

NERI
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NERI Strategy 2008–2012
– Strategic growth

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Foreword

NERI's strategy for the period 2008–2012 addresses a situation with several striking perspectives.

With the mergers that took place in the research landscape in 2006/2007 there is now considerable potential within the University of Aarhus to further strengthen research, education, public sector consultancy and knowledge and technology transfer. NERI's strategy is closely coupled to the University of Aarhus' strategy for the same period – *Strategy 2008–2012. Quality and Diversity* – which NERI helped draw up.

The strategy period is characterized by the environment being high on the political agenda, with attention particularly focussing on how Denmark can contribute to research and technological development aimed at mitigating the environmental consequences of global growth and development. Pressure on natural resources, climate change and the global, national and regional measures to deal with them are major challenges in which knowledge and knowledge-based consultancy are vital if the situation is to be successfully managed at both the national and international levels.

Denmark's ambition in this regard is to fulfil the EU's so-called Barcelona goal of raising total public and private investment in research and development to 3% of GDP by 2010. During the strategy period public investment in research, education and knowledge transfer will be raised significantly through the political agreement on allocation of globalization funding.

NERI's strategy for the period 2008–2012 is a goal-oriented growth strategy that through a national portfolio of strategic environmental research and public sector consultancy tasks is intended to support Denmark's globalization strategy and help position the University of Aarhus as a leading international university in regard to environmental research, education, public sector consultancy and knowledge transfer.

Henrik Sandbech
Director General

1. Introduction

NERI is a national environmental research centre focussing on research-based public sector consultancy in the environment area. On 1 January 2007, NERI became affiliated to the University of Aarhus (AU) as a special entity responsible for research, monitoring and public sector consultancy in the environment area. The core activities in relation to the Danish Ministry of the Environment¹ are stipulated in a 4-year contract that is revised annually. Since 1 January 2008 NERI has been an integral part of the University of Aarhus – a private foundation under the overall responsibility of a Board of Directors.

The present strategy, which builds on the AU strategy for 2008–2012, specifies how NERI is to focus its efforts over the coming five-year period so as to ensure a sound foundation for research-based public sector consultancy in the environment area.

Mission

NERI's mission is to ensure the foundation for research-based initiatives to address issues related to nature, the environment and the climate.

Vision

NERI's vision is to strengthen its position as Denmark's *national environmental research centre*, to expand the AU's core activities to include strategic environmental research and research-based public sector consultancy, and to support development of AU as an environmental university.

NERI will achieve this through a combination of:

- Strategic environmental research of a high international standard aimed at providing a foundation for future decision making
- Research-based environmental monitoring aimed at national and international needs
- Research-based support for authorities and other decision makers in the form of holistic consultancy and integrated models and decision support systems
- Teaching and researcher training based on strategic environmental research
- Cooperation and networks with national and international actors in the environmental research area
- Communication and transfer of knowledge and technology to society at large.

2. Challenges and possibilities

During the strategy period Denmark is to strengthen its image as a world-class knowledge society. Public investments in research, education and knowledge transfer will consequently be raised significantly. The new funds allocated for this purpose will be largely distributed through competition, with quality as the decisive competitive parameter.

¹ Establishment of the Danish Ministry of Climate and Energy on 23 November 2007 entails that NERI is also required to provide public sector consultancy to this new ministry.

There is an increasing need for strategic research, i.e. research aimed at the challenges facing society that is able to provide answers and solutions to high-priority issues.

Research and technological development that can mitigate the environmental consequences of global growth and development are much in focus. New requirements for elucidation of crosscutting transnational relationships between such factors as energy exploitation and climate change, or between the state of the environment and public health, and administration of the increasing number of EU directives in the environment area, are increasing demand for knowledge and decision support.

The merger with AU has placed NERI in a larger research environment encompassing expertise in a number of fields of basic science that can strengthen the strategic environmental research. AU's research portfolio concomitantly has been expanded and strengthened with research environments of a high international standard, and NERI endows AU with an important new role as national advisor to the public sector on matters relating to the environment and nature. NERI will significantly contribute to strengthening AU's profile in public sector consultancy.

Due to the challenges arising from the merger of NERI and AU and the fact that NERI has to enter into a contract with the Danish Ministry of the Environment regarding public sector consultancy, NERI's strategy for 2008–2012 has to focus on maintaining and developing public sector consultancy based on strategic environmental research as NERI's "brand", while concomitantly exploiting the new possibilities open to NERI under the auspices of AU regarding the strengthening of research, education and knowledge transfer in the environment area.

Strategic growth will be necessary to enable NERI to steer towards the vision of being the Danish national environmental research centre and develop the role as chief provider of public sector consultancy in the environment area. It is important that all activities support the overall aim and thereby the development of NERI's role as Denmark's national environmental research centre.

NERI must proactively help ensure that research and development can be focussed on meeting future knowledge requirements in the environment area, both nationally and internationally. NERI thus has to assume a strategic role both nationally and internationally in the provision of expert advice to bodies allocating research funding.

Internally in NERI this entails a shift from a strategy focussing on *maintaining competence areas* to a strategy aimed at *developing competence areas*. The present growth potential has created the possibility to invest in the build-up of competence and the further development of NERI's core activities, and not least the cross-disciplinary integration of core activities. The latter is vital in relation to environmental issues, and demand for this can be expected to increase in the future.

The new possibilities provided by the merger with AU, where NERI is to support a major commitment to education and research and contribute to knowledge and technology transfer, provide the possibility to enhance NERI's portfolio of tasks. It is therefore necessary to qualify and specialize NERI's competences so that they more closely correlate with the various tasks at hand. This will give employees the possibility to develop their own competence profile depending on qualifications and interests.

Strategic growth entails an enhanced level of activity that necessitates enhanced recruitment. It will become increasingly difficult to recruit staff, and NERI therefore has to accord special attention to education. Enhanced recruitment to AU's Masters' degree programmes and PhD programmes via applied research will concomitantly improve the basis for future recruitment to NERI.

Competition for the tasks will increase in the coming years. NERI is ready to take up the challenge via: 1) research of a high international standard; 2) a high publication rate; 3) participation in strong national and international networks; and 4) a strong "brand" image among the public authorities and the general public. Moreover, concerted efforts will be made to further enhance the professionalism of NERI's organization and services and improve competitiveness by enabling tasks and competences to be combined most appropriately.

In the coming strategy period NERI will therefore focus on the following crucial challenges:

- To develop NERI as the national environmental research centre
- To maintain NERI's competitiveness
- To ensure retention and enhanced recruitment of staff.

3. Strategic growth 2008–2012

NERI's main tasks are strategic research, monitoring, research-based consultancy and education (especially researcher training) within NERI's areas of competence. Communication and the transfer of knowledge and technology to society at large play an important role in all of these tasks.

Since NERI's establishment, part of the overall strategy has been that the consultancy, monitoring, communication and education activities have to be restricted to the same scientific fields as the research and be integrated with the research. This principle of coherence and synergy between NERI's various activities ensures better quality in the performance of all the various activities and will be carried forward as a fundamental concept for NERI in order to ensure a continued highly qualified and competitive foundation for NERI's public sector consultancy activities and meet current requirements for scientific knowledge.

NERI's scientific competences encompass the atmospheric environment, the freshwater environment and nature, the marine environment and nature, the terrestrial environment and nature, the arctic environment and nature, and the impact of society on the environment and nature.

Environmental problems and the initiatives to solve them cut across both the various sectors of society and the various fields of basic research at the universities. This applies to environmental initiatives in all the major areas such as climate change, biodiversity, environmental health, aquatic environment, air pollution, chemicals and the utilization and protection of nature. Both EU directives and Danish legislation call for environmental initiatives that cut across scientific disciplines and sector boundaries. Crosscutting research is therefore a fundamental precondition if the results are to be of value as a foundation for decision making. NERI's strength is to be able to carry out crosscutting/interdisciplinary research and ensure a holistic approach to environmental problems and the initiatives to deal with them.

During the coming strategy period NERI will meet these challenges by bringing its core activities more in line with the applied, user-oriented perspective, i.e. NERI's ability to proactively perform knowledge acquisition and method development within themes directed at future needs is strategically important. The scientific knowledge requirements are described in Section 4.

To support the core activities NERI will focus on management, infrastructure and research service as important preconditions for achieving the strategic goals for the core activities.

A number of general initiatives are accorded priority in the strategy: a staff recruitment and retention initiative because competition for qualified staff is expected to sharpen; an internationalization initiative to maintain the high standard of research and ensure that the public sector consultancy activities are coordinated in relation to the supranational and intergovernmental administration and environmental initiatives; and an initiative to ensure accreditation of the research-based public sector consultancy and branding of NERI as a national environmental research centre at AU.

Strategy: NERI 2008–2012				
Core activities	Strategic research	Monitoring	Research-based public sector consultancy	Researcher training
	Communication and knowledge and technology transfer			
Internal support	Management, infrastructure and research service			
Priorities	Recruitment and retention, internationalization, accreditation and branding			

3.1. Core activities

3.1.1. Strategic research

NERI's strategic research is the foundation for knowledge-based management of nature and the environment. NERI's strategic research is based on scientific competence within the areas atmospheric environment, aquatic environment and nature, terrestrial environment and nature and sociological analyses of environmental issues.

The strategic goals for NERI's research during the period 2008–2012 are:

- **NERI shall rank among the world's best environmental research institutions**
- **NERI shall strengthen the development of Danish and European environmental research**
- **NERI shall maintain and expand national and international networks and cooperation**
- **NERI shall continue to develop the interplay between basic and applied research.**

Strategic indicators:

- The research is of an internationally high standard: NERI sets goals for international publication in peer-reviewed journals with a high impact factor and for acquisition of international projects, and contributes to developing new fields of research
- The research is relevant, applied and useful: NERI renders the research useful in relation to environmental decision making and administration
- The research is demand driven: NERI continually adapts knowledge acquisition and preservation to future knowledge requirements
- NERI coordinates environmental research nationally and participates in international networks: NERI sets goals for cooperation with the best research environments
- The research is crosscutting, i.e. it cuts both across basic and strategic research as well as across disciplines: NERI participates in crosscutting research projects
- The research is solution oriented: NERI focuses on solving environmental problems concomitantly with the identification and elucidation of environmental problems.

3.1.2 Monitoring

Overall responsibility for environmental monitoring in Denmark, including monitoring of species and terrestrial natural habitats, lies with the Ministry of the Environment. NERI supports the ministry by providing research-based knowledge pertaining to both national issues and international conventions and agreements, not least Denmark's monitoring obligations pursuant to various EU directives.

The strategic goals for NERI's monitoring activities during the period 2008–2012 are:

- **NERI shall maintain the interaction between monitoring and research**
- **NERI shall further develop scientific cooperation at the national and international levels, including with the users**
- **NERI shall further develop tools and methods for monitoring and for assessing state.**

Strategic indicators:

- The monitoring tasks are resolved in synergy with the research: The NERI Topic Centres are integrated in the NERI research environments
- The monitoring is demand driven: NERI draws up research-based prioritization plans for the environmental authorities based on assessment of national and international political-administrative needs
- The monitoring is of high scientific quality: The NERI Topic Centres document and quality assure the data, models and other tools in accordance with accepted quality standards
- The monitoring is directed at users: The NERI Topic Centres ensure that data are publicly available and utilizable by all variety of institutions and authorities
- The monitoring is scientifically and economically effective: The NERI Topic Centres cooperate on developing research technologies and methods.

3.1.3 Research-based public sector consultancy

As the national environmental research centre, NERI is responsible for providing the majority of public sector consultancy relating to management of the environment and nature in Denmark. In addition, NERI is required to advise the Greenland Bureau of Minerals and Petroleum.

The strategic goals for NERI's research-based public sector consultancy during the period 2008–2012 are:

- **NERI shall maintain and expand its client/user circle**
- **NERI shall maintain and promote research-based public sector consultancy as its “brand”**
- **NERI shall develop public sector consultancy in collaboration with other units of AU.**

Strategic indicators:

- The public sector consultancy is research based: All NERI's consultancy tasks are anchored in a scientific context

- The public sector consultancy is operational and directed at users: Client/user satisfaction surveys demonstrate a high level of satisfaction
- The public sector consultancy is holistic and consistent: All NERI's consultancy tasks undergo quality assurance
- The public sector consultancy continually supports the current knowledge requirements: NERI holds regular contact meetings with clients/users
- The public sector consultancy is anchored in a University of Aarhus context: NERI supports the strategic development of public sector consultancy at AU.

3.1.4 Researcher training

NERI contributes to research-based education within NERI's competence areas through teaching and MSc and PhD supervision. As the national environmental research centre NERI does not carry out research-based education as a core activity, but nevertheless contributes significantly to researcher training.

The strategic goals for NERI's educational activities during the period 2008–2012 are:

- **NERI shall develop researcher training within the AU context through international networks and cooperation aimed at applied research.**
- **NERI shall ensure education and recruitment to the environmental sector with special focus on researcher training**
- **NERI shall establish structures for and cooperation about researcher training in AU.**

Strategic indicators:

- Researcher training is integrated in the strategic research: NERI sets goals for the amount of PhD activity
- Researcher training has international dimensions: NERI connects PhD projects to international research projects
- Researcher training is formalized in cooperation with AU: NERI cooperates on researcher training with all relevant AU faculties
- Researcher training is of a high standard: NERI has qualified supervisors
- Recruitment to researcher training is high: NERI contributes to teaching and supervision of students at BSc and MSc levels in connection with applied research projects.

3.1.5 Communication and knowledge and technology transfer

NERI's communication and knowledge and technology transfer activities are the key to enabling society to utilize NERI's research findings. NERI communicates the most important results of its work and thereby helps raise awareness of NERI and AU locally, nationally and internationally. NERI contributes to the strengthening of cooperation between the public and private sectors on commercialization at both national and international levels through its membership of the National Network for Technology Transfer.

The strategic goals for NERI's communication and knowledge and technology transfer activities during the period 2008–2012 are:

- **NERI shall be a key source of information on nature and the environment for the general public and opinion makers**
- **NERI shall rank among the best research institutions in Denmark as regards communication**
- **NERI shall promote knowledge and technology transfer to society and business through cooperation with the AU Techtrans and Innovation Service (TTIS).**

Strategic indicators:

- The communication activities are integrated in the research: NERI sets goals for communication via media and popular science books
- The communication activities support knowledge and technology transfer: The communication activities present research-based proposals for solving problems in the environment and nature area.
- NERI promotes knowledge and technology transfer: NERI collaborates with TTIS on campaigns and scouting aimed at identifying potentially patentable discoveries in ongoing research projects
- NERI focuses on business collaboration: NERI follows the development via annual statistics prepared by the National Network for Technology Transfer.

3.2. Internal support

As a research institution focussing on commissioned research and accomplishing specific tasks, NERI's organization is characterized by an unambiguous management structure and clear goal-oriented project management. Daily management of the economy and staff is delegated out so as to ensure the greatest possible decision-making authority among those directly responsible for ensuring that NERI's various tasks are accomplished.

The strategic goals for internal support during the period 2008–2012 are:

- **NERI shall through management ensure the necessary prioritization and development of NERI's competence areas**

- **NERI shall have an infrastructure and research facilities that continually support the scientific and technological development of NERI's competence areas**
- **NERI's core activities are to be focussed through effective administrative service functions and IT-supported services**
- **NERI shall through structured division of labour provide employees with the possibility to prioritize, focus and develop**
- **NERI shall utilize and develop competences and qualifications within the organization in a crosscutting manner.**

Strategic indicators:

- NERI's management is qualified: All NERI's managers set development goals for their management competences
- NERI's physical facilities and infrastructure are up-to-date: All departments draw up investment plans and goals
- NERI's service functions are effective: All administrative tasks relating to the core activities are backed up by high-availability, standardized, crosscutting service functions and effective IT services
- NERI maintains effective and professional support and service: Structured division of labour is ensured by regular evaluation of the division of labour within NERI's departments and between the departments and the administration so that the individual employee is ensured the best possible preconditions for resolving administrative and scientific tasks
- NERI employees are highly qualified within their competence area: All employees undergo competence development pertinent to the tasks at hand
- NERI employees are focussed and challenged as regards ability, interests and capacity: Satisfaction surveys show a high degree of employee satisfaction.

3.3. Priorities

The strategic challenges entail a special need to focus on recruitment and retention, internationalization, accreditation and branding.

The strategic goals for priorities during the period 2008–2012 are:

- **NERI shall be an attractive workplace with an international outlook**
- **NERI shall retain and recruit the best research talents by establishing the necessary number of postdoctoral and researcher positions**
- **NERI shall ensure innovative and competitive research environments**
- **NERI's research-based consultancy activities shall be quality assured, possibly through accreditation**
- **NERI's role as the national environmental research centre is to be branded.**

Strategic indicators:

- NERI recruits and retains qualified employees: All departments recruit from both national and international circles

- NERI is an internationally attractive workplace: All functions in NERI ensure that international employees consider NERI to be an attractive workplace, both professionally and socially
- NERI has a high success rate in obtaining competition-based research funding: All departments apply for competition-based research funding both nationally and internationally
- NERI's research-based consultancy activities are quality assured: NERI establishes quality systems in collaboration with other research institutions
- NERI's visibility is high, and NERI is recognized as Denmark's national environmental research centre: All departments incorporate communication activities into accomplishment of the tasks.

4. Competence areas

NERI has eight core competence areas and accords importance to ensuring that these are interlinked in a crosscutting multidisciplinary manner as this is vital for successful comprehension and management of what are often complex environmental issues.

4.1. Core competences

The strategic knowledge requirements for NERI's various competence areas for the period 2008–2012 are outlined below.

4.1.1 Marine ecology

The Department of Marine Ecology's competence centres around the structure and function of marine ecosystems with a view to elucidating their interaction with hydrographic conditions and anthropogenic pressures, both globally (climate change) and nationally (e.g. the effects of the Action Plan on the Aquatic Environment). The research encompasses the development, calibration and validation of models that can be used as tools for syntheses and scenarios. Finally, the department also focuses on the effects of hazardous substances of anthropogenic origin on ecological conditions in the marine environment. The department is involved in the development of The Danish Nature and Environment Portal and is internationally engaged in the Baltic Nest Institute, which develops management models, collects data, carries out analyses and draws up forecasts and scenarios at habitat and ecosystem level for the Baltic Sea for use by environmental authorities and administrations in the implementation of EU directives, etc.

Strategic knowledge requirements for the period 2008–2012:

- Research and development regarding models describing the relationships between physical, chemical and biological conditions in the marine environment
- Climatic effects in the arctic and Danish marine waters
- Monitoring of the marine environment, including strengthening the scientific basis for implementation of relevant EU directives
- Development and use of databases and management models for marine habitats and ecosystems.

4.1.2 Atmospheric environment

The Department of Atmospheric Environment is the national information centre for atmospheric measurements and modelling. The competences encompass measurement of organic and inorganic chemical substances in the air, particles, water and biological samples. The department possesses modern analysis facilities and runs the national atmospheric monitoring programme under the National Monitoring and Assessment Programme for the Aquatic and Terrestrial Environments (abbreviation in Danish: NOVANA). The department's air pollution models cover the whole geographical spectrum from global to local with a high temporal and spatial resolution. The models describe and include the most important physical/chemical processes and encompass both gasses and particles. Measurements and models are used for mutual verification and validation in connection with so-called Integrated Monitoring, which provides high geographical resolution, a greater understanding of the controlling processes and information on the contribution from various sources and types of source. The models are also used for forecasts and monitoring, assessments and scenario calculations and as decision support tools.

Strategic knowledge requirements for the period 2008–2012:

- Relationships between changes in emissions, air pollution and climate change, including historical and future changes in relation to the Arctic
- The effect of new emissions associated with the use of hydrogen technology and biogenic fuels
- The effect of new emission-limiting measures on national and European air quality
- The regional and global airborne transport and deposition of new hazardous substances, including exposure and effects on health
- Coupling between air pollution and the nitrogen cycle, including the significance of continued nitrogen deposition for the quality of terrestrial and aquatic environments
- The occurrence, formation and composition and national and international sources of harmful particulate fractions
- Coupling of atmospheric models with impact and consequence models within health, nature and ecosystems, and with economic analyses.

4.1.3 Freshwater ecology

The Department of Freshwater Ecology is an internationally leading knowledge centre in the field of freshwater ecology and river basin management. The competences are centred around the structure and function of freshwater ecosystems with a view to determining how they are influenced by anthropogenic pressures. The development of methods for restoring watercourses, lakes and river valleys and for analysing measures to reduce environmental pressure from agriculture is an integral part of the department's research, as is the development of models for quantifying the effect of eutrophication, climate change, physical pressures and hazardous substances on freshwater ecosystems and for use in river basin management planning. The development of management-related models, restoration methods and measures at river basin level supports both national and international authorities with the implementation of EU directives, aquatic environment plans and action plans.

Strategic knowledge requirements for the period 2008–2012:

- Agricultural nutrient loading of the aquatic environment, including the development of models for quantifying loss, the effects of measures and the effects of eutrophication on lakes

- The effects of climate change on hydrology, loss, retention and turnover of nutrients and on ecological structure and function of watercourses and lakes
- Methods for integrated nature restoration of watercourses and river valleys, and for restoration of freshwater and brackish lakes
- Relationship between biodiversity in watercourses, lakes and river valleys and catchment characteristics, focussing on catchments of various scales
- Monitoring strategies in relation to NOVANA, EU directives, climate change and hazardous substances.

4.1.4 Wildlife ecology and biodiversity

The Department of Wildlife Ecology and Biodiversity's competences centre around research, monitoring and consultancy in relation to 1) wildlife ecology and population biology, where the build-up of knowledge about bird and mammal populations supports the consultancy work on hunting, the Birds Directive and the Habitats Directive; 2) biodiversity, in particular the use of methods and models to elucidate biological diversity. The research encompasses biodiversity patterns on various scales with a view to being able to meet the need for consultancy concerning national and international action plans and nature conservation legislation. The department is strongly anchored in the European and international research cooperation.

Strategic knowledge requirements for the period 2008–2012:

- Build-up of the knowledge foundation for wildlife management regarding mammals and terrestrial birds
- Knowledge about the effects of commercial and recreational activities on populations, especially focussing on the effects of agricultural production, technical facilities, traffic, sailing and hunting
- The knowledge foundation for conservation of biodiversity is to be expanded through analyses of biodiversity patterns on different scales and of the anthropogenic and natural factors that affect them
- Development of modelling tools for forecasting the impact of anthropogenic pressures (e.g. major facilities, land use in agriculture and forestry, and climate change) on biodiversity
- The Topic Centre for Biodiversity and Terrestrial Nature is to be expanded in cooperation with the Department of Terrestrial Ecology, including concepts for favourable conservation status and the development of indicators for climate change.

4.1.5 Terrestrial ecology

The Department Terrestrial Ecology's competences encompass the areas terrestrial ecology, ecotoxicology and risk assessment of chemicals (where the department has special competence in carrying out field experiments of the effects of pesticides on plants and insects) and laboratory experiments with soil fauna and herbivorous insects, including carrying out tests under GLP (Good Laboratory Practice). The department possesses special competence in the risk assessment of GMOs and calculation of critical loads for nitrogen deposition on vulnerable terrestrial habitat types. The department's competences also encompass genetic studies of animals and plants, plant biomarkers of pesticide effects, population models, statistical models, GIS models and the development of management-oriented decision-making tools.

Strategic knowledge requirements for the period 2008–2012:

- Ecotoxicological effects of chemicals (biocides, pharmaceuticals and pesticides) on organisms exposed to multiple stress factors, including climate change, determined through the use of new techniques
- Environmental assessment of nanotechnology products
- Effects on biodiversity caused by eutrophication, acidification, water level changes, management measures and climate change
- Quantitative effect and risk assessment of genetically modified plants
- Methods for the overall assessment of pressures on nature caused by cultivation practice in agriculture
- Development of decision support systems for sustainable food production (focussing especially on Africa and Asia).

4.1.6 Environmental chemistry and microbiology

The Department of Environmental Chemistry and Microbiology's competences in the environmental chemistry area encompass the development of new state-of-the-art methods for high-sensitivity analysis of chemical substances in complex matrices. The department has considerable experience with 1) charting the occurrence, transport and fate of persistent organic pollutants in the environment; 2) investigating hazardous substances in consumer products; and 3) developing methods for determination of the substances' availability.

In the microbiology area the department's competences encompass 1) the occurrence, dispersal, diversity and virulence of bacteria belonging to the family *Bacillus*; 2) investigation of the effects of genetically modified microorganisms and plants on natural microbial communities; 3) investigation of microbial community structure and function; and 4) dispersal of genes between bacteria in the environment.

Strategic knowledge requirements for the period 2008–2012:

- Environmental and human exposure to chemical substances, including 1) the development of new passive sampling techniques and biosensors; 2) investigation of transport across biological membranes; and 3) investigation of the relationship between exposure and toxicity
- The use of biological processes to clean up chemical pollution
- Significance of the environment for the occurrence, development and spread of infectious diseases in animals and man, including 1) the function of pathogens in the environment and interactions between pathogens and micro-, meso- and macrofauna and plants; 2) the spread of pathogenic microorganisms and their characteristics in the environment; and 3) the development of methods for cultivating hard-to-culture bacteria with a view to identifying new opportunistic pathogens.

4.1.7 Policy analysis

The Department of Policy Analysis focuses on integrated analyses of the interplay between environmental conditions and society's activities. The theoretical background for the integrated analyses is environmental policy and recognition that the development of solutions to environmental prob-

lems has to be based not only on knowledge of the environmental problems, but also on an understanding of the interplay between society's activities and the state of the environment. Integrated analysis combines, interprets and communicates knowledge from various scientific disciplines in such a manner that the whole chain of causes and effects pertaining to a particular problem is assessed in a holistic manner, while ensuring that the result is directly useful to decision makers. Taking a crosscutting and problem-oriented approach the department works to develop the methodological basis for integrated analyses, i.e. environmental economics, environmental sociology, environmental geography, risk analysis, environmental reporting, environmental indicators and analyses of atmospheric emissions. The department's competences, scientific activities and strategic goals fall into three main areas: 1) environmental reporting and emissions; 2) sociological analysis of environmental issues; and 3) pressures on the environment – spatial and temporal analyses.

Strategic knowledge requirements for the period 2008–2012:

- Emission models for use in calculating and forecasting Danish emissions and assessing Danish obligations in the atmospheric emissions area
- Concepts and methods for reporting trends in the state of the environment, including environmental indicators, forecasts and scenarios that can contribute to the need for information in relation to environmental policy initiatives
- The foundation and methods for environmental economics analyses and evaluation of measures, including economic assessment of environmental measures, environmental regulation and nature management
- The internal dynamics of societal systems and the actions and attitudes of the population and institutions in relation to environmental issues, including the significance of communication and dialogue about them. A key element is to describe the potential for change in practice
- Geographically based analyses of environmental pressures and effects on the environment, nature and the landscape, and the development of GIS-based methods for integrated environmental planning
- Scenario methods for assessing the significance of societal development for the environment and nature, and methods for analysing risk scenarios.

4.1.8 Arctic environment

The Department of Arctic Environment is responsible for researching and monitoring contaminant levels and effects in the arctic environment and contaminant exposure among the population of Greenland. The effects of climate change are monitored and analysed at ecosystem level in High Arctic and Low Arctic regions of Greenland. The competences are employed in an interdisciplinary context focussing on modelling the combined effects at ecosystem level in order to contribute to circumpolar initiatives to protect the arctic environment. The department is responsible for providing environmental advice to the Greenland Home Rule regarding raw materials and nature management. The department's competence in the field of marine mammal ecology and migratory patterns, including assessment of the animals' sensitivity to man's activities, supports the national action plans for seals and harbour porpoises, as well as implementation of the Habitats Directive.

Strategic knowledge requirements for the period 2008–2012:

- The effects of climate change on the arctic ecosystems and hence on the conditions for human existence

- Effects on the environment and nature in connection with raw materials extraction and the development of tools for identifying particularly vulnerable natural habitats
- Effects of pollutants (including hazardous substances derived from transboundary transport) on animals and man
- Anthropogenic pressures on marine mammals and the description of their population structure, ecology and migratory routes as the basis for improved management.

4.2. Crosscutting themes

The crosscutting themes for the period 2008–2012 are: Climate, biodiversity, energy and environment, environment and health, and state-of-the-environment assessments and management models.

4.2.1 Climate

Changes in our climate will have a number of effects on nature and the environment in Denmark. Among the most important are increases in temperature, sea level and precipitation and an increase in the frequency of extreme weather phenomena. Among other things, these changes will influence nutrient cycles, including atmospheric deposition, leaching, etc. The extinction and migration of individual species can thus be expected, as can effects on ecosystem structure and function. In relation to both the national monitoring and assessment programme NOVANA and the arctic monitoring programme, there is a general need for an interdisciplinary scientific approach to identify suitable indicators and develop methods to enable differentiation between the effects of anthropogenic pressures and a slowly developing change in climate. Regular monitoring based on appropriate key indicators and expansion of the research into the driving processes and the interplay between the factors affecting ecosystem development are a precondition for being able to document a climatic effect at the national and international levels. Only on that basis can steps be taken to counteract the undesirable effects of climate change or exploit its possible beneficial effects for society. In an international perspective there is a general need for an interdisciplinary scientific approach in the climate area to undertake comparative studies on comparable ecosystems/habitats having the same climatic background. Moreover, more attention needs to be accorded to particularly vulnerable ecosystems (e.g. internationally protected water bodies and terrestrial habitat types) where changes in water level, salinity, nutrient loading, disturbance, etc. will result in more pronounced changes in their structure and nutrient turnover, thereby affecting the possibility to comply with the international objectives for their environmental and/or conservation status.

The effects of climate change on nature and the environment have consequences for various sectors of society (e.g. agriculture, nature management, forestry and fishery), thereby necessitating adaptation. Climate adaptation research has to be based on assessments and models of future climatic trends and the expected climatic effects. Due to the interdisciplinary nature of the issue and the fact that climate research encompasses a number of different research fields, the research efforts are coordinated across departmental boundaries. In addition, there is a need for the development of economic analysis tools to serve as a basis for prioritization of society's efforts to limit greenhouse gas emissions, manage the environment and adapt to climate change.

As regards the Arctic, the interdisciplinary approach will provide valuable new knowledge about the effects of climate change on the transport of harmful and hazardous pollutants to the Arctic, on the distribution of the sea ice and on the exploitation of marine resources, in particular for fishery and oil extraction. It will also make a valuable contribution to understanding of the effects of cli-

mate change on the structure and function of terrestrial ecosystems and feedback to the global climate. Moreover, it will also elucidate the effect of climate change on arctic societies, which are highly dependent on natural resources. Comprehensive, interdisciplinary strategic research that is primarily founded on a detailed understanding of the interplay between climatic, biological, geophysical and anthropological factors in the arctic landscape is a precondition for being able to provide a qualified scientific assessment and integrated consultancy regarding the effects of the climate on the environment and society in the Arctic.

NERI will be responsible for the national coordination unit for climate adaptation research, which is being established as part of the government's climate adaptation strategy. Moreover, NERI plays a special role in contributing to coordination of all University of Aarhus interests in the climate area. All NERI departments will be scientifically, strategically and organizationally involved in both tasks.

Strategic knowledge requirements for the period 2008–2012:

- A research-based foundation for decision making in the climate adaptation area within relevant sectors of society
- Development of economic models as a decision-making foundation for societal adaptation to climate change
- Identification of appropriate indicators for describing and quantifying the effect of climate in the national monitoring and assessment programme NOVANA
- Development of models for the effects of climate change on animal and plant survival and migration and on invasion of Danish ecosystems by new species
- Effects and consequences of temperature increases on oxygen deficit and nutrient loading of Danish marine waters and the Baltic Sea
- Development and application of global and regional models of marine currents and the atmosphere, and studies of circulation patterns and dynamics of carbon dioxide, particles and ozone
- Analysis of marine food chains as a function of changes in the ice cover in the Arctic
- Development and application of fjord models along the coast of Greenland
- Determination of the effects of climate change on the structure and function of arctic terrestrial ecosystems and feedback to the global climate, including biogenic emissions
- Adaptation of methods and tools used in strategic environmental planning and management in order to incorporate long-term climatic considerations into environmental assessments (SEA, SIA), cost-benefit analyses, multicriteria analyses and scenario analyses
- Establishment of long-term scenarios that take into account marked structural and technological changes and changes in attitudes associated with the climate issue as compared with the present situation
- Analyses and investigations that elucidate attitudes and practices and their origins, as well as analyses of how attitudes and practices can be addressed in relation to the climate issue.

4.2.2 Biodiversity

That Europe is densely populated and highly industrialized places great demands on management of our natural resources. Local and transboundary pollution, global climate change, hydrological changes and habitat fragmentation cause changes in biodiversity. Climate change entails an enhanced risk of local extinction and immigration of species with potentially invasive characteristics. Conversely, conservation measures aimed at preservation of favourable conservation status and

protection of small and vulnerable populations will benefit biodiversity. The challenge lies in differentiating and quantifying the pressures and developing indicators and criteria for favourable conservation status for species and habitats such that the authorities have an unambiguous basis for drawing up regulatory measures. The management of biodiversity is not solely a national responsibility, but has to be seen in a larger European context where nature management is increasingly interbound through the Habitats Directive, the Water Framework Directive, the Birds Directive, etc.

Interdisciplinary research is needed to provide new knowledge about the significance of abiotic factors for biodiversity at various geographic scales with a view to quantifying changes in biodiversity caused by eutrophication, acidification, water level changes and various management measures. This entails 1) the development of modelling tools at both large and small spatial and temporal scales with a view to being able to follow and forecast the effects on biodiversity of exploitation of the landscape by the various sectors of society; 2) greater focus on the interplay of abiotic and biotic factors across boundaries in nature, for example between watercourses and river valleys or between the cultivated and non-cultivated landscape; 3) expansion of the scientific knowledge foundation for calculating critical loads for terrestrial natural habitats; 4) development of forecasts of the vulnerability of species and natural habitats to expected climate change under different management measures; and 5) development of a common norm for classifying ecological quality of inland and marine waters.

In the European context, attention is presently focused on data harmonization and the development of computer-based tools for analysing large amounts of biodiversity data in order to obtain an adequate insight into the spatial and temporal development of European nature for use as the knowledge foundation for developing optimal management strategies for protection of biodiversity and ecosystems at the European scale.

The national monitoring and assessment programme NOVANA provides a wealth of valuable data about both terrestrial and aquatic ecosystems and species that can be utilized in national and international management at a level that has not previously been possible. An interdisciplinary approach will contribute to the development of management tools that can help strengthen and focus the monitoring undertaken pursuant to the Habitats Directive and the Water Framework Directive and identify new measures for safeguarding and improving the status of the NATURA 2000 sites.

Strategic knowledge requirements for the period 2008–2012:

- Knowledge of the occurrence of invasive species in the marine waters around Denmark and their significance for the structure and function of the marine ecosystems
- An improved knowledge foundation for nature restoration in marine waters aimed at re-establishing plants and animals
- Development of knowledge-based nature management based on large data sets, quantitative analyses and advanced information technology in cooperation with the European LIFE WATCH research infrastructure project
- Establishment of methods and models for calculating critical loads and limits for pressures on terrestrial habitats from nitrogen deposition, water level changes and disturbances
- Development of soil quality indicators based on the species composition of soil organisms
- Development of biodiversity indicators at national, landscape and habitat levels
- Development of concepts for the integration and balancing of management considerations among the Habitats Directive, the Birds Directive and the Water Framework Directive

- An up-to-date knowledge foundation for calculating the economic and spatial consequences of various policy initiatives and measures on the nature and environment fronts
- Establishment of procedures for involving citizens and stakeholders in nature management.

4.2.3 Energy and environment

Risk assessment of new forms of energy necessitates a greater understanding of all links in the chain from production of fuels, emissions, processes in the atmosphere to effects on man and the environment in order to be able to develop good models for atmospheric/physical processes, for example in connection with increased use of hydrogen technology and new fuels in the transport sector.

This crosscutting theme will elucidate the consequences for the environment and human health of the use of different forms of energy (hydrogen technology, biomass, fossil fuels and renewable energy). This will contribute to the development of transport models (atmosphere) and consequence assessments in connection with societal development and means of regulation (traffic, biomass combustion, biofuels, transboundary transport, environmental zones, filters, wood burning stoves, etc.).

Strategic knowledge requirements for the period 2008–2012:

- Improved models for describing geographic distribution of atmospheric emissions from different sectors (agriculture, traffic, industry, etc.), including prognoses and consequence assessments of atmospheric emissions with the focus on greenhouse gasses
- Development of concepts for integrating and weighing up consideration for increased use of sustainable/renewable forms of energy and for nature management
- Improved knowledge foundation for assessing the environmental and health consequences of the use of biofuels (emissions and formation of particulates)
- Analyses of the social competences, norms and routines that together with the technologies present in homes determine household energy consumption
- Development of new technology for producing bioethanol from marine macroalgae.

4.2.4 Environment and health

Each year more than 100,000 chemical substances are used in the EU that could potentially be released into the environment. New substances are continually being added, moreover. The effects of these substances on man and the environment are only adequately known in fewer than 1,000 cases. As regards the effects of the substances in combination, our present knowledge is completely inadequate. The substances are used as intermediary products in industry or are present in products in the homes of individual consumers. In addition, a large number of organic substances are formed during combustion or during various degradation processes in the environment. In other words, man, animals and plants are exposed to a large number of man-made chemical substances either through direct contact, through food intake, through the air or through biological processes. Some of the substances are suspected of interfering with hormone production or fertility, or causing allergy, but with most of the substances we know very little about their unintended effects on man, animals and the other components of the ecosystems.

As much as a third of all deaths in the world are attributable to infectious diseases. Worldwide there has been an explosive increase in the number of cases of illness caused by bacteria that were previously only rarely responsible for infections. These “new” infectious diseases are caused by bacteria such as *Camphylobacter* and *Legionella*. Many “disease genes” are found in a large number of non-pathogenic bacteria present in the environment. This suggests that these genes are not only of significance in connection with infectious diseases, but also play an important role in the survival and activity of the bacteria in the environment. The environment is thus not only a reservoir of pathogenic microorganisms, but probably also a “fitness centre” where new potentially pathogenic bacteria develop. At the same time, antibiotic resistance is expected to comprise an increasing medical threat over the next decade.

This crosscutting theme in the chemicals area will focus on the development and use of new methods for risk assessment that incorporate knowledge about the magnitude of human and environmental exposure to these substances. There is a great scientific need to develop methods and models that can take into account coupling between the effect of multiple stress factors and exposure to mixtures of chemical substances, e.g. biocides, pharmaceuticals and pesticides. In addition, there is a need for strategic research focussing on the development and use of state-of-the-art methods for determining exposure to apolar and polar chemical substances and nanoparticles in relevant matrices such as soil, water, biota, foods and consumer products.

As regards air pollution, there is a special need for a greater understanding of the relationship between air quality (particles, gasses, odour, allergens and microorganisms) and health through research into human exposure to air pollution and assessment of the possibilities for reducing this exposure.

The many combinations of factors in daily life (emissions, exposure, mixtures of substances and sensitivity to their effects) that influence the pressure on population groups or ecosystems necessitate prioritization of the efforts. Of key importance is the development of methods to identify the most serious so-called high-risk scenarios in an intelligent, reproducible and transparent manner through the development and application of scenario models as a management-oriented decision-making tool.

The aim of an interdisciplinary approach is to 1) strengthen the knowledge foundation for assessing the risk of chemical substances to man and the environment, among other things in connection with the EU chemicals regulation REACH; 2) elucidate the health effects of human exposure to airborne hazardous substances with a view to societal development and means of regulation, for example within the transport and energy sectors, and assessment of the environmental and health effects of a number of often persistent hazardous substances. Knowledge of emission and concentration levels, exposure and effects of acidifying substances is necessary in order to be able to introduce specific legislation and behaviour-regulating measures aimed at minimizing human and environmental exposure to these substances.

As regards pathogenic microorganisms, there is a great need for knowledge about their natural history, i.e. their ecology, niche exploitation and interactions across the boundaries of trophic levels. Such knowledge is vital for our understanding of the mechanisms behind the development and spread of infectious diseases in animals and man.

Strategic knowledge requirements for the period 2008–2012:

- Significance of important hazardous substances in marine food chains, mass balances of hazardous substances and risk assessment
- Development of methods for integrated analysis of the impact of the environment on public health (interplay between risk assessment, economic analyses and sociological analyses and development in society's policies and activities)
- The environment as a proxy for health effects. Identification of areas where monitoring data for environmental pressures can be used as early warning indicators of health effects
- Identification of exposure pathways for chemicals from the environment to the population, including the accumulation of persistent organic pollutants in man, the occurrence of chemicals in consumer products and assessment of environment-related and health-related exposure to combinations of chemicals, including particulates
- Development of new state-of-the-art methods for determining the availability of apolar and polar chemical substances in relevant matrices (soil, water, biota, foods and consumer products) with a view to assessing exposure and toxicity
- Identification of exposure pathways for microorganisms from the environment to the population, including the occurrence of pathogenic and/or antibiotic-resistant microorganisms in the environment.

4.2.5 State-of-the-environment assessment and management models

The management of environmental problems necessitates the development of models able to provide realistic scenarios for the effect on nature, the environment and health of such factors as climate change, atmospheric emissions of pollutants, nutrient loading of the aquatic environment, transport of environmental toxins to the Arctic and developments in the transport and energy sectors. Environmental policy is planned on the basis of models for calculating the effects of the environmental policy measures on the state of the environment. It also necessitates a research-based knowledge foundation for performing economic assessments of environmental measures, environmental regulation and nature management with a view to prioritization in the aquatic, nature and atmosphere areas based on the desire to ensure “most environment for the money”.

This crosscutting theme focuses on 1) the need for research into physical, chemical and biological processes of relevance to modelling of the interplay between pressure on the environment and the state of the environment; 2) development of model concepts and statistical and mathematical tools for use in developing models for describing the very complicated processes that control the way nature develops and the interplay with the societal processes that affect the environment. This is of relevance in NERI's marine research, biodiversity research, freshwater and groundwater research, atmospheric research and terrestrial nature and environment research. Finally, there is a need for research that couples economics and natural science and further incorporates aspects concerning sociology, regulation and environment, including environmental economics.

Strategic knowledge requirements for the period 2008–2012:

- Development and application of open source management models in ecoregions
- Development and application of ecological and economic management models
- Development and application of environmental and fishery models for monitoring and management

- Overall economic analyses of aquatic environmental measures at the local, regional and/or national levels with a view to identifying the economically most appropriate assortment of measures/initiatives, including appropriate localization of measures
- Integrated water resource management (river basin management planning and spatial planning) focussing on the build-up of competence in relation to issues inside and outside Europe.

5. Economy

In several respects the economic perspectives for the period encompassed by the present strategy are good.

Now that the environment and climate issue is back on the political agenda, there is renewed demand for research-based public sector consultancy. Moreover, the marked growth in national public research funding (the so-called globalization fund) and international research funding (FP7) together with the expectation that cost coverage will improve both nationally and at the EU level set the scene for a growth scenario.

5.1 Income

NERI's economy from 2008 onwards is based on a block grant from the Ministry of the Environment, globalization funding from the Ministry of Science and Innovation via the University of Aarhus, and external funding for research and research-based consultancy obtained through national and international competition.

The block grant comprises a 4-year rolling contract between NERI/AU and the Ministry of the Environment. The contract stipulates that the parties enter into a strategic cooperation on the acquisition and transfer of knowledge with a view to contributing to a knowledge-based environmental policy and a research-based decision-making foundation for authorities, businesses and private individuals. The strategic cooperation encompasses research and researcher training as well as research-based monitoring, consultancy and communication.

From 2009 onwards the contract tasks can be tendered in competition after appropriate advanced notice has been given, although in such a way that the research portion of the block grant may not be reduced. Through continued competitiveness and proactive adaptation to new knowledge requirements it should be possible to preserve and even augment the economic volume of the contract between the Ministry of the Environment and NERI/AU. In several areas, moreover, it is possible to expand the circle of clients for research-based public sector consultancy at both the national (Environment Centres, other ministries, Municipalities and Regions) and international (supranational and intergovernmental bodies) levels.

With climate and climate change being high on the national and international political agendas NERI expects to increase cooperation in both the research area and the monitoring/consultancy area. The national coordination unit for climate adaptation research will be located at NERI from 1 January 2008. In this connection it is NERI's ambition to be the key link between the research and the users/customers within the relevant sectors of society, who will demand a science-based foundation for decision making.

As a part of the University of Aarhus, NERI will contribute to the marked growth in research and researcher training, and NERI will therefore participate in the University of Aarhus's obligation to accept more PhD students. In future, globalization funding in the form of new block grants to universities will thus be one of NERI's sources of income. NERI's international research profile concomitantly supports the University of Aarhus's competitiveness in relation to the future benchmarking of the universities in connection with allocation of the block grants.

5.2 Expenditure

NERI will use approx. 50% of the block grant from the Ministry of the Environment directly on specific tasks as agreed upon with the Ministry, and approx. 50% on the acquisition of basic knowledge of relevance to public sector consultancy in NERI's areas of competence. In addition, NERI will ensure that the acquisition of knowledge can be financed by research projects commissioned in national and international competition. This externally commissioned research requires joint financing, and it is therefore vital that NERI, in cooperation with the Ministry of the Environment, can maintain the apportionment of the block grant.

NERI will stick to the principle of synergy between research, monitoring, consultancy and education and communication. NERI's competence areas are therefore selected in collaboration with users and customers, and key activities in relation to these competence areas are accorded priority over more peripheral activities.

NERI must be a cost-conscious organization that efficiently utilizes resources in order to be able to maintain competitiveness during the coming strategy period, which will be one characterized by greater competition.

During the preceding strategy period NERI emphasized maintenance of the core competences, and an investment deficit accumulated that needs to be eliminated in the coming strategy period. NERI has to continually ensure that the research infrastructure is up-to-date and can support high-quality research and development. NERI must continue to be an innovative and attractive workplace that can attract and retain highly qualified employees.

The strategic economic goals for the period 2008–2012 are:

- NERI shall maintain competitiveness in relation to research-based consultancy
- NERI shall function proactively in relation to future knowledge requirements
- NERI shall expand its customer network
- NERI shall maintain a high standard of scientific research
- NERI shall be an attractive workplace.