguard sustainability, and
- energy context-aware systems which integrate real-time information from (wireless) sensor networks and external information sources such as weather forecasts.

6.1.1 Strategic Position, Scope and Ambition Level

In March 2007, the European Council agreed on an action plan on European energy policy. The plan sets new, binding targets for the reduction of greenhouse gas emissions from energy consumption. These will be met through increasing the use of renewables to 20% over the whole EU of the total energy consumption by 2020, mostly via highly decentralized “green” power generators (like from wind, biomass, or solar energy; or from µCHPs or energy storage systems) forming Virtual Power

Plants. In the 20 20 20 scenario of the EU, 20% of the energy consumed should come from renewable resources in 2020, and furthermore the energy consumption should be reduced by 20% and the CO2 emission should be reduced 20% in 2020 compared to the situation in 1991. In the Copenhagen agreements even a 40% target is at stake.

ICT provides one of the enabling technologies to realise these goals. The energy generation and transportation technologies in use today were mostly designed for a different era based on centralised energy generation and economies of scale. Today they are facing a transition to address the goals of the new EU energy policy. This will require a convergence between energy and ICT infrastructures. The driving forces for this transition are the security of energy supply in case of massive rollout of renewable energy solutions on a small scale and environmental concerns. ICT will lead to the creation of new energy markets, decentralized control and coordination, and ICT is expected the only way to retain the system quality and reliability as found in the current electricity system, that currently is considered to be the most complex and dependable system, made by humans.

The Netherlands has internationally a strong position in ICT systems and hence is well prepared to tackle the above energy reduction, distributed control, and sustainability challenges. Recently, we see that a large number of researchers have become active in the field of energy reduction and control *within* and *with* ICT. They are applying the methods and techniques of their expertise research domain and develop them further in the energy domain. A programme on smart usage of energy is well timed to bundle the activities of the various groups and to foster the cross-fertilization and achieve convergence. Given the enormous potential of excellent researchers and the necessity to bundle their very diverse research areas we believe that we can expect exciting innovative research in this field, This can push the Netherlands forward as the worldwide leader on smart usage, generation, and transportation of energy be it in form of electricity, natural or biogas or heat.

Researchers from Dutch universities and institutes like CWI are solicited to submit proposals to perform fundamental research on Smart Energy Systems as outlined in this programme. An important criterion for the evaluation of the projects is that the results of the projects should in the long run lead to a quantifiable and substantial energy reduction in the form of kWhs saved per kWh used by ICT as well as a hardware or software footprint indication.

6.1.2 Scientific & Technological Relevance

International Technological Trends

According to a recent report 2020 [11] of the Climate Group and McKinsey, ICT is a key player in the battle against climate change and offers the possibility of 7.8 Gt reduction of CO_2 emission in 2020. On the climatization and conditioning level of data centers steps have now been set to reduce consumption. The next target is designing more energy efficient computer architectures and data communication facilities. A recent annex of this report calculates a saving of 140-240 billion dollar in the US by reducing the energy consumption due to smart energy management of ICT systems. Also the European Commission is stressing the importance of ICT for energy reduction and sustainability and invests in research in this area. For concrete actions of the EU we refer to two recent reports [13][14].
Amongst others, the plans have resulted in research programmes in FP7: for example the calls FP7-ICT-2009-4 en FP7-ICT-ENERGY-2009-1 with a.o.

- Objective 6.3 ICT for Energy Efficiency
- Objective 6.4 ICT for environmental services and climate change adaptation
- Objective 6.5 Novel ICT solutions for Smart Electricity Distribution Networks

- Objective EeB-ICT-2010-10.2: ICT for energy-efficient buildings and spaces of public use.

Although the area of Smart Energy Systems is rather young, worldwide, various research groups are active in this field e.g. the Fraunhofer institutes in Germany [10], MIT energy initiative [8], UC Berkeley Centre for the built environment [9]. Because the field is rather young there are no well-known and accepted conferences and journals in this field yet; most workshops are in conjunction with recognised conferences.

A small sub-set of relevant conferences, journals and workshops in this field are:

- *e*-Energy 2010 first International Conference on Energy-Efficient Computing and Networking in cooperation with ACM SIGCOMM, April 13-15 2010.
- IEEE/ACM Workshop on Energy-Efficient Design (WEED 2009) held in conjunction with the 2009 International IEEE/ACM Symposium on Computer Architecture (ISCA-36) June 2009
- IEEE workshop on Energy Efficient Circuits and Systems 2009, October 2009
- ACM BuildSysFirst "Workshop On Embedded Sensing Systems For Energy-Efficiency in Buildings" in conjunction with ACM SenSys 2009, Berkeley, CA
- Energy and Buildings, an international journal devoted to investigations of energy use and efficiency in buildings, published by Elsevier.
- IEEE Journal on Smart Grids (first issue planned January 2010)
- IEEE Power & Energy society workshop, Calgary, Alberta, Canada, July 2009
- IFAC Conference on Control Methodologies and Technology for Energy Efficiency, CMTEE 2010, to be held in Vilamoura, Portugal, March 29-31, 2010
- IRED conference series driven by the European projects on SmartGrids
- The EU SmartGrid ERA initiatives

Position of Smart Energy Systems in the Netherlands

The Netherlands has internationally a strong reputation in the field of embedded systems (a.o. ESI), dependable systems (a.o. NIRICT/CEDICT), intelligent communications (a.o. BSIK Freeband), broadband communication systems and technologies (a.o. COBRA), and smart systems (a.o. VU and CWI). We see that researchers in these fields can combine their research in the new field of 'ICT and energy'. Because 'ICT and energy' is a spearhead issue which is most actual and relevant economically as well as environmentally, and a societal theme of growing importance, we expect that more and more researchers need to focus on this area. ECN (the Energy research Centre of the Netherlands) [17] is active in the field of Smart Energy Systems and Smart Grids as well as in Smart Building systems in the utility as well as in the residential sector. Researchers of ECN designed the PowerMatcher and HeatMatcher technologies, based on software agents for coordination systems which are able to match the demand and supply of electricity more efficiently. ECN is collaborating with the Flemish research organization VITO (Vision on Technology) for PowerMatcher development and European industrial companies, research institutes and universities in European framework projects.

At the moment, research programs for electricity systems exist in the form of e.g. the IOP EMVT and EOS (SenterNovem), These programs mainly focus on the electrical engineering part of energy systems and have a more applied signature. ICT systems are considered here only to a limited extent, although their importance is being acknowledged increasingly. The demand for more and fundamental research in the design of ICT solutions for energy systems has therefore increased considerably in recent years, when facing the developments in various scientific areas as well as the growth of industrial and societal demands.

6.1.3 Industrial Relevance & Economic Benefits

If the Netherlands take a leading role in scientific research in Europe on fundamental issues related to energy efficiency *in* and *by* smart ICT systems, Dutch industry can benefit from this research. There is no doubt that many players in the Netherlands that are active in this field will support this programme and will benefit from the results of the research: multinational companies like Philips, NXP, IBM, Siemens, and Sony/Ericsson; energy system stakeholder companies like Joulz (formerly Eneco Infra), Stedin (formerly Eneco Netbeheer), Essent, Enexis, the AlLiander-holding companies, NUON, Eneco, Greenchoice, Delta, Oxiio; research institutes like ESI, ECN and TNO, and SME companies like Nedap, TI-WMC, Recore Systems, Plugwise, Homa Software, Genexis, Phase to Phase, Alfen, Almende and Reggefiber.

Economic benefits also definitely will be reaped in the areas of the usage of energy, like reducing the total costs of energy for consumers and companies, and a better use of the electrical power supply infrastructure and assets.

6.1.4 Research themes

Four themes have been defined, of which the first two address the energy reduction *by means of* ICT, and the last two the energy reduction *within* ICT contexts.

Energy reduction by means of ICT systems

Theme 1: Smart ICT methods for energy saving and generation in buildings
The ultimate goal of this theme is to create a *zero energy building* (ZEB) or *net zero energy building*, with possibilities for supplying to the electricity net in case of electricity surplus. ZEB is a general term applied to a building with zero net energy consumption and zero carbon emissions annually and that can also supply energy to the power grid. This goal is highly relevant as renewable energy is a means to cut greenhouse gas emissions. Today, buildings use 40% of the total energy in the US and European Union [7].
A zero energy building can only be realised with smart ICT systems than can match the generation capacity and the loads in a possibly thermally passive building (using demand side management or demand response), through the use of highly efficient (ICT controllable) appliances in the building operating in a smart way to reduce energy consumption and by including energy storage. Also, such ICT systems should be capable of supplying temporary (excess) energy to the electricity grid or energy storage appropriately.

Sensing, monitoring and actuating systems in relation to the user perception and preferences are expected to play a key role in reducing overall energy consumption in buildings. Leveraging sensor systems to support energy efficiency in buildings poses novel research challenges in monitoring use of the space, controlling devices, interfacing with smart energy meters and communicating with the energy grid. This includes developing energy efficient control systems, integrating heterogeneous devices, personalizing and presenting data to generate energy awareness to all stakeholders. These challenges include making sensed data available to any connected device, facilitating reasoning from multiple sources of data achieving global energy conservation over a combination of different systems (sensor fusion), and devising control systems that support a multitude of network actuators.

Islanded zero energy buildings (IZEB) are autonomous from the energy grid supply - energy is only produced on-site. One of the key issues in IZEB design is the balance between energy conservation and the distributed generation of renewable energy (solar energy, wind energy, etc.). Zero energy homes use a combination of the two strategies.
This means that:

1. devices have to be ultra energy-efficient (during on-time as well as during off-time)
2. various distributed generation techniques have to be employed
3. there needs to be local storage to cope with temporary under- or over-production of energy either by storing heat or electricity
4. a smart control and scheduling system to schedule and control the energy streams in a house given the (expected and current) behaviour of the occupants, the outside temperature, the size of the electricity and heat storages, etc..
5. in case of a net ZEB a smart control system for supplying (excess) energy to the electricity grid has to be employed, given the in-house demands as well as the (local) state of the electricity system (e.g. in the form of prices) and the grid in the form of the current load profile.

Some challenges are:

1. Standby power, also called phantom power, refers to the electricity consumed by many appliances when they are switched off or in standby mode. The typical power loss per appliance is relatively low (from 1 to 25 W) but when multiplied by the billions of appliances in houses and in commercial buildings, standby losses represent a significant fraction of total world electricity use. According to [2], standby power accounts for as much as 10% of household power-consumption. The good news is that governments, manufacturers and standards organisations are now working together to cut standby losses significantly. However, care should be taken that any additional ICT equipment to reduce the total energy consumption of appliances or houses operate with very low standby power, otherwise the energy gain in active mode is diminished by the extra standby power.
2. If a house is connected to a grid any electricity that cannot be consumed in the home can be exported to the electricity distribution network or stored in in-house batteries. In current price and metering models, for the house-owner it is advantageous to consume the locally generated electricity in the home as much as possible. Therefore ICT systems will be employed to coordinate the micro-generation or PV with the electricity demand and storage in the home, as well as delivery to or acquisition from the electricity distribution network. Such ICT systems may, for example, determine when to switch on a generator when electricity is needed at home, or when there is an electricity shortage in the grid (or at a higher price). Temporary surplus of energy needs to be stored (e.g. in batteries) or delivered to the electricity network and temporary shortage needs to be supplied from the batteries or by the electricity network.
3. Smart sensor systems that sense the state of the house and its individual users, and predicts and controls energy requirements in the building.
4. to develop efficient in-house communication protocols to enable interoperability between electricity producing (e.g. micro-generators), consuming (e.g. white goods such as dishwasher and freezer) and control units.
5. to develop an efficient and low-cost, energy-efficient (in-house) ICT infrastructure that can control the consumption and production of a house in real-time ("Demand Side Management") through systematic and pervasive use of ICT and also can support the electricity grid system in an active role; e.g. to reduce wind energy imbalance. In particular for the real-time control and monitoring of decentralized generation (Virtual Power Plant (VPP), μ-CHPs), both for in-house usage and for delivery to the power grid, a lot of fundamental ICT knowledge is needed in the area of scalable and manageable distributed systems.
6. to develop ICT solutions to facilitate and promote the energy awareness of consumers and devise smart feedback mechanisms.

7. To develop ICT techniques (e.g. monitoring and sensing equipment) to support house occupants in improving their energy-efficiency without observable changes in Quality of Living. Related to this is to study to what extend house occupants are willing to sacrifice Quality of Service (Quality of Living) for energy-efficiency.

Theme 2: Smart control systems for flexible electricity supply networks (Smart Grids)

Traditionally, most western countries have supplied domestic electricity through generation in large central power stations, with subsequent transmission and distribution through networks. The generation efficiency of the power stations varies between around 35% for older coal stations to over 50% for modern combined cycle stations, averaging to about 39%. When transmission and distribution losses are considered, the average overall efficiency of the system sinks to 35%.

In a few years from now a large percentage of the electricity will be generated by decentralized micro-generators [4][5].(e.g. micro-CHPs, like Stirling engines and fuel cells, and solar cells). Micro generation systems generate electricity at the kilowatt level which will allow the units to be installed in an individual home and connected directly with the domestic heating and electrical systems, which by definition entails very high efficiency (up to 90%) in usage of primary energy. Also, it allows for delivery of electricity to the power grid, where the distance to its consumer may be limited, e.g. in the same city or neighbourhood. The micro-generation concept has the additional benefit of reduced distribution and transmission losses, delivering significant advantages in terms of overall efficiency relative to centrally-generated power. This concept offers an attractive transition technology in the reduction of primary energy consumption to carbon (CO2)-neutral emissions.

In the long run, we will rely on renewable energies. Renewable energies are generally based on a large number of even smaller sources of power, producing power much closer to the location in which it is used. Some installations, such as those producing heat, can only supply users in their immediate area, while equipment which produces electricity, such as wind turbine, biomass systems, or photovoltaic roof panels, can be used to supply to electricity networks. The introduction of renewable energy will be more efficient once the development of new ICT systems for obtaining energy efficiency and meeting grid requirements takes off, while maintaining high standards of comfort, quality and reliability of services as well as connectivity. In addition, the future availability of storage devices (such as batteries in electric cars) opens up new perspectives and constraints, both from the sides of storage and supply (to the grid), as well as demand (from the grid).

The demand for electricity in a large network varies dynamically as millions of users continuously switch on and off independently their equipment. The wholesale price of electricity, paid by distributors to (large scale) generators, also rises and falls with demand. A similar approach could be applied to massive amounts of small-scale generators, seen as a Virtual Power Plant (VPP). An intelligent system employed by the operator of a small-scale generation resource, such as photovoltaic panels on a house, or a fuel-cell, would be able to recognise when surplus energy can best be sold on the market, and when it should be used to heat water, for example. Similarly, continuous agreements for supplies during short or long durations, involving e.g. prices, timing, and quantities could be made between network operators and small-scale suppliers in new service models adding new ICT-players to the energy field.

ICT provides the means to manage the operation of millions of small-scale electricity generation appliances, both on behalf of their owners and for the networks into which they feed. ICT tools can monitor a range of variables and ensure that both individuals and the network as a whole gain maximum efficiency from the energy generation capacity available. Development of such ICT systems will therefore fuel the installation of new and renewable-energy-based generation capacity, through maximising the return on investment so making it more affordable. In this way, it can more quickly meet its goals in the field of stable electricity supply, energy efficiency and emissions reduction, and provide consumers with higher quality energy supplies.

The electricity grid has to cope with the variable output of future generators and variable uptake of consumer devices, many of which are still unknown. In principle, the smart grid is an upgrade of 20th century power grids which generally "broadcast" power from a few central power generators to a large number of users, to instead be capable of routing power in more optimal ways to respond to a very wide range of conditions. The conditions to which a smart grid must respond, may occur anywhere in the power generation, distribution and demand chain. Events may occur generally in the environment (clouds blocking the sun and reducing the amount of solar power, a very hot day), commercially in the power supply market (prices to meet a high peak demand exceeding one dollar per kilowatt-hour), locally on the distribution grid (MV transformer failures requiring a temporary shutdown of one distribution line) or in the home (someone leaving for work, putting various devices into hibernation), which motivate a change to its power flow. In addition, several constraints are put by the power grid itself as well as the devices connected to it. Future smart grids must:

1. Be able to heal itself; it should continue its operation despite some failing parts
2. Be resistant to man-made or natural disruptions
3. Allow demand response support to micro-generators and loads to interact in an automated fashion in real-time, coordinating demand to flatten spikes.
4. Enable decentralized control, needed because of the size of the grid and the amounts of its users.
5. Reduce transmission costs by means of enabling local demand and supply in the grid.
6. Provide higher quality power that will prohibit outages and save the costs thereof in case of occurrence
7. Accommodate emerging generation and storage options (like electric cars)
8. Enable to operate on the electricity markets
9. Run more efficiently e.g. through using more highly efficient distributed generators and less centrally generated electricity.
10. Cope with the electrical-engineering possibilities and restrictions of the grid itself.

One of the problems smart grids are facing is that not all decentralized micro-generation systems have forecastable electricity generation patterns. For example solar cell’s power output is dependent on the cloud coverage, the time of the day and the amount of indirect and direct sunlight. Wind energy is only available if there is wind and micro-CHP systems only produce electricity in case of a heat demand. As a consequence, decentralized systems sometimes produce electricity when there is no need for it locally.

Some challenges are:

1. to develop models for forecasting the electricity consumption potential and production pattern of a house / neighbourhood;
2. to develop decentralized and real-time scheduling, planning and optimization techniques that can manage the scale and variability of the distributed generators and the local demands, by decentralized ICT systems;
3. to develop automated market-mechanisms for matching supply- and demand, by means of decentralized ICT systems
4. The combination of decentralized generation of electricity, smart grids and ICT techniques must lead to a dependable electricity network. Due to the

scale of smart grids and the needed dependability, fundamental research in dependable and large decentralized ICT systems is required.

5. To develop modelling, verification, simulation and visualization techniques for smart grids.

Energy reduction within ICT systems

Energy consumption is one of the main concerns of today's ICT hardware and software designers and systems integrators. Regarding energy-efficiency the first type of devices people usually think of are portable devices as these devices rely on batteries and therefore the functionality is strictly limited by the energy consumption. However, for high performance computing there is also an increasing need for energy-efficient architectures to reduce the cost for cooling and packaging. Today also the performance of many of these systems is limited by energy dissipation and electricity supply. As a result of EU-initiatives, the climatisation in data centres now is improving. As a next step more energy efficient processors dissipating less heat have to be designed. In addition to that, there are also environmental concerns that urge for more efficient architectures in particular for systems that run 24/7 (24 hours per day 7 days per week) such as wireless base stations, servers parks, data centers and search engines (e.g. Google has an estimated server park of one million servers that run 24/7).
Energy reduction can be done at several layers: reduce energy for processing and storage of data, reduce energy for communication, operating systems and software. Cloud computing mechanisms might also offer possibilities for energy saving.

Theme 3: Energy reduction in processing and storage of information

Today most modern general purpose processors are optimized for speed rather than for low energy consumption. In typical general purpose processors a lot of energy is wasted in instruction decoding, speculative execution and memory hierarchy. In ASICs (Application Specify Integrated Circuits) and reconfigurable platforms this overhead is significantly lower, but unfortunately their programmability is limited. Research is needed to reduce the energy consumption of processors. In the coming years energy-efficient multi-core architectures will be developed with tens to hundreds of cores.
In this theme we plan to perform research on energy-efficient systems (hardware as well as software), efficient compiler technologies, mapping and scheduling technologies and run-time technologies.
Energy reduction in hardware is more or less evident, but the sustainability-role of software may be less evident. Without doubt efficiency of software impacts all ICT products. Software may make all kinds of processes run more efficiently, by doing tasks in the right order, in their right combination, and at the right moment. Therefore software will also impact the environmental footprint of these products.

Some challenges are:

- How to program future parallel architectures with hundreds of programmable cores, in an energy-efficient and cost-effective way. Accessing a small and local memory is much more energy-efficient than accessing a big and distant memory. Transporting a 32-bit value over a 1 mm on-chip distance in a 45 nm technology will require more than 50 times the energy of a 32-bit operation in the same technology, whereas a 32-bit off-chip memory access consumes more than a 1000 times the energy of a 32-bit operation. Transporting data over a wireless interface is even more expensive energy-wise. A multi-core architecture, with local memory, intrinsically encourages the use of locality. Due to locality the communications within a core are more frequent than between cores. Exploiting the locality extensively improves the energy-efficiency substantially. However, application developers and compiler designers prefer one large shared memory. The challenge is to make optimal use of local memories.

- how can we make applications, compilers and operating systems energy aware? What are goods metrics and benchmarks to measure the efficiency of software?
- When the system can adapt (at run-time) to the environment, significant savings in energy costs can be obtained. For example, if a computer system can rapidly switch to a low-power standby or hibernate mode (like in most laptops), when it is temporarily not needed, significant savings can be obtained. One step further would be to switch off certain parts of the system that are currently not needed. A research question is how to exploit the adaptivity of applications on a microscopic level for multi-core architectures.
- How to promote energy awareness of PC users. Forrester Research predicted that there will be around 1.3 billion computers worldwide by the year 2010 [15]. So there is much potential to save energy there.

Theme 4: Energy reduction in communication

ICT is a vital factor in our modern society without which our economy, education, logistics, leisure activities etc. would come to a standstill. A hot theme is the power consumption of the exploding internet usage. The Google data centers already consume hundreds of megawatts, of which typically 50% is lost in cooling via inefficient air-conditioning mechanisms. It is predicted that in 2015 the internet routers in Japan will consume 9% of the national electrical energy. In Italy, Telecom Italia is the second largest energy consumer, immediately after the Italian railways. A very significant part of ICT's power consumption also lies in the access network and in in-building networks. Always-on GSM and UMTS base stations, and ADSL and VDSL lines for providing broadband communication to every home, are major energy consumers. Wireless data communication is becoming ever more popular, as it allows get access to communication everywhere. However, it consumes orders of magnitude more energy per transmitted bit than wired communication, in particular as it is often not specifically directed to the user but radiated to all directions.
In this programme, we propose to investigate new ways to drastically reduce the energy consumption of ICT service provisioning.

Some research challenges are:

- Power-efficient optical communication techniques
  - Optical signal routing: all-optical forwarding of the data payload of internet packets avoids power-consuming opto-electrical conversions. Together with all-optical processing of the packet label, ultra-fast packet routing will become feasible. Thus current electrical routers can be vastly outperformed, both in power consumption and in speed.
  - Optical fibre access networks: access networks commonly operate in always-on state. Due to the fibre's ultra-low losses and extremely large bandwidth, optical fibre access lines consume significantly less power than the electrical copper lines (twisted pair, and coaxial) in use today. In addition, smart optical routing techniques can deliver capacity on demand which is tailored to the actual user demands; thus the network's power efficiency can be further improved.
  - Radio over fibre techniques: remote generation and modulation of radio waves and transporting these to simple small antenna sites allows to create small high-capacity radio cells. These can suffice with considerably less radiation power, and will reduce interference levels with other cells thus improving the communication efficiency.
- Power-efficient wireless communication techniques
  - Low power cognitive radio transceivers: The power dissipation reduction achievable by adaptive and optimum use of the radio spectrum should not be offset by a decrease in efficiency caused by the required flexibility of the transceiver. Therefore, low-power cognitive radio transceivers at power dissipation levels at or below those of traditional transceivers are required.

    - Wideband transceivers and wake-up radios for small and adaptive cell sizes: There is a trade-off between power dissipation of the network, cell size and traffic density. Depending on the application and traffic density, an adaptive optimum combination of wake-up radios to enable access points to go into deep sleep modes and adaptive cell sizes will provide the largest power savings when moving to small cell sizes.
    - Low-power transceivers with strong spatial selectivity, MIMO and adaptive RF pre-processing: The power dissipation of radio links is amongst others due to the dispersion of radio energy in 3 dimensions. By limiting this spatial dispersion using adaptive beamforming, an increase in channel capacity (through MIMO) can be increased, and transmit power (through beamforming) as well as interference (through adaptive nulling) be reduced, each of which will contribute to the reduction of the total power dissipation.
    - Optimum combination of radio technologies with optical fibre technologies: A system that combines the radio technologies with the optical fibre technologies resulting from this program will have many parameters for optimizing the overall system. A careful analysis of the optimum combinations of the parameters is needed to keep power dissipation, cost, and performance/stability of such a system manageable.
- Intelligent networking techniques
    - Knowledge-based Control Plane: The idea is to leverage the vast amounts of information that soon can be collected about the applications and the operation of a system, from sensors, sensor networks and from the involved devices themselves, e.g. what access points or base stations do they see, the state of the batteries, etc. Cognitive techniques (e.g., memory, learning, prediction and anticipation) can be applied to this information to optimize system operation regarding energy consumption, radiation exposure and increasing battery life. The distributed architectural entity that realizes this, its protocols and algorithms, we call the Knowledge-based Control Plane. As an example: instead of downloading a non-time critical large amount data via an energy consuming 3G interface, the system can predict that short-range low-power connectivity to an optical infrastructure is coming up soon and it decides to defer the transfer.
    - Cooperative techniques for energy saving: Cooperation between entities, in which one entity is willing to assist another one in achieving its tasks, has great potential for reducing energy consumption. An example is a device that needs access to Internet and has the choice of doing it on its own via its much-energy consuming cellular 3G interface, or doing this by a short-range low-power radio hop to a cooperative device that already has an underutilized 3G interface operational. Architectures, protocols, algorithms for achieving cooperation need to be investigated, e.g., game-theoretic approaches for competing devices, distributed optimization methods for inherently cooperative environments such as home networks and personal networks. Here we can learn from developments in Wireless Sensor Networks, where frugal use of energy resources is of key importance. Wireless sensor nodes run for years on a single AAA battery.

6.1.5 Distinctive Character & Added Value

This programme can bring the Dutch scientific community to the forefront of Smart Energy Systems research in the world. Dutch research in ICT is first class and very competitive internationally. To retain and strengthen this position and to solve problems related to most actual economical as well as environmental themes of ICT and energy, new research initiatives are required. Devising innovative solutions which reduce energy consumption *within* ICT as well as *by means of* ICT requires new interactions between the various strong research disciplines in the Netherlands. The constraints of reduced energy consumption and decentralized generation of "green" power are causing a fundamental shift in thinking, moving the field of research from a statically analysable centralised problem to a dynamic and decentralized one. This is a significant change and brings with it new opportunities where new solutions and directions are imperative to manage this paradigm shift.

The programme is distinctive from other programs in the energy field (like those of SenterNovem and EU-FP7) by focusing on the fundamental ICT aspects of energy systems and conversely on the energy aspects of ICT systems. The SenterNovem EOS and EU-FP7 programmes focus on short term and medium term results, while the SES programme focuses on fundamental solutions with long term results.

ICT has been recognized to be of major importance in future energy systems, due to the above paradigm shift, and the need for automated, decentralized, and smart control of future energy systems. Additionally, energy aspects clearly will become leading in devising solutions to meet the exploding ICT demands of our society.

6.1.6 References

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6.2 Guidelines for drafting an abridged proposal

Structure of pre-proposal

The pre-proposal should be written in English. It should be a complete document, and reference to any external documents (other than literature references) should therefore be avoided as much as possible. The text in the section 4 should not exceed 1600 words.

1a Project Title

A short but specific title for the research for which funding is being requested. (Same as the title entered in the project information screen).

1b Project Acronym

If applicable. (Same as the acronym entered in the project information screen).

1c Principal investigator

Only enter the name of the main applicant (who is also the point of contact and intended project leader).

2 Classification

You are requested to indicate the compartment in which you believe your research belongs. Choose from the following:
Compartment 1, Application oriented research
Compartment 2, Curiosity-driven research

Composition of the Research Team (maximum 1200 words)

Please indicate here which parties are likely to make up the research team:

- names of involved researchers, university/ies and/or institute(s)
- names of companies and/or societal organisations that will be involved as partners.

In so far as possible, please give surnames and initials, titles, scientific background (including a brief resume) of the researchers. Please state who will act as academic sponsor to the trainee research assistant (PhD candidate).

4 Content of the proposed project (total 1600 words)

Structure this section as follows:

4a Scientific aspect

This section should consider the following aspects:

- research question and intended results
- research method
- significance of the proposed research.

4b Innovation

Give description of the innovative character of the proposed research.

4c Relevance

Formulate anticipated applications on which the research will focus and their relevance to both scientific and non-scientific parties, as well as systems and problems.

4d Utilisation (maximum 400 words)

Mandatory for applications in compartment 1.
Brief description of the problem and the proposed solution, the utilisation plan, the potential users and the past performance in utilisation.
Describe the problem which will be solved and whose problem it is. Indicate what the societal and economic consequences will be if the problem will not be solved.
Describe how the proposed research results will contribute to the solution of the problem. Indicate when the proposed research results will lead to new methods, products, processes or services. Describe the market for these non-scientific applications. Indicate if and how the research results can become part of standardisation or norms.
Indicate steps of a plan to make sure the results of the research will be applied by its potential users.
Indicate any relevant information on intellectual property. Are there any existing contracts with third parties in relation with the research subject? Give an overview of relevant patents in the area of the research proposal

4e Positioning of the project proposal

Describe how the proposal can be distinguished from current research, in the Netherlands and abroad. Indicate cooperation's with other research groups.
Give information on the embedding of the proposed project in current initiatives of the research group and/or section. Indicate if the proposal is part of a research program of the research institute of the applicant(s).

5 References

Brief summary of the references cited in the pre-proposal.

6 Budget

Give an indication of the type of implementing parties for whom you require funding and of the total project budget (= grant + university contribution(s) + contribution from industry and/or societal organisations). The grant requested may not exceed € 400,000 for smaller projects and € 750,000 for larger projects. The maximum duration of the project is four years.

6.3 Guidelines for drafting a detailed proposal

Structure of research proposal

All proposals should be written in English. The proposal should be a complete document, and reference to any internal documents should therefore be avoided. Sections 6, 7 and 8 combined should not exceed 5000 words. This equates to approximately 10 pages.

Reviewers

You are asked to suggest up to three potential reviewers per email to ses@nwo.nl .
Please supply their full name, title(s), affiliations, gender and email address. *The reviewers may not have any conflict of interest with your proposal.*
You are also required to inform the programme office by means of an email whether or not you will be participating in the experimental peer review procedure.

1a Project Title

A short but specific title for the research for which funding is being requested. (Same as the title entered in the project information screen).

1b Project Acronym

If applicable. (Same as the acronym entered in the project information screen).

1c Principal investigator

Only enter the name of the main applicant (who is also the point of contact).

2 Summaries

Brief summaries of the research proposal (maximal 250 words) and the utilisation (maximal 250 words). The utilisation summary is mandatory for applications in compartment 1 and optional for applications in compartment 2. These summaries will be passed on to the reviewers.

3 Classification

You are requested to indicate the compartment in which your research belongs, based on the same descriptions as in the pre-proposal round.

4 Composition of the Research Team

The research team has three parts:

- the individuals for whom the grant is being requested ('vacancies')
- the input from universities and/or institutes
- the input from the 'potential users'.

Please give surnames and initials, titles, scientific background and affiliation (university, institute, company, institution etc.) of all those involved. If the research is a PhD project, please state who will act as academic sponsor to the trainee research assistant (PhD candidate).

5 Research School

Specify the research school(s) at which the project staff will be conducting their research.

6 Content of the proposed project

Structure this section as follows:

6a Scientific aspect

This section should consider the following aspects:

- research question and intended results
- research method
- scientific significance of the proposed research.

6b Innovation

Give description of the innovative character of the proposed research.

6c Relevance

Formulate anticipated applications on which the research will focus and their relevance to both scientific and non-scientific parties, as well as systems and problems.

6d Utilisation

Mandatory for applications in compartment 1, optional for applications in compartment 2.

This section should contain sufficient details for the referees and the assessment committee to judge in how much time application beyond science can possibly take place.

1 Description of the problem and the proposed solution.
Describe the problem which will be solved and whose problem it is. Indicate what the societal and economic consequences will be if the problem will not be solved. Describe how the proposed research results will contribute to the solution of the problem. Indicate when the proposed research results will lead to new methods, products, processes or services. Describe the market for these non-scientific applications. Indicate if and how the research results can become part of standardisation or norms.

2 Utilisation plan
Give the contact details (name organisation/company, contact person, address, telephone number, email) of companies and organisations which are willing to participate in the users committee.
Indicate steps of a plan to make sure the results of the research will be applied by its potential users. If third parties are involved during the project, it is important they expressed their support. Indicate which users support the project and/or contribute to the project.

3 Past Performance
Give any past performance on utilisation. Indicate if any scientific results were commercialised or applied.

4 Intellectual property, contracts and patents
Indicate any relevant information on intellectual property. Are there any existing contracts with third parties in relation with the research subject? Give an overview of relevant patents in the area of the research proposal

6e Positioning of the project proposal

Describe how the proposal can be distinguished from current research, in the Netherlands and abroad. Indicate collaborations with other research groups.
Give information on the embedding of the proposed project in current initiatives of the research group and/or section. Indicate if the proposal is part of a research program of the research institute of the applicant(s).

7 Description of the proposed plan of work

Please indicate roughly how the entire research project is to be phased, in periods. More specifically, you should indicate which activities are likely to be carried out in the first two years. Indicate roughly which tasks will be undertaken by which members of the research team. The project duration must not exceed four years.

8 Expected Use of Instrumentation

What equipment or software will be needed? Present arguments. Please differentiate between existing equipment/software, and equipment/software that needs to be purchased.

9 Literature

Give a brief summary of the references cited in the proposal. You are also requested to list the five most important publications by all team members.

10 Budget

General
The project budget consists of two components:

A. the researchers, activities/equipment/software and the additional travel budget for which you are requesting funding.
B. the input from industry or societal organisations (not eligible for funding); applicable only to proposals in compartment 1

Component A (grant requested)

(1) Staff

- Standard amounts are available to cover the salary costs of researchers. See tables 1 and 2).
- Funding for other staff may be requested only in conjunction with one or more researchers. They may not be appointed for longer than the subsidised researchers. Indicate whether you are employing staff with secondary vocational, professional (HBO) or university qualifications. See table 1 and 2.
- The standard amounts include provision for salary increases over the project period.

(2) Other

- Funding may be requested for project-related equipment/software, provided their total costs are lower than the costs reserved for the salaries of the involved researchers.
- An itemised budget must be submitted for both additional international travel expenses and project-related equipment/software. Clear arguments for each item must be presented, and related to the research positions for which funding is being requested. The standard tariff for travel is 2000 euro per researcher per year. If this standard is exceeded, please argue why.

Component A total

Projects will be awarded a grant of no more than € 750,000. It is not possible to apply for extra resources during the course of the project.

Component B (input from industry and/or societal organisations)

This component may cover (1) capitalisation of the hours worked, (2) the costs of material and aids used and (3) use of equipment and machinery. (4) financial contribution

(1) Capitalisation of hours worked

This refers to salary costs and social insurance contributions, plus an extra 50% in overheads. The participating parties are expected to make an active contribution to the project. This will be reflected in the plan of work, which will include an estimate of the number of hours to be worked by each staff member. For senior research staff (postdoctoral) the maximum tariff is 106 euro per hour, for other staff the maximum tariff is 75 euro per hour (1250 hours per year at maximum).

(2) Costs of materials and aids used

This must be based on cost prices (for suppliers) or historical purchase prices.

(3) Use of equipment and machinery

Take account of past depreciation and intensity of use.

Summary of project budget

Complete the table below.

Component A (to be funded from grant)

(1) Staff (see tables 1 and 2)	No FTE x amount	
a) appointment of PhD student(s)	…….. FTE x € ……..	= €
b) appointment of postdoc(s)	…….. FTE x € ……..	= €

f) appointment of other (new) staff	.... FTE x €	= €
.... +		
Subtotal, staff		= €
(2) Other		
a) materials and internal travel *)	.... FTE x €	= €
b) international travel budget *)	.... FTE x €	= €
c) project-related equipment/software *)	.... FTE x €	= €
d) (foreign) visiting researchers	.... FTE x €	= €
.... +		
Subtotal, other		= €
Component A: subtotal (1) + (2)		**= €**
Component B (4) Financial contribution	-/-	**= -/- €**
Total grant		**= €**

Component B (inbreng vanuit de bedrijfsleven of maatschappelijke partijen)

(1) Capitalisation of hours to be worked, plus 50% overheads	= €
(2) Cost of materials and aids used	= €
(3) Use of equipment and machinery	= €
.... +	
Total Component B	= €
TOTAL PROJECT BUDGET (= Component A +B)	**= €**

*) For compartment 1 these are without V.A.T., for compartment 2 these amounts are including V.A.T.

6.4 Specific conditions, Compartment 1

Table 1

For PhD students (AIOs), postdocs and other staff, please use the standard salaries agreed in NWO-VSNU (Association of Universities in the Netherlands) contracts effective from 1 April 2001. At 1 July 2009 the STW standard salaries were as follows, in € and based on 1.0 FTE:

job title	PhD student	postdoc	other staff, qualification level		
duration			MBO	HBO	
1 year	n.a.	not possible	43,859	52,744	
2 years	n.a.	119,278	88,814	106,808	
3 years	n.a.	181,168	134,894	162,223	
4 years	182,727	not possible	182,125	219,024	

The standards differ between compartments 1 and 2 because STW uses a different financing scheme, based on invoices. This means funds for travel, material and investments can be applied for separately. The amounts requested are without V.A.T. Further STW covers unemployment risks and offers the possibility to extend projects if applications for that are approved. STW does not provide bench fees.

6.5 Specific conditions, Compartment 2

An individual bench fee of € 5,000 will be made available for each trainee research assistant (AIO) or postdoc. The bench fee is intended mainly to cover their travel costs in the Netherlands and abroad, including attendance at conferences, as well as a contribution towards the costs of printing the AIO's PhD thesis

Table 2

For PhD students (AIOs), postdocs and other staff, please use the standard salaries agreed in NWO-VSNU (Association of Universities in the Netherlands) contracts effective from 1 April 2001. At 1 July 2009 these standard salaries (excluding individual bench fees) were as follows, in € and based on 1.0 FTE:

job title	PhD student	postdoc	other staff, qualification level		
duration			MBO	HBO	university
1 year	n.a.	not possible	47,514	57,140	68,345
2 years	n.a.	129,342	96,307	115,820	138,530
3 years	n.a.	196,635	146,413	176,078	210,605
4 years	200,013	not possible	197,868	237,959	284,620

Table 3

The individual bench-fee applies for PhD student and postdocs. As agreed in the Universities' Collective Agreement effective as of 1 July 2009, the bench-fee in € on basis of 1,0 FTE:

job title	aio	postdoc	other staff		
duration			MBO	HBO	university
1 year	n.a.	n.a.	n.a.		
2 years	n.a.	5,000	n.a.		
3 years	n.a.	5,000	n.a.		
4 years	5,000	n.a	n.a.		